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Economic Impact Analysis for the Final Secondary Aluminum Production National Emission Standard for Hazardous Air Pollutants

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1.0 INTRODUCTION

The purpose of this economic impact analysis (EIA) is to evaluate the economic effects of the emission control costs estimated to occur as a result of the Secondary Aluminum Production National Emission Standard for Hazardous Air Pollutants (NESHAP) applicable to the traditional secondary aluminum industry, the aluminum die casting industry, the aluminum foundry industry, and firms owning and operating aluminum sweat furnaces. The EIA was conducted for one regulatory option chosen by the United States Environmental Protection Agency (EPA) for the regulation of affected secondary aluminum facilities in the secondary aluminum industry. This analysis compares the economic impacts of the regulation to baseline industry conditions that would occur in absence of the regulation.

Section 112(d) of the Clean Air Act (CAA) lists source categories of major sources and specific area sources of hazardous air pollutants (HAP's) for which regulations must be developed. The U.S. Environmental Protection Agency (EPA) is currently preparing maximum achievable control technology (MACT) standards for emission sources in the secondary aluminum industry. For the purposes of developing the MACT standards, the secondary aluminum industry is defined to include any secondary aluminum facility that performs any of the following:

- crushing and shredding;
- thermal scrap drying;
- scrap drying/delaquering/de-coating;
- furnace operations (including melting, holding, fluxing);
- sweating; and
- dross cooling.

These secondary aluminum processes are carried out at facilities classified under several Standard Industrial Classification (SIC) codes, including SIC 3334 (primary aluminum); SIC 3341 (secondary smelting and refining of nonferrous metals); SIC 3353 (aluminum sheet, plate, and foil); and SIC 3354 (aluminum extruded products). For a more detailed discussion of the primary aluminum industry, see the EPA document entitled, *Economic Impact Analysis for the Primary Aluminum MACT*, dated March 1996.

This regulation may also impact firms producing products in SIC 3363 (aluminum die casting); SIC 3365 (aluminum foundries); and in SIC 4953 (refuse systems), SIC 5015 (motor vehicle parts-used), and SIC 5093 (scrap and waste materials) or firms owning and operating aluminum sweat furnace facilities. Table 1-1. lists industries potentially impacted by the Secondary Aluminum NESHAP with applicable SIC codes and corresponding North American Industry Classification System (NAICS) codes.

TABLE 1-1. AFFECTED INDUSTRIES WITH APPLICABLE SIC CODES AND NAICS CODES

Industry Description	Standard Industrial Classification Code	North American Industry Classification System
Primary Aluminum Production	3334	331312
Secondary Smelting and Refining of Nonferrous Metals	3341	331314
Aluminum Sheet , Plate , and Foil	3353	331315
Aluminum Extruded Products	3354	331316
Aluminum Die-Casting	3363	331521
Aluminum Foundries	3365	331524
Refuse Systems	4953	562920
Motor Vehicle Parts - Used	5015	421140
Scrap and Waste Materials	5093	421930

The purpose of this economic impact analysis is to assess the market impacts of this regulation for the secondary aluminum industry and other affected markets and entities. Chapter 2 of this report is an industry profile which contains a compilation of economic and financial data on the affected industries. Included in this profile are an identification of affected secondary aluminum facilities, a characterization of market structure, discussions of the factors that affect supply and demand, a discussion of foreign trade, a financial profile, and the quantitative data inputs for the economic impact analysis model. Chapter 3 outlines the economic methodology used in this analysis, the structure of the market model, and the process used to estimate industry supply and demand elasticities. Chapter 4 presents the control costs used in the model, the estimated emission reductions expected as a result of regulation, the cost-effectiveness of the regulatory alternative, and an estimate of the economic costs of the regulation. Chapter 5 presents the estimates of the primary impacts determined by the model, which include estimates of price, output, and industry revenue impacts. A financial impact analysis is included, as well as a discussion of the limitations of the model. Chapter 6 presents the secondary economic impacts, which are estimated quantitative impacts on the industry's labor market, foreign trade, substitute products, and regional markets. Chapter 7 specifically addresses the potential impacts of regulation on small affected firms. Lastly, Appendix A presents the results of sensitivity analyses conducted to quantify the extent to which the model results are sensitive to specific input data.

1.1 BACKGROUND

The Clean Air Act stipulates that HAP emission standards for existing sources must at least match the percentage reduction of HAPs achieved by either: (1) the best performing 12 percent of existing sources, or (2) the best 5 sources in a category or subcategory consisting of fewer than 30 sources. This minimum level of control is referred to as the MACT floor. The level of control proposed in this regulation is the MACT floor level of control. The analysis evaluates the economic impacts of the MACT floor regulatory alternative for the secondary aluminum industry (which includes secondary aluminum smelters and refiners, secondary aluminum dross reclamation facilities, aluminum die casters, aluminum foundries, and firms owning and operating sweat furnaces.)

2.0 AN INDUSTRY PROFILE OF THE SECONDARY ALUMINUM INDUSTRY

2.1 INTRODUCTION

The purpose of the industry profile is to present financial and economic data on the secondary aluminum industry to assess the economic impacts of the final MACT standards on price, output, and consumption in the secondary aluminum market, and firm-level impacts such as unemployment and plant closures. This chapter provides a broad overview of the market structure of the industry.

2.1.1 BACKGROUND

2.1.1.1 Types of Scrap

Aluminum scrap can be divided into two major categories: "new" and "old" scrap. New scrap is generated in the manufacturing of primary aluminum, semifabricated aluminum mill products, or finished industrial and consumer products. New scrap includes classifications such as borings and turnings (from machinery operations); clippings, cuttings, and other solids (from the aircraft industry, fabricators, and manufacturing plants); residues formed during the melting process (dross, skimmings, spillings, and sweepings); and obsolete or surplus products (e.g., castings and mill products). New scrap is the easiest to process because its components and alloys are known by the company performing the recovery.[1]

New scrap is further categorized as either "runaround" (also known as "home") scrap or "purchased" scrap. Runaround scrap is new scrap that is recycled by the same company that generates it; because it is used by the company that generates it, such scrap never enters the marketplace. Purchased scrap is new scrap that is imported, purchased, or processed under a toll agreement (i.e., an arrangement whereby one facility contracts with another to convert scrap, according to specifications, for a pre-set fee) by secondary smelters, aluminum product manufacturers, or others. An important consideration is that aluminum scrap recovery and consumption data do not include measures of runaround scrap because this scrap is not traded in the aluminum scrap market.

Old scrap includes any aluminum product recovered after its useful life. Major sources of old scrap are used aluminum cans and utensils, old wire and cable, obsolete aircraft, and aluminum engine and body parts from junked automobiles.

The method for processing scrap depends on the type of scrap handled. Figure 2-1 presents an overview of the methods used to process scrap aluminum.[2]

2.1.1.2 Relationship Between the Primary Aluminum and Secondary Aluminum Industries

For the purposes of this EIA, the term "primary aluminum producer" refers to any of the 12 U.S. firms that produce aluminum from alumina/bauxite.[1] It is important to note that these firms may also include secondary aluminum processes, as defined by EPA, in their plant operations. Unless otherwise noted for this EIA, the term "secondary aluminum producer" refers to those firms whose sole purpose is to process aluminum scrap into molten aluminum or aluminum ingot. Alternatively, the term "secondary aluminum industry" refers to all firms that conduct secondary aluminum processes.

The secondary and primary aluminum industries are somewhat interrelated. There is an overlap in marketing between the two segments of the industry--both in the purchasing of scrap and in the selling of processed aluminum. In processed aluminum, primaries and secondaries

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[1] Alumax, Inc. merged with Alcoa in 1998. Alcoa has also announced plans to acquire Reynolds Aluminum pending regulatory approval. The recent consolidation of firms within the primary aluminum industry has reduced the number of domestic firms from 13 to 12.

compete for molten metal sales in the deoxidizing market and in the alloy market--especially in the low-copper alloys. Because secondary aluminum is usually cheaper than primary aluminum, secondary aluminum sells first. The price of secondary aluminum is usually lower than primary aluminum due to lower production costs. Secondary production saves more than 95 percent of the energy required to produce aluminum from bauxite because secondary recovery eliminates the most electricity-intensive phases of production.[3] The two industries can also directly compete in the scrap purchasing market. However, the two industries also have a number of common differences, including:

Raw materials. The primary producer uses bauxite, secondary uses scrap.

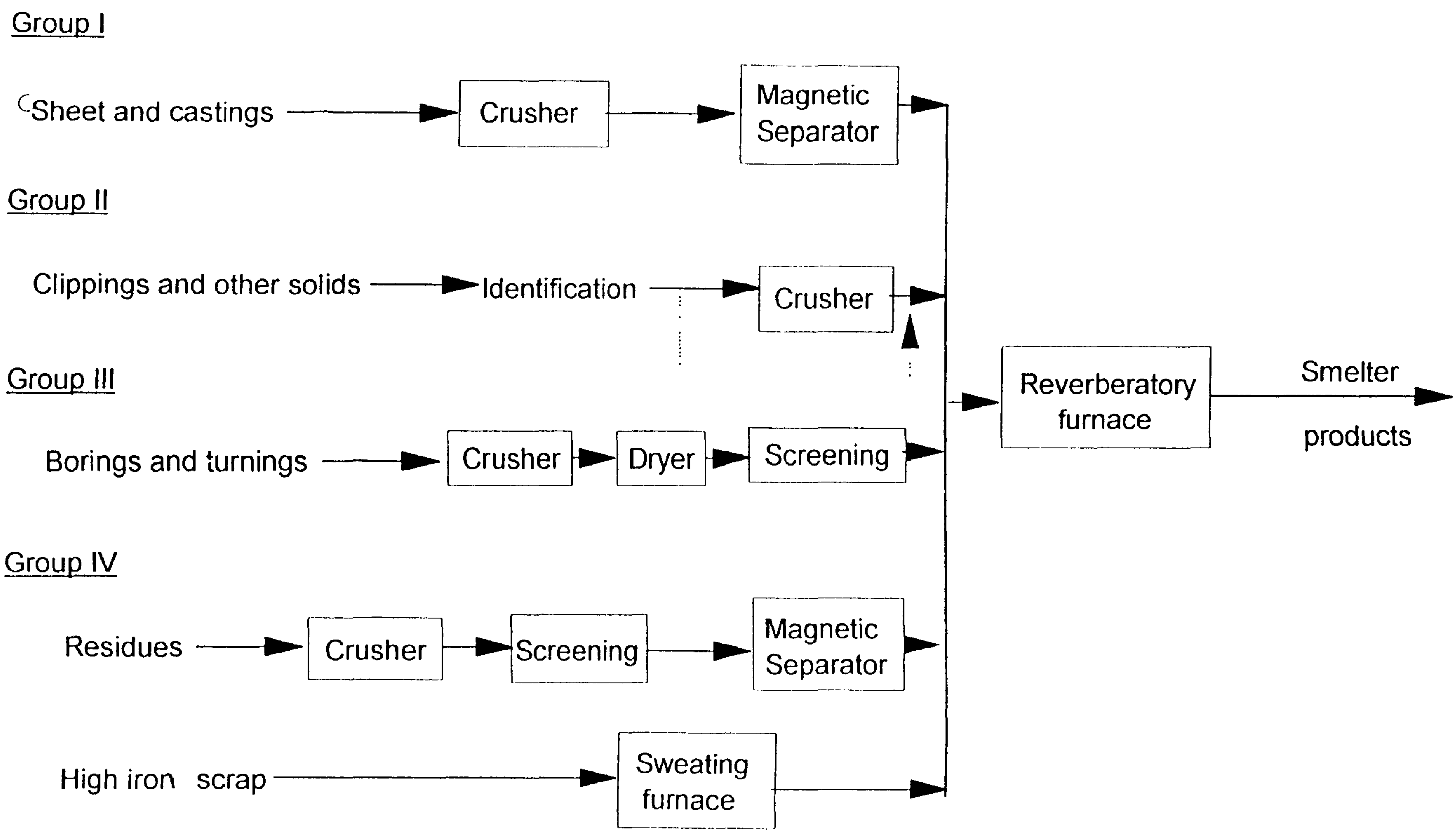
Prices. Primary and secondary prices can fluctuate somewhat independently of one another because each has different factors of production. (However, the two often move in the same direction--for instance, as primary prices go up, scrap usually becomes more expensive as well.)

Plant sites. Primaries locate near plentiful, low-cost power sources since electricity is the most expensive factor in producing primary aluminum. Secondaries cluster in areas which provide them close proximity to supplies of scrap and their customers, such as the heavily industrialized Midwestern States.[4]

2.1.1.3 Problems in Characterizing the Secondary Aluminum Industry

As defined for regulatory purposes, the secondary aluminum industry is a complex mix of firms and entities that includes both large international conglomerates, as well as small independent scrap dealers that shred aluminum cans before shipping them for further processing. Unfortunately, the wide variety and scale of entities and the high level of integration complicate efforts to compile data to characterize the industry.

FIGURE 2-1. Methods for Processing Scrap Aluminum



A second problem is that data are often not available at the level of detail desired. The economic and financial data that are often available are for the primary aluminum industry. Even though all primary aluminum firms use new scrap in the production of aluminum, for the most part, data are not available for determining what proportion, if any, of their operations are devoted to secondary aluminum processes. For example, the available data characterizing aluminum demand do not differentiate between primary and secondary aluminum sources of metal and, as previously mentioned, data that are available do not include runaround scrap consumption. (Note that hereafter, all data presented in this EIA do not include estimates of runaround scrap.) Another example of the lack of the detailed data necessary to profile the industry involves data that are provided by SIC. In SIC 3341, data do not break out aluminum operations from other secondary nonferrous metal production operations, such as copper recycling.

2.1.2 ORGANIZATION OF CHAPTER 2

Section 2.2 provides a characterization of the market structure of the secondary aluminum industry. This section describes the facilities that may be affected by the MACT standards, the distribution of production by firm, an assessment of market concentration and integration, and the most current distribution of employment by firm and facility, as permitted by the available data.

Section 2.3 focuses on the supply side of the industry, including historical data on secondary aluminum recovery. The extent to which product substitutes are available for secondary aluminum is included in this section. Foreign trade levels for the last few years are presented, as are the determinants of the supply of secondary aluminum.

Section 2.4 presents historical consumption trends and the factors that determine the level of demand for secondary aluminum. Historical price levels are also discussed in this section. However, price elasticity of demand estimates available in the literature are reported in Chapter 3 of this report.

Section 2.5 describes the financial conditions of firms in the industry. Revenue estimates are presented for two of the major sectors (SIC's 3341 and 3353) in the industry. In addition, financial data are presented for average firms in these sectors of the industry in three different states of financial health--below average, average, and above average.

Section 2.6 discusses the outlook for secondary aluminum in terms of supply, demand, and price levels. This discussion is based on a literature search for industry projections as well as an assessment of the historical industry trends presented in previous chapters. Any changes in economic conditions that may affect domestic supply and demand are identified.

2.2 MARKET STRUCTURE

An EIA requires that the facilities affected by a regulation be identified and classified by some production factor or other quantifiable characteristic. Unfortunately, consistent and complete data are unavailable to accurately characterize the firms and facilities that comprise the secondary aluminum industry. Throughout this EIA, the word "firm" refers to the company or producer, while facility or plant refers to the actual secondary aluminum processing site. Given the lack of quantifiable data characterizing the entities in the industry, this chapter provides a qualitative discussion of the industry. A brief review of the data that were collected in the Secondary Aluminum/Aluminum Processing Follow-up Information Collection Request (ICR) immediately follows the qualitative description of the industry.

The secondary aluminum industry has developed into a major market force in the domestic aluminum industry. The recycling of scrap provides a source of aluminum that not only helps the aluminum industry to maintain its growth, but also helps to conserve energy and slow the depletion of bauxite resources.[5]

Secondary aluminum is sold in a highly competitive market with numerous sellers, no one of which is large enough to influence market price.[6] For many applications, secondary aluminum is comparable to primary aluminum, however, for some applications only primary aluminum is employed. There is competition between the sectors for those grades of metal which secondary smelters can produce.

The major aluminum producers have been very astute at recognizing the trend in the secondary aluminum market and have adapted extremely well by incorporating the recycling process into their own operations. All of the major primary producers now include secondary in their total production, in addition to their primary operations. In fact, scrap recovery by primary producers has been the fastest growing component of total secondary consumption in the U.S. over the past 2 decades. Primary producers consumed nearly 50 percent of all secondary aluminum in 1992, up from 32 percent in 1980, and only 16 percent in 1970.[7]

Figure 2-2 presents the overall flow of scrap aluminum by sector. The following are the major sectors involved in the processing of scrap aluminum:[8]

- **The primary aluminum producers** are also part of the secondary industry. Unlike the secondary smelters and non-integrated producers who have to go into the market to buy scrap, primaries have a captive scrap supply, which they generate from their operations. They sometimes also purchase scrap from manufacturers that they supply.

- **Secondary smelters** are the traditional core of the secondary industry. In 1993, they consumed approximately 36 percent of all the aluminum scrap generated in the United States.

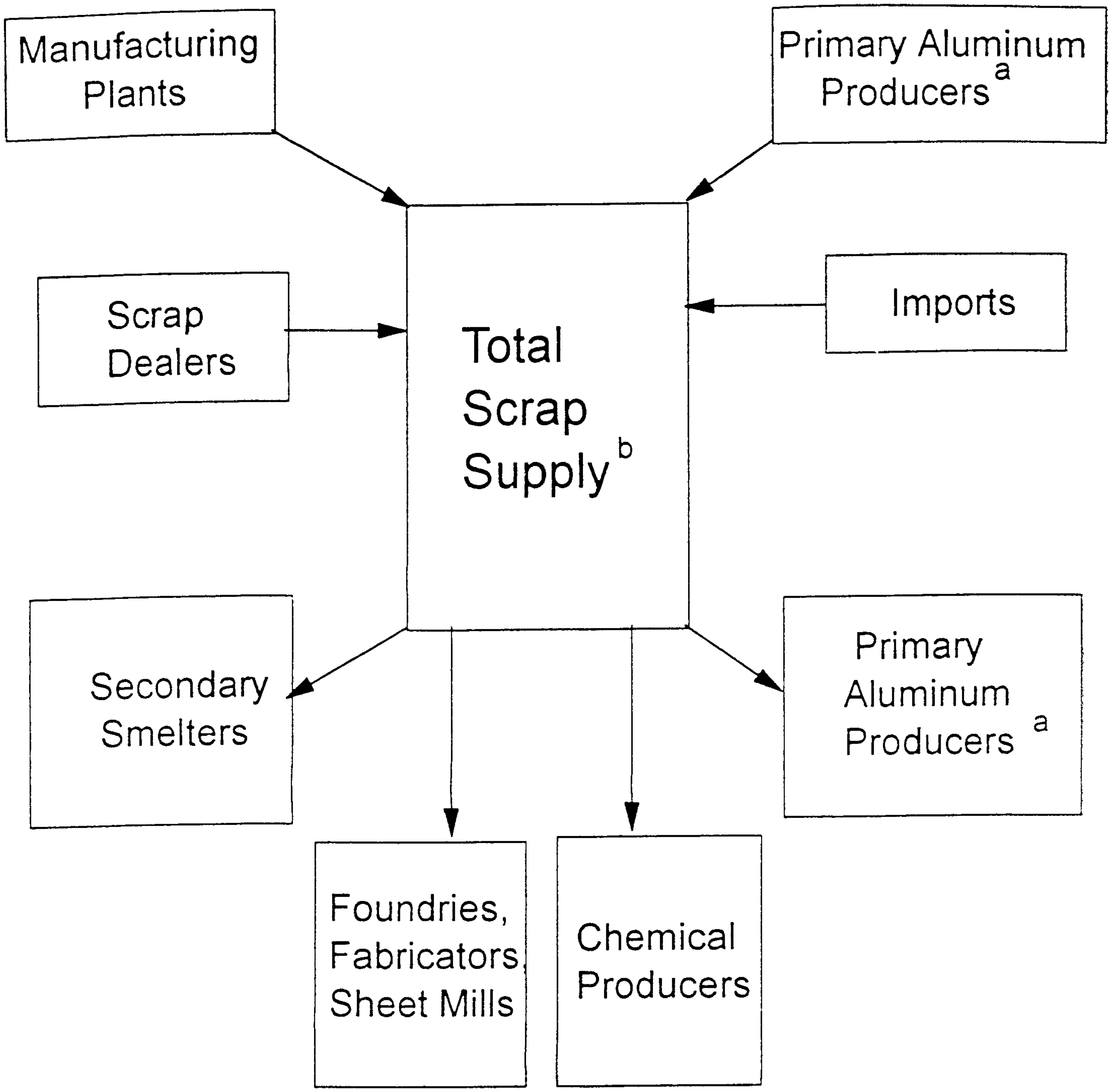
- **Non-integrated fabricators, foundries, and chemical producers** represent the second major industrial group within the secondary industry. Since they are not affiliated with the primaries, they are dependent on scrap for a good portion of their raw materials.

These entities utilized about 22 percent of the total scrap consumed in 1993.[9]

- **Dealers and brokers** are also included in the secondary aluminum industry. The dealers and brokers gather scrap from numerous sources, segregate the scrap by type, shred and bale the scrap, and ship it in truckload or carload quantities to secondaries, fabricators, or primaries.

Waste and scrap are generated at various stages during the production of primary aluminum, the manufacture of aluminum mill and foundry products, and finishing of industrial and consumer end products containing aluminum. The primary aluminum producers, aluminum foundries, and independent aluminum fabricators recycle a portion of the waste and scrap they generate. They also recycle scrap they purchase or receive on toll from others. The manufacturers of industrial and consumer products usually sell or toll their aluminum scrap to scrap dealers, to secondary smelters, or to their aluminum suppliers.

Most manufacturers do not have the space nor the time to store, segregate, and bale scrap. As a result, most scrap is gathered by dealers, who then either sell to larger dealers or segregate and bale the scrap themselves and then ship trailer loads or carloads to smelters or independent fabricators.[10] A dealer operates a collection plant in which he processes scrap received from many sources, segregates by type, cleans contaminated scrap to a commercially-usable condition, and packages it for shipment in carload or truckload quantities to an industrial consumer.[11] The dealer is the most important factor in the collection of scrap, and while there is no accurate data on what percentage of scrap moves through dealers, it is thought to be quite high.[12]



[a] For the purpose of this profile, this grouping refers to the 13 firms that produce primary aluminum from alumina/bauxite (and may conduct secondary aluminum processes at their plants as well).

[b] Does not include runaround scrap.

FIGURE 2-2. FLOW OF ALUMINUM SCRAP AND SECONDARY ALUMINUM IN THE U.S., 1991

Dealer processing may involve sweating, cleaning, shearing, cutting, and/or grading. Scrap is commonly identified according to its source. Sometimes the material is sorted as it is delivered or picked up by the dealer. For example, a scrap source may use only one alloy; or it may keep all scrap segregated, often earning a premium price or minimum quantity waiver for this service.[13]

After the scrap is processed by the dealer, it follows one of many possible routes. The aluminum may be sold to a broker who is an intermediary in the distribution process, dealing usually in large quantity transactions between any type of scrap producer and scrap consumer whether there may be a dealer, private industry, or government entities involved; or the scrap may be directly exported by either a dealer or a broker; or it may be sold by any of the foregoing directly to a scrap consumer.[14]

The 12 primary aluminum producers all participate in either the collection or utilization of new aluminum scrap. They frequently purchase scrap from their industrial customers or on a contract conversion basis.[15] Over the last decade or so, major primary aluminum producers have also operated used beverage can (UBC) recycling programs to recover the increasing amounts of old aluminum scrap that are being generated by use of aluminum containers. The tremendous increase in the amount and percentage of aluminum cans recovered in the United States over the last decade has resulted in an upsurge of secondary aluminum recovery by the primary producers.

Up until they were surpassed by the primary aluminum producers in 1987, the largest consumers of aluminum scrap reaching the marketplace were the secondary aluminum producers. Unlike scrap dealers who buy and sell many different metals, and the foundries and diecasters who cast other metals, the secondary aluminum smelter is totally dependent on one metal--aluminum. The secondary producers are entirely dependent on scrap for raw material and cannot operate without it. Because of this, scrap buyers for secondary aluminum producers occupy a position of vital importance to their companies. The secondary smelters use aluminum scrap for at least 90 percent of their raw manufacturing material.[16]

Secondaries generally purchase scrap in trailerload--30,000 pounds (lb)--and carload--40,000 lb--quantities, but some buying may even be done in truckloads of 10,000 lb. These shipments are usually mixed lots--not necessarily one type of scrap. Buying is handled through the smelter's own staff, which keep in constant contact with the market.[17]

The secondary producer does not, in general, use the most selective, higher purity aluminum scrap except as an alloy "sweetener." A dealer, who may offer these more expensive grades to primary producers, fabricators, or billet makers, risks rejection if the scrap does not conform to specifications. If rejected, it is often downgraded to a smelter's specification and a resulting lower price.[18]

Non-integrated fabricators, including foundries, extruders, chemical producers, and some sheet mills producing building products comprise the balance of the aluminum scrap consumers.[19] These sectors of the industry are the most difficult to characterize due to the lack of secondary aluminum data pertaining to their use of scrap.

2.2.1 AFFECTED FIRMS AND FACILITIES

The U.S. Department of Commerce's Bureau of the Census publishes the number of companies reporting aluminum inventory data. For December 1994 they reported that there were 12 integrated companies with inventories of scrap (i.e., primary aluminum producers, which may also produce mill products); 141 nonintegrated companies with scrap inventories (nonintegrated is defined as companies that produce mill products in the U.S. and that are not affiliated with a domestic primary ingot producer); and 25 smelters with aluminum scrap inventories (smelters are defined by the Census as companies whose aluminum facilities are exclusively devoted to producing specification ingot from scrap).[20] Comparable December 1997 domestic company estimates were 13 integrated companies, 124 nonintegrated companies, and 22 smelters with scrap inventories.[21] Information obtained from the ICR shows that there are 135 secondary smelters and secondary dross reclamation facilities that may be affected by this regulation.

The remainder of this section discusses the data that have been used in other publications to describe individual sectors--scrap dealers, aluminum die casters, aluminum foundries and secondary smelters--of the secondary aluminum industry.

2.2.1.1 Scrap Dealers

In 1985, the U.S. Bureau of Mines estimated that several hundred scrap dealers purchased and collected scrap from industrial plants as well as scrap contained in discarded industrial or commercial products, and that such scrap was then sold to the independent secondary smelters, the integrated producers, and others, including about a dozen firms that used it to produce aluminum chemicals and for other dissipative applications.[22] Also in 1985, the Aluminum Association estimated that aluminum scrap was commercially recovered from about 200 operational automobile shredders and from shredded white goods (major appliances) that were also processed in these shredders in about 20 specialized residue processing facilities in the U.S.[23]

Many scrap dealers own and operate sweating furnace and these firms may be impacted by this regulation. Sweat furnaces are units dedicated to the reclamation of aluminum from scrap materials that contain high levels of iron. Scrap dealers and brokers such as automotive scrap dealers often own and operate sweating furnaces. It is estimated that 1650 sweat furnaces may be owned and operated by businesses in the United States currently.[24] Firms owning and operating sweat furnaces are predominately small businesses and widely dispersed throughout the United States.

2.2.1.2 Aluminum Die Casting Firms

Approximately 350 die casting companies operate about 450 facilities in the United States currently. These companies produce aluminum castings under high pressure in permanent metal molds. Ninety-five percent of aluminum die castings are made from post-consumer recycled aluminum. The industry is geographically dispersed, with facilities in thirty states and high concentrations in California, New York, Pennsylvania, and the Upper Midwest. Many facilities are located in urban and residential areas. The industry was once dominated by small, family-owned shops, but these type firms account for less than one-half of the aluminum die cast production currently. Small family-owned operations have been replaced by larger operations with higher productive capacity in an effort to increase profits through economies of scale.[25]

The 1997 Economic Census provides economic data for 290 aluminum die casting companies that operate 317 establishments in the United States. The establishments are located throughout the United States with the highest concentration in California, Ohio, Illinois, Wisconsin and Indiana. The industry employed over 27,000 workers in 1997 and, over eighty percent of these were production workers.[26]

2.2.1.3 Aluminum Foundries

Foundries cast aluminum, ferrous, and other nonferrous metals into products using disposable molds constructed of sand, wax, foam, or other materials. Approximately 2500 ferrous and nonferrous foundries operate domestically. It is estimated that 1530 of these foundries process aluminum and may be affected by this regulation. Foundries are located in forty-nine states with concentrations in California and the Upper Midwest. The industry is dominated by small businesses. However, forty percent of industry production is accounted for by a small number of captive operations (foundries within larger companies).[27]

The 1997 Economic Census reports information concerning 593 aluminum foundries operating 625 establishments in the United States. These foundries are located throughout the United States with concentrations in California, Ohio, Pennsylvania, Wisconsin, Michigan, Illinois, Indiana, New York, and Texas. This industry employs over 34,000 people and over 80 percent of these employees are production workers.[28]

2.2.1.4 Secondary Smelters

The five key products included in SIC 3341 are secondary aluminum, secondary precious metals, secondary lead, secondary copper and secondary zinc. Of all the metal produced by the secondary smelting industry, secondary aluminum represented the largest product category, accounting for 38.5 percent of the industry's aggregate shipments in 1990.[29]

In the early 1970's, it was estimated that there were 72 full-time secondary aluminum smelters operating 86 plants, and thousands of small foundries that occasionally processed small quantities of scrap aluminum. At that time, the industry was dominated by small producers with 53 of the 86 plants producing less than 500 tons per month. Seventeen plants produced between 500 and 1,000 tons per month, while 13 plants produced between 1,000 and 3,000 tons per month. Only three plants produced in the range of 3,000 to 7,000 tons per month.[30] In 1982, there were 76 secondary ingot plants in operation. By 1985, this number had decreased to 69.[31] In 1992, the Aluminum Association estimated that there were 49 companies operating 68 secondary aluminum ingot plants.[32] The following section presents the geographic break-down of these plants in 1992.

2.2.2 LOCATION AND EMPLOYMENT

Because transportation costs limit the effective distance over which firms buy and sell locally, or at most regionally, there is a heavy concentration of secondary aluminum plants in areas that are near scrap supplies or consumers of secondary aluminum. A cursory look at the distribution of secondary smelters in the U.S. reveals a heavy concentration of smelters in the automotive and appliance manufacturing areas of the country.[33] Figure 2-3 presents the locations of primary and secondary smelters in the U.S.[34]

Table 2-1 presents employment data for the secondary smelting of nonferrous metals

(SIC 3341) and the aluminum plate, sheet, and foil industries (SIC 3353). For SIC 3341 (which includes non-aluminum smelting firms), a decline in employment of approximately 22 percent occurred from 1982 to 1996. During the same period, employment declined by 15 percent in the aluminum, plate, sheet, and foil industry. Although the general trend during this period is employment declines, yearly fluctuations exhibit increases and decreases in employment within these industries. In the baseline year of 1994, 14,400 workers were employed in secondary smelting of nonferrous metals and 22,200 in the aluminum plate, sheet, and foil industry.

Of the 14,400 people employed in the secondary smelting and refining industry (SIC 3341) in 1994, approximately 36 percent were salaried employees, or those performing managerial, administrative or technical duties. The balance of the industry's work force were production workers. A typical secondary smelter and refining establishment in 1992 employed 26 production workers and 9 salaried employees. In terms of the number of people employed per establishment, the secondary smelting and refining industry has been, historically, predominantly populated by relatively small manufacturing facilities.[35]

2.2.3 MARKET CONCENTRATION

U.S. Bureau of Census publishes data that characterize market concentration for SIC 3341 and SIC 3353. There does not appear to be a great amount of market concentration in SIC 3341. In 1992, the 4 largest companies in SIC 3341 accounted for 28 percent of total shipments, the 8 largest for 41 percent, the 20 largest for 60 percent, and the 50 largest for 79 percent. Figure 2-4 displays the market concentration in SIC 3341 for 1982, 1987, and 1992. Overall, there has been a slight increase in market concentration between 1982 and 1992.[36]

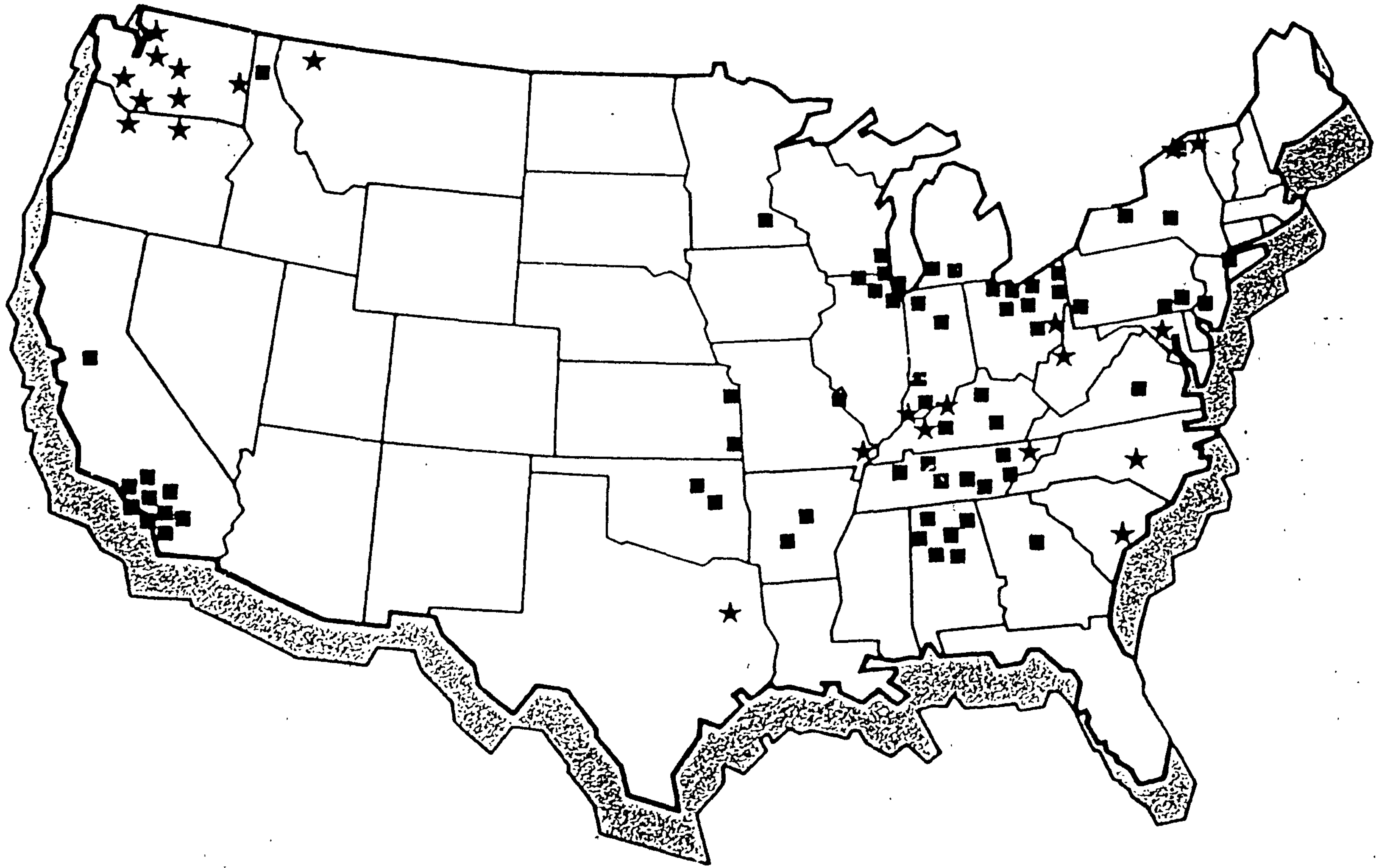
Figure 2-5 presents the 1982, 1987, and 1992 market concentration data for SIC 3353.[37] There is a substantial level of market concentration in this industry. Three major producers--Alcoa, Alcan, and Reynolds Metals -- dominate the North American aluminum industry and thus dominate the market for sheet, plate, and foil. Alcoa, Alcan, and Reynolds combined have 78 percent of the key can market that accounts for about half of all sheet, plate, and foil shipments.[38] In 1992, the 4 largest companies in this SIC accounted for 68 percent of total shipments, the 8 largest combined for 86 percent, the 20 largest for more than 99 percent, and the 50 largest for 100 percent, respectively. The concentration for the 4 largest companies decreased from 74 percent in 1987 to 68 percent in 1992; the ratio for the 8 largest companies decreased from 91 percent to 86 percent over the same period of time.

2.2.4 INTEGRATION

Integration is a measure of the control firms have over the product and factor markets for its output. Figure 2-6 presents the 1994 and 1995 gross shipments of aluminum ingot (including primary ingot) for integrated, nonintegrated, and smelting firms using the Bureau of the Census' definitions for these three terms.[39] Again, the Census defines integrated firms as companies that produce primary aluminum ingot (from alumina) and may also produce mill products; nonintegrated producers are defined to be firms that produce mill products that are not affiliated with a domestic primary ingot producer; smelters are defined as companies whose aluminum facilities are exclusively devoted to producing specification ingot from scrap. These data show

FIGURE 2-3. LOCATIONS OF PRIMARY AND SECONDARY SMELTERS IN THE U.S.

SOURCE: The Aluminum Association, Inc



★ *Primary*

■ *Secondary*

TABLE 2-1. EMPLOYMENT IN THE SECONDARY ALUMINUM INDUSTRY [40]
(Thousands)

Year	SIC 3341	SIC 3353
1982	19.2	27.8
1983	17.2	28.1
1984	17.7	26.9
1985	16.0	26.9
1986	14.6	26.7
1987	12.5	26.1
1988	13.2	26.1
1989	14.6	25.7
1990	14.7	25.1
1991	13.2	24.9
1992	13.6	24.4
1993	13.4	24.2
1994	14.4	22.2
1995	14.9	22.9
1996	15.0	23.5

FIGURE 2-4. **MARKET SHARES OF LARGEST FIRMS IN SIC 3341**

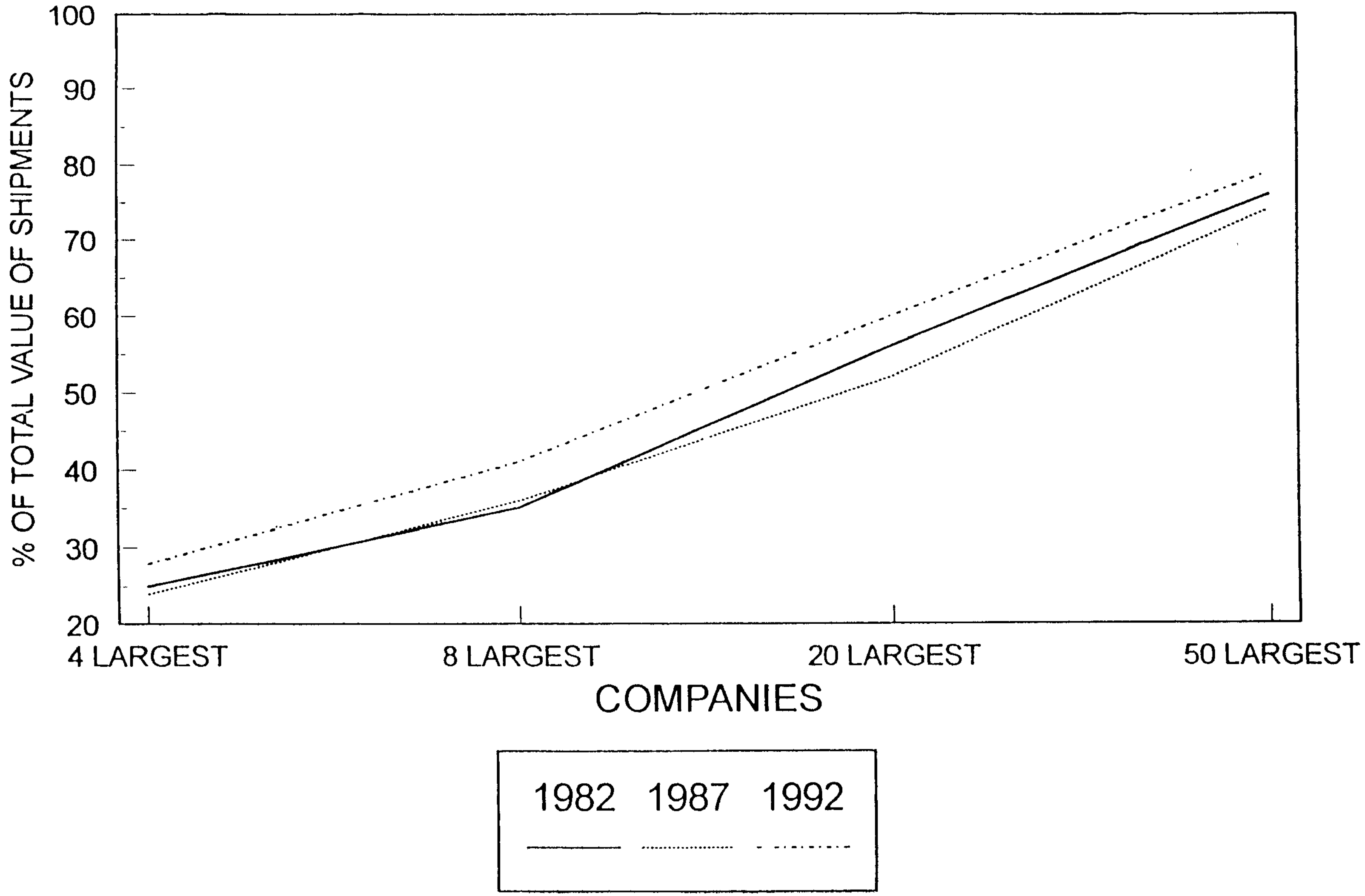
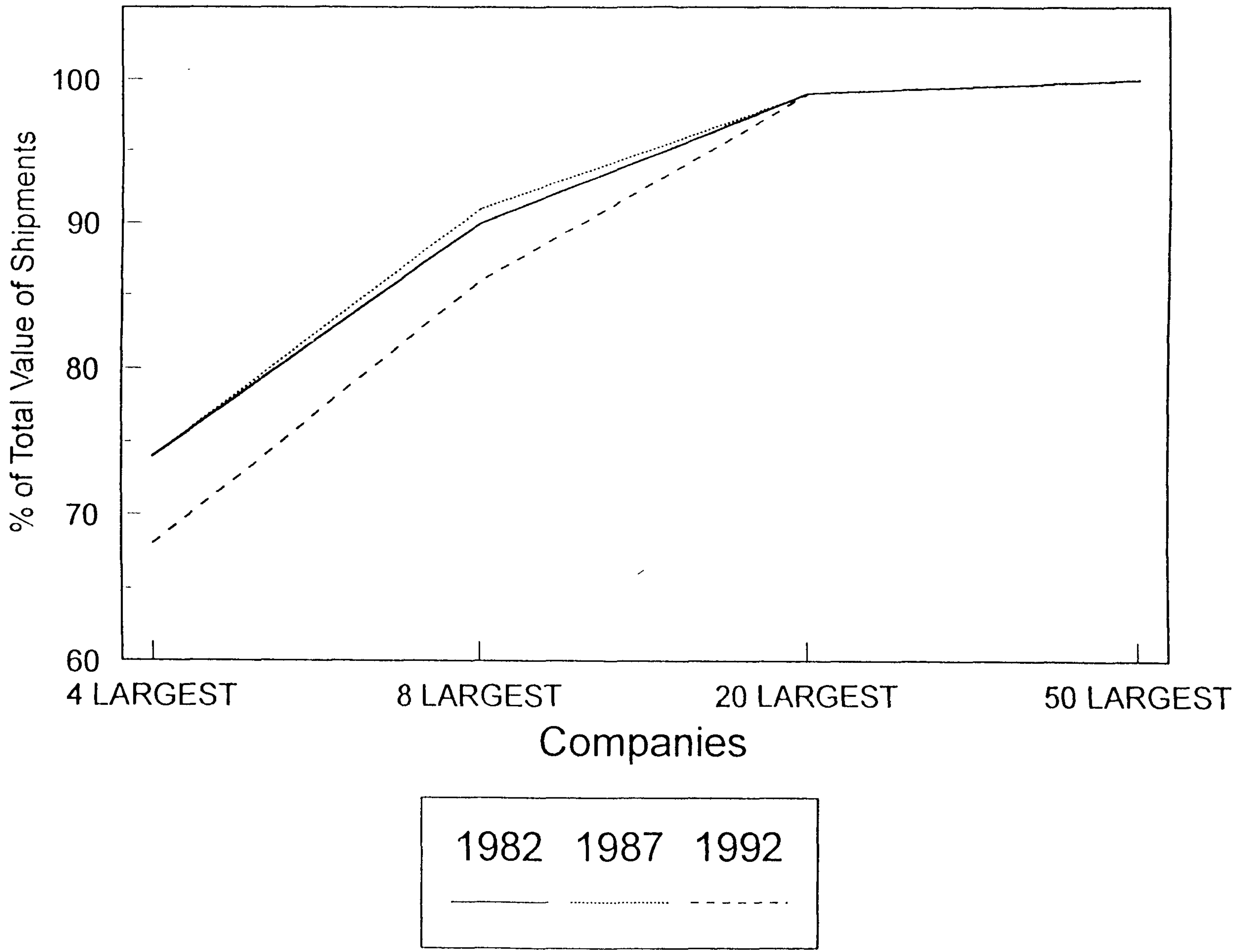


FIGURE 2-5. **MARKET SHARES OF LARGEST FIRMS IN SIC 3353**



that of the total ingot shipped in 1995, over 50 percent were from primary producers and 26 percent were from secondary producers. When compared to the 1994 data, this represents an increase in the percentage of total gross shipments of ingot by integrated producers, at the expense of nonintegrated firms. The integrated producers had the largest percentage of gross shipments prior to 1992, at which time the shipments by nonintegrated producers increased to take the lead. It is important to distinguish between vertical and horizontal integration and assess the characteristics of each with respect to the secondary aluminum industry.

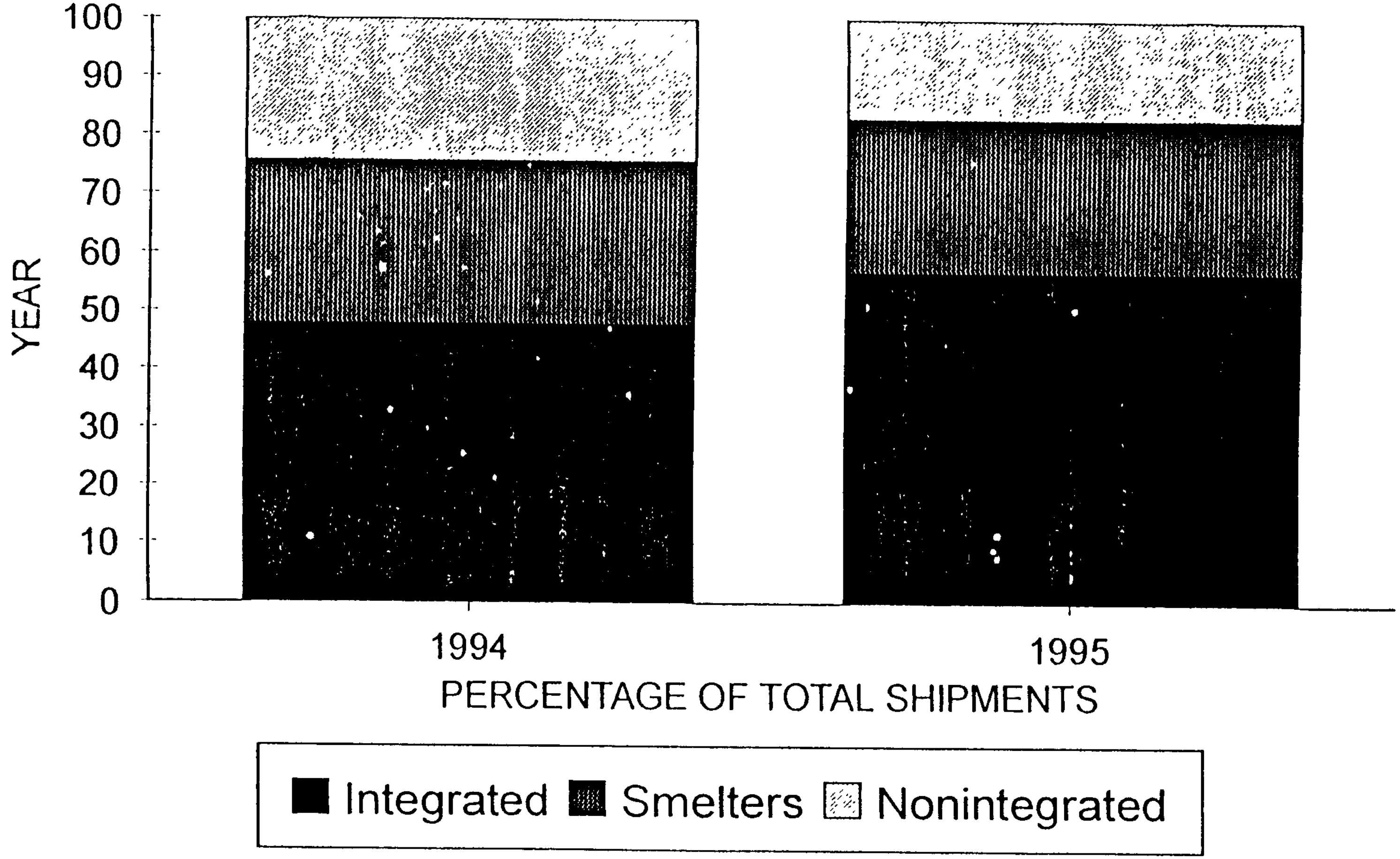
2.2.4.1 Vertical Integration

For the purposes of this EIA, a vertically integrated producer (or supplier) is a firm which either collects the scrap necessary to produce secondary aluminum (i.e., vertical integration backward to suppliers), or manufactures products using secondary aluminum as an input (i.e., vertical integration forward to product markets).

Vertical integration in the aluminum industry is extensive. It includes backward integration in the mining, refining and smelting of primary aluminum (including sheet ingot, casting ingot, and extrusion billet), and forward integration to the production of semifabricated and fabricated products downstream, including sheet, plate, and foil offerings.

It is known that primary aluminum producers run thousands of UBC collection centers throughout the U.S. It is also known that some aluminum fabricators (e.g., of can sheet metal) are integrated backward to primary aluminum producers, some of which, as mentioned above, collect UBC.

FIGURE 2-6. **GROSS SHIPMENTS OF ALUMINUM INGOT, 1994-1995**



The vast majority of secondary aluminum firms rely upon the demand for their metal from other industry's firms. This derived-demand relationship is typified by the automobile industry which is completely separate from the scrap dealer and secondary aluminum ingot producer. In fact, for aluminum automobile products, the cast aluminum producer is often times a separate entity located between the secondary aluminum industry and the final product market.

2.2.4.2 Horizontal Integration

Horizontal integration exists when a firm owns a number of different facilities, each of which functions at the same stage of the production process. Horizontal integration is common in the secondary aluminum industry. A number of companies own more than one facility. According to data from the preliminary ICR, 33 of the firms own more than one secondary aluminum facility, with Aluminum Company of America owning 18 plants, Reynolds Metals Company owning 18 plants, Alcan Aluminum owning 16 facilities, Kaiser Aluminum owning 8 plants, and Southwire Company owning 6 plants.

2.2.5 TOTAL CAPACITY

Capacity for scrap production is a matter of managing collection and installing processing equipment. Neither has very long lead times and, with the heightened importance of recycled containers, an increased proportion of aluminum scrap will be returned to production channels semiautomatically. Another portion of the scrap may require more elaborate separation equipment than heretofore--particularly that which is potentially recoverable from municipal waste streams and junked motor vehicles.[41]

2.3 PRODUCTION, SHIPMENTS, AND CAPACITY UTILIZATION

Increased costs for energy, growing concerns over the siting of waste disposal sites, and improvements in recycling technologies have provided the impetus for increased recycling rates. Additionally, some of the increase in aluminum scrap recovery can be attributed to a changing and growing end-use consumption pattern. Aluminum products developed for the construction, transportation, and electrical industries tend to have a fairly long life and are slow to enter the scrap supply stream. The emergence of the aluminum beverage can in the mid-1970's with a life cycle of 3 months has added dramatically to the scrap aluminum supply.[42]

It is estimated that over 25 percent of the total "old" aluminum scrap potentially available to the industry is recycled; on the other hand, almost 100 percent of the prompt industrial or "new" scrap is currently being recycled.[43]

2.3.1 PRODUCTION AND CAPACITY TREND

Historical data of the total supply of secondary aluminum are provided by the Aluminum Association. It is important to note that the production and capacity data reported in this section do not accurately capture captive production in the industry. Table 2-2 shows that secondary aluminum supply has maintained approximately 25 to 30 percent of total supply over the 1984-1994 period (the drop in the percentage that occurred from the early 1980's to the mid-1980's can largely be attributed to a decline in energy prices over that period, which made primary aluminum production relatively more competitive with secondary aluminum). In the 1983-1993 period, secondary recovery grew at a 6.4 percent annual rate, while primary production increased at a 1.5 percent annual rate.[44] In 1997, the percentage of secondary production relative to total rose to approximately 36.5 percent.[45] While primary production in the U.S. has increased by about 430 thousand metric tons since 1970, secondary production has increased by more than triple that amount, or 1.4 million metric tons.[46]

Table 2-3 shows that old scrap recovery, at 1,632 thousand metric tons in 1993, was up approximately 2 percent from 1992, then decreased by about 8 percent in 1994. The percentage of the total secondary supply from old scrap has increased from 46 percent in 1983 to 55 percent in 1993. Between 1993 and 1997, old scrap decreased as a percentage of total secondary supply from 55 percent to 49 percent.

From 1982 to 1993, aluminum can reclamation programs have returned over 18 billion pounds of aluminum beverage cans to the supply stream. Most of this scrap was returned to domestic primary producers for production of can sheet. To a lesser degree, UBC's have also been used by secondary aluminum producers in the manufacturing of casting alloys, and some have been exported to foreign countries for conversion there into can sheet. The large-scale aluminum can recovery programs of the major primary aluminum producers have substantially added to the rate of aluminum recycling from old scrap--UBC's share of total old scrap has doubled since 1975.[47] Can recycling has grown into a very real component of the U.S. supply picture. In 1998, 62.8 percent of the 102 billion aluminum cans produced were recycled. A total of 9.1 billion pounds of aluminum were recycled and aluminum beverage cans accounted for 2.0 billion pounds of this total. Aluminum from recycled cans and other products currently accounts for about 33 percent of the aluminum supply.[48]

Table 2-4 presents the trends in aluminum can recovery between 1983 and 1998. Over this time period, the number of aluminum cans collected each year has increased, except for a slight decline in the recovery rate of UBC's in 1991 from the previous high of almost 64 percent in 1990. Industry analysts believe that low UBC prices in 1991 caused can stockpiling by UBC collectors. The percentage of aluminum cans collected increased by more than 8 percent year-to-year in 1992 for a record high of almost 68 percent. The recovery rate was somewhat lower in 1993 through 1998 but was still above the 1991 rate except in 1995. Discussion of price trends for UBC and other types of aluminum scrap are provided in section 2.4.3.

2.3.2 COMPETITION AND SUBSTITUTES

Substitutes for aluminum include: plastics, magnesium, steel, copper, wood, titanium, graphite, paper, and fiber epoxies. Copper can replace aluminum in electrical applications;

TABLE 2-2. SECONDARY ALUMINUM SUPPLY IN RELATION TO TOTAL ALUMINUM SUPPLY: 1984-1994 and 1997 (in thousands of metric tons)[49,50]

YEAR	TOTAL SUPPLY*	SECONDARY ALUMINUM SUPPLY	RATIO OF SECONDARY ALUMINUM SUPPLY TO TOTAL
1984	7,235	1,760	0.24
1985	6,594	1,762	0.27
1986	6,655	1,773	0.27
1987	7,035	1,986	0.28
1988	7,534	2,122	0.28
1989	7,437	2,054	0.28
1990	7,863	2,393	0.30
1991	7,805	2,286	0.29
1992	8,371	2,756	0.33
1993	8,966	2,944	0.33
1994	9,514	3,080	0.32
1997	10,092	3,685	0.37

*Total supply = domestic primary production + imports of ingot and mill products + metal recovered from scrap (i.e., secondary aluminum).

TABLE 2-3. TRENDS IN SECONDARY ALUMINUM RECOVERY: 1982-1997[51,52]
(in thousands of metric tons)

YEAR	TOTAL SECONDARY RECOVERY	FROM NEW SCRAP	FROM OLD SCRAP	RATIO OF OLD SCRAP TO TOTAL
1983	1,773	953	820	0.46
1984	1,760	935	825	0.47
1985	1,762	912	850	0.48
1986	1,773	989	784	0.44
1987	1,986	1,134	852	0.43
1988	2,122	1,077	1,045	0.49
1989	2,054	1,043	1,011	0.49
1990	2,393	1,034	1,359	0.57
1991	2,286	969	1,317	0.58
1992	2,756	1,144	1.612	0.58
1993	2,944	1,312	1,632	0.55
1994	3.080	1,580	1,500	0.49
1995	3,190	1,595	1,595	0.50
1996	3,310	1,772	1,538	0.55
1997	3,690	2.177	1,513	0.49

TABLE 2-4. TRENDS IN U.S. ALUMINUM CAN RECLAMATION: 1983-1998[53]

YEAR	POUNDS OF ALUMINUM CANS COLLECTED (IN MILLIONS)	NO. OF ALUMINUM CANS COLLECTED (IN BILLIONS)	PERCENT OF ALUMINUM CANS COLLECTED[a]
1984	1,226	31.9	52.8
1985	1,245	33.1	51.0
1986	1,233	33.3	48.7
1987[b]	1,335	36.6	50.5
1988	1,505	42.5	54.6
1989	1,688	49.4	60.8
1990	1,934	55.0	63.6
1991	1,969	56.8	62.4
1992	2,142	62.7	67.9
1993	2,015	59.5	63.1
1994	2,149	64.7	65.4
1995	2,017	62.7	62.2
1996	1,969	62.8	63.5
1997	2,052	66.8	66.5
1998	1,938	64.0	62.8

[a]Based on aluminum beverage can shipment data--lagged on quarter.

[b]Beginning in 1987, UBC data includes estimates of exported can scrap.

magnesium, titanium, and steel can substitute for aluminum in construction; glass, plastics, paper, and steel can substitute for aluminum in packaging. However, substitution of one of the above materials for aluminum in an ongoing manufacturing process is seldom possible. The substitute must offer advantages in long-term costs and performance to justify the cost of change.

The strong growth of aluminum markets over the past 30 years has occurred largely at the expense of other materials. For example, aluminum has replaced a significant part of the steel and glass beverage container market; has penetrated the wood and steel markets in residential, industrial, and commercial construction; and is increasing its share in the castings markets in competition with zinc and iron. It has also replaced copper in the high-voltage transmission of electrical power. With the exception of copper, also a highly strategic commodity, aluminum could be replaced by many of the original materials should it become in short supply.[54]

The enormous strides that aluminum has made in displacing steel and other materials in the container/packaging, automotive, aerospace, and construction markets demonstrates the substantial investment the industry has made in research and development.[55]

As alluded to earlier, primary aluminum can often substitute for secondary aluminum, though usually at a higher price. However, there are applications where substitution of secondary aluminum for higher purity metal is not acceptable, such as in automobile and appliance trim applications.[56]

2.3.3 IMPORTS AND EXPORTS

Aluminum scrap is also traded in the international marketplace. Price and shipping costs usually determine whether scrap is sold in domestic or international markets. U.S. trade in aluminum scrap has grown dramatically over the past 30 years. Most of the scrap shipped into the U.S. comes from Canada. Japan has been the major recipient of U.S. scrap exports since the mid-1970's.

Table 2-5 shows that in 1990, exports of aluminum scrap began to decline after reaching a 5-year high of 586,000 metric tons in 1989. This downward trend in scrap exports continued until 1994, when there was a 30 percent increase from 214,000 metric tons to 307,000 metric tons. 1993 was the first year since 1982 that the U.S. had a trade deficit in scrap aluminum. Japan continues to be the principal destination of aluminum scrap exported, accounting for almost one-half of total 1993 exports.

As can be seen in Table 2-5, the amount of scrap that was imported rose from about 7 percent of total supply in 1984 to 12 percent in 1995. Scrap imports in 1991 decreased approximately 18 percent to 218,000 metric tons from a 1990 level of 265,000 metric tons. Imports had steadily increased over the preceding 5 years and have increased each of the 3 subsequent years. Canada remains the major scrap importer to the United States, supplying almost 58 percent of U.S. total aluminum scrap imports in 1993.[57]

According to the Aluminum Association, exports of sheet and plate rose about 7 percent in 1993 to 1.178 billion pounds; foil shipments increased approximately 17 percent to 83 million pounds. Sheet and plate imports to the U.S. in 1993 rose 8 percent to 813 million pounds. Foil imports increased 20 percent in 1993 to 61 million pounds after a decrease of 8 percent between 1991 and 1992.[58]

The United States International Trade Commission reports trade information for SIC 3341 (secondary nonferrous smelting) and 3353 (aluminum sheet, plate, and foil). Historical export and import data for these SICs for the period 1992 through 1998 are presented in Table 2-6. SIC 3341 has consistently reflected trade deficits for the period 1992 through 1998. In contrast, SIC 3353 has shown trade surpluses for the period. For the baseline year of 1994, SIC 3341 experienced a trade deficit of $746,370,000 , while SIC 3353 shows a trade surplus of $751,167,000.

TABLE 2-5. TRENDS IN ALUMINUM SCRAP FOREIGN TRADE: 1983-1995 (thousand metric tons)[59,60]

YEAR	TOTAL U.S. SCRAP CONSUMPTION[a]	IMPORTS OF SCRAP[b]	EXPORTS OF SCRAP[b]	NET EXPORTS
1984	2,010	145	258	113
1985	1.978	131	375	244
1986	1,986	165	347	182
1987	2.204	191	368	177
1988	2.348	207	487	280
1989	2,280	223	586	363
1990	2,561	265	538	273
1991	2.456	218	464	246
1992	2.960	272	298	26
1993	3.186	312	214	-98
1994	3,336	390	307	-83
1995	3.480	419	430	-11

[a]As reported (rather than as estimated).

[b]Aluminum scrap includes both scrap and dross.

TABLE 2-6. EXPORT AND IMPORT STATISTICS FOR SIC 3341 AND 3353
For the period 1992 through 1998
(Thousands of nominal dollars)

Year	SIC 3341 Secondary Nonferrous Smelting and Refining		SIC 3353 Aluminum Sheet, Plate, and Foil	
	Total Exports	General Imports	Total Exports	General Imports
1992	$9.058	$820,426	$1,365,375	$808,905
1993	12,028	702.926	1,318,023	824,503
1994	17,907	764,277	1,688,466	937.929
1995	20.484	895.331	2,362,045	1,438.353
1996	19,929	873,307	2.153,347	1.160.400
1997	25,596	1,183,903	2,481,654	1,280.850
1998	18.822	953.535	2,367,880	1,391,951

2.3.4 SUPPLY DETERMINANTS

The distinction between new and old scrap was first described in section 2.1.1.1. The amount of new scrap supplied tends to change with the changes in fabrication loss attendant from changing applications of aluminum; old scrap supply tends to vary according to the changing lifetimes of different applications, but is also responsive to prices and governmental regulation.[61]

Some in the aluminum industry believe that the recovery of aluminum cans is coming close to reaching its maximum levels. However, the companies involved in the secondary aluminum industry say that they are not about to abandon any plans for the future growth of their field, and increasingly are turning to other sources of used aluminum to sustain their successes.[62] Some believe that the increase in aluminum can recycling, which is viewed as part of a general recycling movement in this country, can spread to other aluminum products such as lawn chairs and building materials.

Many in the industry expect to see an increase in plants built to improve the scrap recovery and recycling process because the major obstacle to recovering scrap is that, except for UBC's, it usually does not come in a condition that is conducive to aluminum recovery. Often the presence of other alloys and post-production elements such as paint can make it impossible or uneconomical to recover useful aluminum. Many see that these plants will be needed in order for growth to continue in the secondary aluminum market.

In addition to the obstacles sometimes found when recovering aluminum from scrap, scrap is also subject to the effects of the free market as shown by the drop in aluminum can recycling rate between 1990 and 1991. It all boils down to competition, according to Michel Primeau, a recycling official with Alcan, one of the big three aluminum can sheet producers along with Aluminum Company of America (Alcoa) and Reynolds. "At Alcan we grab as many used cans as possible. The company that has access to the most cans has a competitive advantage."[63]

Another problem is its seasonal nature--beverage can use is slack during the winter and high during the summer. However, it is relatively easy for suppliers to stockpile scrap to offset the seasonal highs and lows.

Because most processors of aluminum scrap do not recover it themselves directly from the consumer market, it has become a commodity collected and sold by dealers who attempt to set the most favorable prices by affecting the supply of scrap on the open market. John Dickinson, of the Aluminum Association notes:

> I tend to think supply and demand may be the more driving force . . . as demand for scrap has increased in recent years and more companies are reliant on its use, the price has started to increase even though recovery methods are more efficient than they used to be and it's easier to obtain certain types of scrap.[64]

One factor that may be helping the aluminum recycling rate is that aluminum can and sheet makers have invested heavily in recycling over the years, which gives them a strong incentive to use secondary materials. Industry has established a recycling infrastructure that includes 10,000 buyback centers nationally.

In the nine bottle bill States, up to 90 percent of aluminum cans are recycled, according to Ralph Cheek, president of Imco Recycling Inc., a major processor of UBC's. He estimates the other States average roughly about 50 percent. The rapid expansion of curbside programs across the country (in 1991, nearly 4,000 were reported, an increase of 40 percent over 1990) should have a positive impact on supply, and should lower the cost of obtaining UBC scrap to secondary aluminum firms (all other factors held constant).[65]

Recent developments in the industry related to supply include a promotional effort by

Alcoa and Reynolds Metals Company to increase the recycling of aluminum foil wrap and formed aluminum containers (such as those used for frozen entrees, baking items, and deli trays).[66]

2.3.5 CAPACITY EXPANSION

Little information was located that projected secondary aluminum plant capacities. The following excerpts provide some general background on capacity that may affect capacity levels in the industry.

> Can reclamation and remelt facilities are being expanded in lieu of building new primary aluminum smelters. This added remelt capacity can be built in half the time and at one-tenth the cost of primary facilities.[67]
>
> . . . the highest reported recycling rate in the world is Ontario's 88 percent and in Europe, Sweden's 85 percent. Thus, aluminum can reclamation in the U.S. has the potential to sustain its steady growth.[68]
>
> Imco Recycling Inc. plans to increase capacity at its UBC recycling plant in Urichsville, Ohio. The $2.5 million expansion was expected to increase annual capacity at the plant by 25 percent.
>
> Alcan Aluminum Corp. announced plans to more than triple the UBC processing capacity at its Oswego, New York rolling complex. Upon completion of the $23 million expansion project, the recycling unit reportedly would have the capacity to recycle 5 billion UBC's (75,000 tons) per year.[69]

2.4 DEMAND AND END USE MARKETS

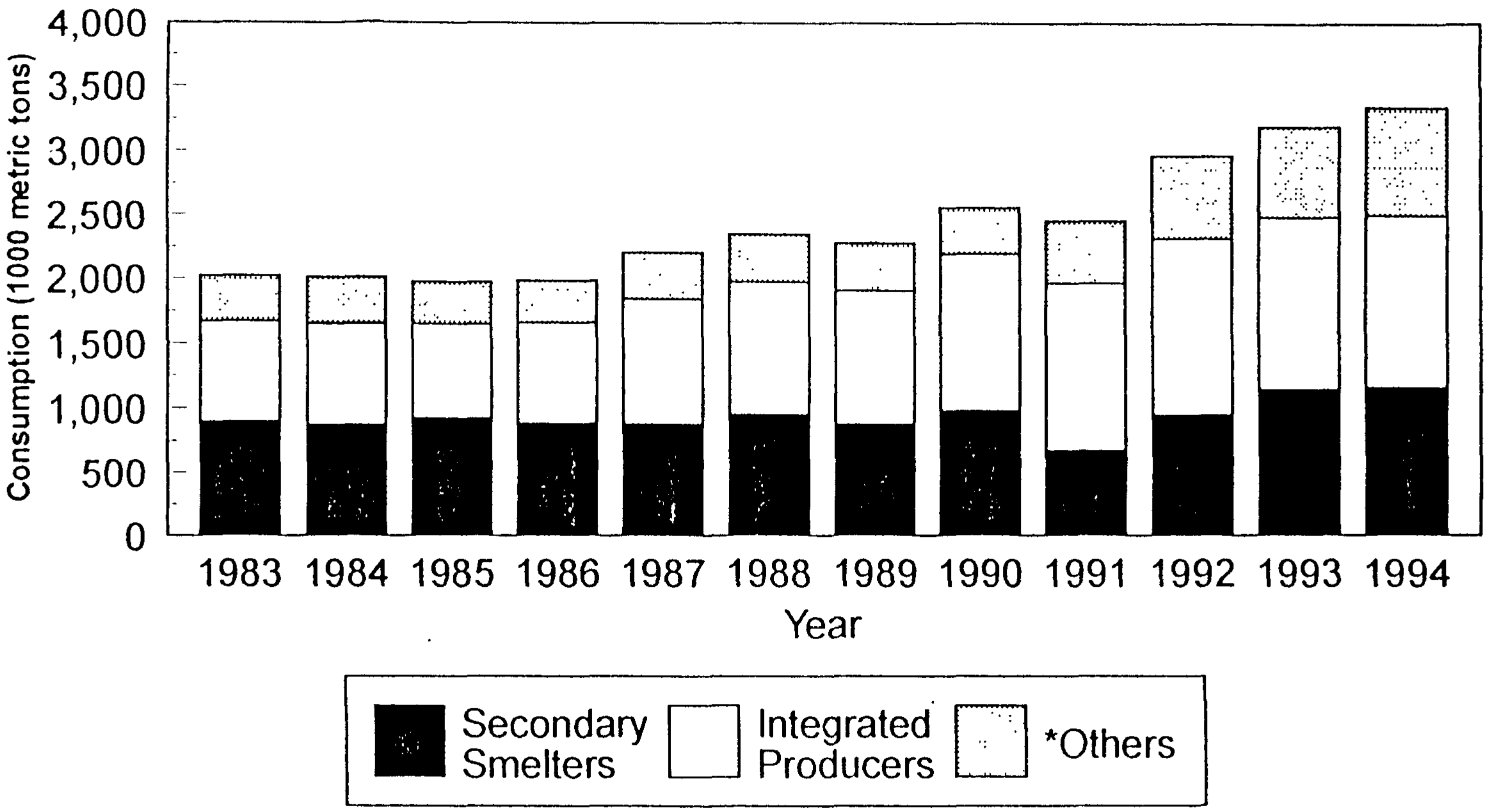
This chapter presents a discussion of secondary aluminum demand. The demand for secondary aluminum is derived from the demand for the manufactured products which use it as a raw material. Therefore, the level of secondary aluminum demand is determined by the market conditions present in the industries that use secondary aluminum as an input into their manufacturing process. Unfortunately, data characterizing the end uses of secondary aluminum are lacking. In particular, descriptions of the use of aluminum in product markets do not differentiate primary metal demand from secondary metal demand.

2.4.1 CONSUMPTION TRENDS

Figure 2-7 presents the historical trend in demand for aluminum scrap over the last decade.[70] This figure shows that the percentage of total consumption of aluminum scrap by secondary smelters declined from approximately 44 percent in 1983 to slightly greater than 33 percent in 1993. It is likely that much of this decline is attributable to the increase in UBC recycling activity from the primary producers.

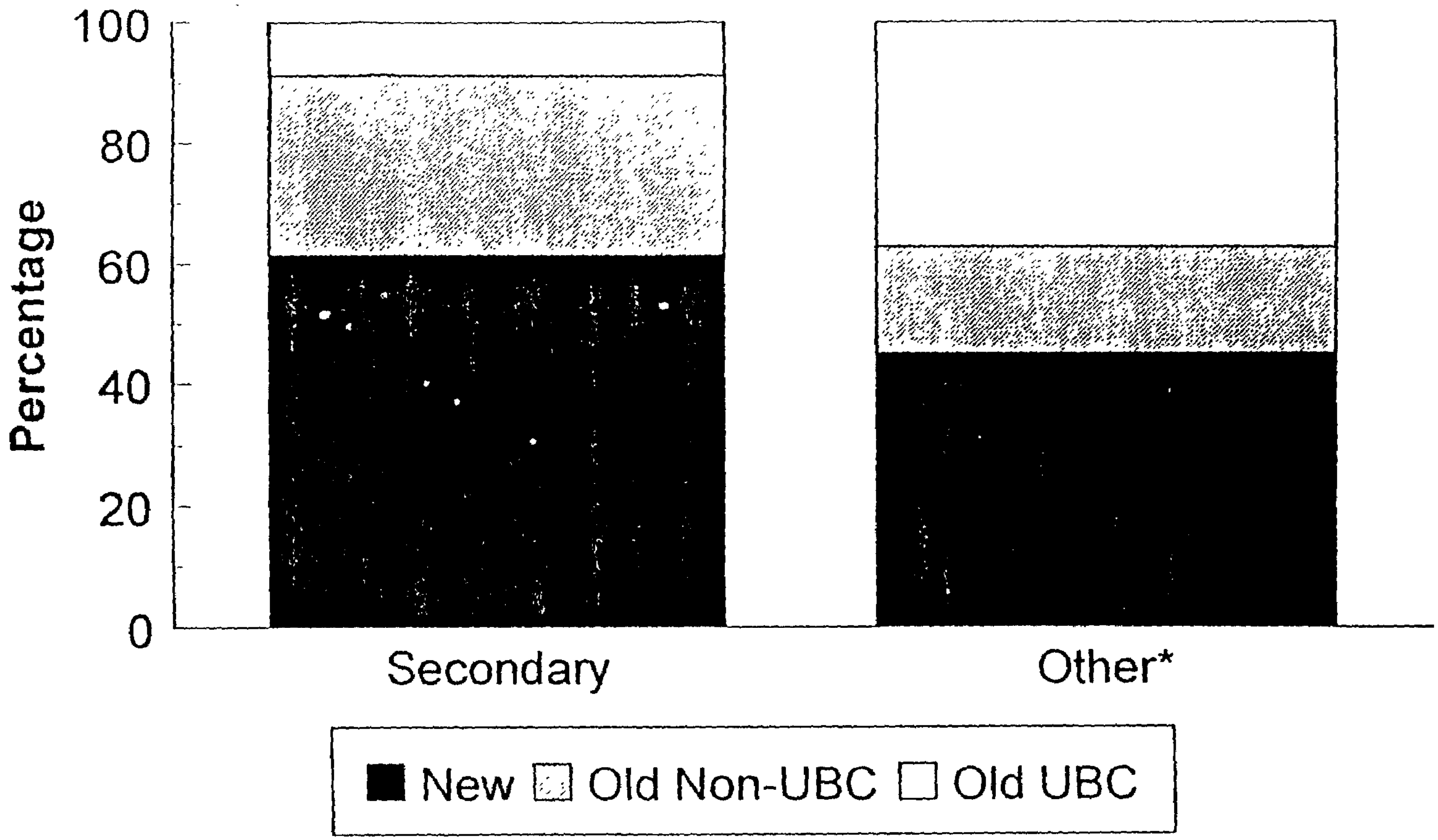
Figure 2-8 displays the consumption in 1994 of secondary aluminum scrap by consumer class and by type of scrap.[71] This figure shows that in 1994 secondary smelters consumed a higher proportion of their total scrap in the form of new scrap. Prior to this, the highest percentage of scrap consumption by secondary smelters had been old non-UBC scrap. A higher percentage of old scrap than new scrap is consumed by primary producers, foundries, fabricators, and chemical plants. Of this old scrap, a significantly higher percentage comes from aluminum cans than for the secondary smelters.

FIGURE 2-7. **TRENDS IN DEMAND FOR ALUMINUM SCRAP**



*"Others" includes fabricators, foundries, and chemical producers

FIGURE 2-8. **CONSUMPTION OF SCRAP ALUMINUM BY CONSUMER CLASS, 1994**



*Primary, Foundry, Fabricator, Chemical Plant

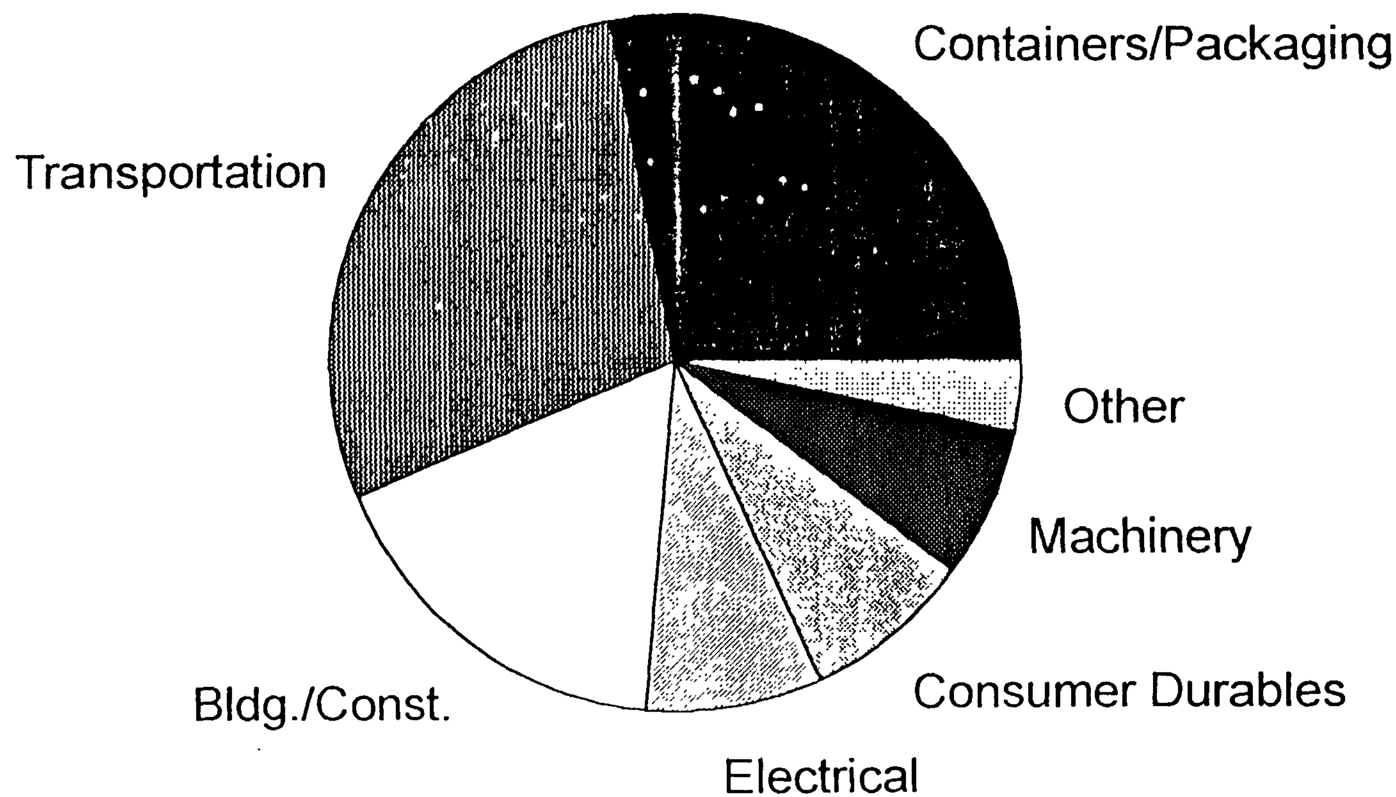
2.4.2 DEMAND DETERMINANTS

There is a lack of specific information on the end-use product markets for secondary aluminum. It is known that a significant proportion of secondary aluminum comes in the form of aluminum UBC's, and that currently aluminum holds 96 percent of the beverage can market, and 76 percent of the total beer and soft drink market--a complete reversal from 20 years ago, when steel cans and glass bottles dominated the market.[72] It is also known that many of these aluminum UBC's are used in the production of additional can stock, although figures were not available to characterize the percentage use of UBC's for this purpose. Given the paucity of data on the specific products where secondary aluminum is a significant input, the following section describes the demand determinants for aluminum in general (both primary and secondary). This discussion is followed by a brief description of the products that are known to use secondary aluminum.

2.4.2.1 Primary and Secondary Aluminum

Figure 2-9 displays the breakdown of aluminum consuming sectors in 1994 (the consumption of aluminum is not broken down between primary and secondary aluminum).[73] Important end-use sectors for aluminum include packaging, construction, and transportation. In 1994, these three end-use sectors accounted for 64 percent of domestic industry shipments as compared to 72 percent in 1992. The transportation industry, with almost 25 percent of the aluminum consumption, was the largest consumer. The automotive sector has been increasing its use of aluminum in recent years and is expected to continue to do so in the future. This was the first year since the mid-70's that the container and packaging industry did not dominate the industry. These sectors consumed approximately 24 percent of the total. The building and construction industry accounted for approximately 15 percent of consumption. Approximately 7 percent of the total aluminum consumed in end products was used in the electrical and communications industries, and about 7 percent went into consumer durable goods,

FIGURE 2-9. **ALUMINUM CONSUMPTION BY SECTOR, 1994**



including refrigerators, air conditioners, washing machines, and other appliances. Aluminum use for industrial equipment and machinery was about 6 percent of consumption.

Over time, technical developments, structural changes within sectors, and competition from other materials will account for changes in the intensity of aluminum use in these end use sectors. In the building and construction sectors, for example, the main demand determinant is new construction activity, as well as the price of substitute materials, such as steel. The accelerated use of aluminum for doors and windows in residential housing is attributed to higher levels of new housing construction in recent years. In the transportation sector, demand is derived from the production of motor vehicles and parts. Aluminum's substitution for heavier materials could result in higher demand levels in future years.[74] In the electrical sector, demand is derived from the use of aluminum in household appliances. Because of consumer resistance and local electrical code restrictions based on poor performance in the past, the future use of aluminum is not projected to be high in this sector. In the packaging sector, demand is based on the demand for food and food products. The increased use of convenience foods will be beneficial in this sector.

2.4.2.2 Secondary Aluminum

Aluminum scrap is not used to any appreciable extent for aluminum extrusions, but largely goes to aluminum casting. The product mix in 1994 shows that about 61 percent of secondary aluminum alloys produced are used in the production of die cast alloys, with most of the remainder going for sand and permanent mold casting.[75] Some secondary metal is also used for deoxidizing in processing steel, and in aluminum wrought products and extrusion billets.

Secondaries sell primarily 15-lb and 30-lb ingots to the casting industry, with the 30-lb size being the most widely used. Some casters, however, buy much larger ingots. The ingots have several notches in them, which permits the caster to divide each ingot into smaller segments. Sales policies may vary from company to company, but contracts between secondary smelters and foundries normally run no longer than 3 months at a time.[76] Because casters generally keep only a one- or two-week supply of ingot on hand, deliveries from the smelter to the foundry are frequent.

There is competition between secondaries and primaries in hot metal and in the secondary ingot market. Secondaries are used for most casting alloy ingot because their prices are normally lower than primaries' casting alloy ingot. They are also preferred in many cases because they will often do quite a bit of custom tailoring of alloys for specific customers. However, primary producers generally are called on when a customer desires a low-iron, low-zinc, or low-manganese alloy. These three metallics are more difficult to dilute. Primaries also occasionally get the business when a customer wants a slightly greater degree of purity. In most instances, though, secondary and primary alloy ingot have virtually equal purities.

The presence of several unwanted metals in aluminum scrap tends to limit its use for producing wrought alloys. The amount of dilution with primary aluminum or high purity scrap (such as electrical conductor wire) required to bring the scrap to a specific wrought alloy composition is in direct proportion to the amount by which a given contaminant exceeds the specification.

Because die-cast alloys contain silicon, zinc, and copper, and auto-shredder scrap contains high levels of other-metal "impurities," (generally zinc and copper). aluminum now recovered from autos is more generally suited to the production of specification casting ingot than for use in the production of wrought alloys. Comparison of the non-automotive alloys show that even when mixed they are essentially compatible for many common end-use applications.[77]

2.4.3 PRICES

Given the fact that the secondary aluminum industry as defined by EPA consists of all the entities that collect, process, and make semifabricated products from scrap aluminum, there are several product prices of interest to the industry. First of all, the price of scrap is important to scrap dealers who must be able to make a profit from the revenue that scrap sales bring; similarly, the price of secondary ingot must provide a margin over the costs to produce the ingot. Finally, the price of semifabricated aluminum products must also allow foundries and fabricators to make a profit or else they will eventually withdraw from the industry. The following discusses the data that were readily available on the price of aluminum scrap and secondary ingot.

In October 1992, the London Metal Exchange began 3-month trading on its new secondary aluminum alloy ingot contract. Cash trading began in January 1993.[78] As the scrap market becomes more developed, the pricing of scrap has become more efficient. As scrap dealers become more consolidated, for example, their ability to find inventories and thus make more market savvy decisions has been enhanced. In past periods of rising prices, secondary operations have normally benefitted from a lag between scrap and ingot prices. Because of the scrap markets increased efficiencies, much of that lag has been largely eliminated.[79]

Table 2-7 presents the number 380 secondary ingot, cast aluminum scrap, used beverage can scrap, and scrap aluminum clippings prices for the last several years. These data, which are unadjusted for inflation, show that the price of scrap and secondary aluminum ingot has declined over the last few years after peaking in 1988. Table 2-8 shows the annual average price for primary aluminum ingot (U.S. spot market prices and London Metal Exchange (LME) prices) and for alloy aluminum ingot for the period 1992 through 1999. Further discussion of these

TABLE 2-7. TRENDS IN SECONDARY ALUMINUM AVERAGE PRICES, 1985-1997 (in cents per pound)[80,81,82,83,84,85,86,87]

Year	No. 380 Secondary Aluminum Ingot-3% Zn	Cast Aluminum Scrap (Midwest)	Used Beverage Can Scrap	Scrap Aluminum Clipping (Midwest)
1985	57.0	24.5	33.8	32.4
1986	59.8	25.5	38.1	37.1
1987	71.4	35.8	49.7	49.5
1988	98.1	52.1	69.0	74.3
1989	89.9	45.9	63.0	63.1
1990	76.2	35.9	49.7	49.8
1991	65.2	24.9	40.3	36.0
1992	64.6	22.7	40.2	34.0
1993	64.8*	20.0	36.7	32.0
1994	74.7**	N.A.	53.1	N.A.
1995	80.5	N.A.	N.A.	N.A.
1996	67.3	N.A.	N.A.	N.A.
1997	75.5	N.A.	N.A.	N.A.

Note: Primary aluminum ingot and number 380 secondary aluminum ingot (a popular type of secondary ingot) should not be compared as pure substitutes since number 380 secondary aluminum ingot includes alloying agents such as zinc and copper, which are not included in the primary ingot.

*First seven months of 1993. In mid-July, American Metal Market discontinued the publication of secondary aluminum ingot prices and substituted an indicator price series.

**The prices of No. 380 ingot (3% zinc) for 1994 through 1997 are from Platt's Metals Week and cannot be directly compared to the prices shown for 1985 through 1993, which are from American Metals Market.

TABLE 2-8. RECENT TRENDS IN PRIMARY ALUMINUM INGOT AND ALUMINUM ALLOY PRICES FOR 1992 through 1998 [88, 89]
(cents per pound)

Year	Average Annual Primary Aluminum Prices		Aluminum Alloy Price London Metal Exchange
	U.S. Spot Market	London Metal Exchange	
1992	57.5	57.1	45.6
1993	53.3	51.7	66.0
1994	71.2	67.0	75.03
1995	85.9	81.9	59.1
1996	71.3	68.3	66.4
1997	77.1	72.6	54.7
1998	65e	61.6	53.6

e = estimated

prices, including the reasons for recent declines in prices is provided in the following sections.

2.4.3.1 Scrap Prices

The price of aluminum scrap is affected by the fact that such scrap is largely a substitute for alumina consumption (in the production of primary aluminum). Scrap prices should, therefore, follow approximately the same relative trend as alumina prices--modified slightly downward by virtue of the fact that, for direct users of scrap, the alternative is the more slowly changing price of refined aluminum.[90] Scrap prices are also affected somewhat by the degree of recycling activity in the U.S. For example, if more States adopt mandatory beverage deposit legislation, then the price of scrap aluminum should be affected downward somewhat due to the increase in supply of UBC's.

Over the past few years, the cost differential between primary aluminum and scrap has narrowed considerably. In 1988, the price for virgin (primary) aluminum hit an all-time high, averaging about $1.10/pound. In that year, the price difference between primary and UBC was about 40 cents/pound, a margin which made it much cheaper for can sheet makers to recycle than use virgin material. After that, the price of primary aluminum declined, aided by the former Soviet Union dumping aluminum onto the world markets. By late 1992, the price for primary aluminum had dropped to 57 cents/pound--almost half of what it was in 1988. At that time, the difference in price between primary aluminum and UBC's stood at about 17 cents/pound. In 1994, the price of both primary aluminum and UBC's rose and the price margin decreased to approximately 14 cents/pound.[91] At that margin, recycling is less profitable due to the necessary decontamination and remelting process, which costs money and results in UBC weight loss.[92]

2.4.3.2 Secondary Aluminum Ingot Prices

Secondary aluminum ingot prices, as quoted by American Metal Market, have followed the trend of scrap aluminum prices over the last several years. The year end 1993 and 1994 prices for selected secondary aluminum ingots are presented in Table 2-9. These prices represent the prices at specified points in time and are presented to illustrate the relative difference in aluminum alloy prices.

TABLE 2-9. YEAR-END PRICES FOR A SAMPLING OF SECONDARY ALUMINUM INGOT, 1993-1994 [93, 94]

Type of Ingot	Price (cents per pound)	
	1993	1994
Alloy 319	64.52	102.30
Alloy 360 (0.6% copper content)	67.00	102.79
Alloy 380 (1% zinc content)	61.96	98.98
Alloy 413 (0.6% copper content)	67.09	102.51

2.5 FINANCIAL DATA

Although the economic impact analysis will be conducted on a market level for secondary aluminum smelters, the examination of firm-level revenue and profitability trends are useful as a preliminary indicator of the baseline conditions of affected firms in the industry. Firm-level data also provide an indication of the financial resources available to affected firms and the ability of their resources to cover the increased compliance costs associated with the MACT standards.

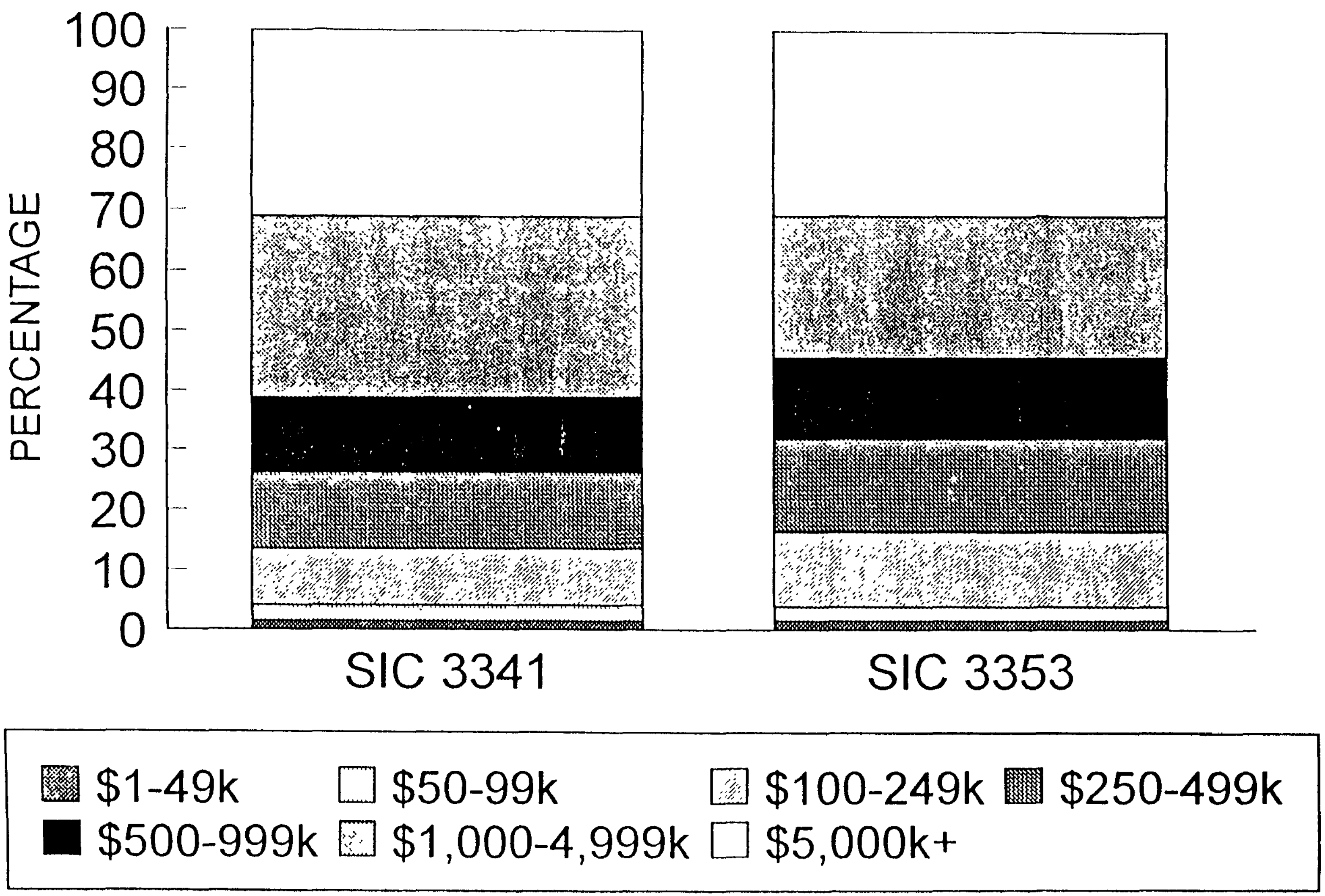
2.5.1 REVENUES

Dun and Bradstreet (D&B) collects the financial statements of both public and privately owned U.S. firms in all size ranges and most lines of business. These data are then compiled by SIC code numbers into "typical" balance sheets and financial statements for firms in that SIC. For example, in 1992, the median firm in D&B's database for SIC 3341 (secondary smelting of nonferrous metals) had revenues of almost $3.2 million; similarly, for SIC 3353 (aluminum sheet, plate, and foil), the typical firm had sales of nearly $1.4 million. In 1994, the revenues for the median firm in SIC 3341 were almost $5.8 million, and data were not provided for SIC 3353.[95] In 1997, the revenues for the median firm were $24.2 million and $3.1 million for SIC 3341 and SIC 3353, respectively.

D&B also publishes a break-down of sales by SIC into 7 sales range categories. Figure 2-10 presents the percentage of firms with either primary or secondary classifications in a particular SIC (firms were classified into SIC's on a secondary capacity if at least 10 percent of the total revenue from that business was in a particular SIC).[96] These data show that there is a higher percentage of firms with sales over $5 million in SIC 3353 than in SIC 3341, probably due to a greater degree of integration in the aluminum, sheet, and plate sector of the industry. A second source of firm-level revenue data is published by Gale Research Incorporated. This source provides a list of the largest companies categorized by SIC code. Unfortunately, for SIC

FIGURE 2-10. **PERCENTAGE OF TOTAL FIRMS IN GIVEN SALES RANGES**

1994



3341, it is not possible to differentiate the aluminum companies from the other nonferrous metals companies, and for SIC 3353, there is no way to distinguish which companies use secondary aluminum in their production process.

2.5.2 CAPITAL FORMATION

The United States Census Bureau publishes capital expenditure data for SIC's 3341 and 3353, although there is no way of knowing how much of this activity is due to outlays related to secondary aluminum operations. Table 2-10 presents the trends in capital expenditures for these SIC's over the 1982-1996 period. These data indicate that levels of capital investment are much higher in the aluminum plate, sheet, and foil industry than in the secondary nonferrous smelting industry. While this latter industry has seen capital investment fluctuate over the time period, the aluminum plate, sheet, and foil industry has seen capital investment increase fairly steadily through 1991 and decline somewhat over the 1992 through 1996 period.

Because of the relatively high energy costs that U.S. primary aluminum companies must pay, few expect to see any additional capital investment in primary smelters in the near future. Instead of investing capital in smelters, some companies are turning instead to perfecting the scrap recovery processes. One such firm, Nichols-Homeshield Casting, recently built a new $65 million plant in Davenport, Iowa, to handle scrap recovery and recycling.[97] Investments in recycling infrastructure are a bargain when compared to the cost of a new smelter required for virgin aluminum.[98]

2.5.3 PROFITABILITY

A recent article noted that because of the tight margin that exists between the price of UBC's and primary aluminum, recycling is only profitable now at efficient plants with state of the art technology.[99] According to conventional wisdom in the industry, under standard

TABLE 2-10. CAPITAL INVESTMENT IN SIC'S 3341 AND 3353 [100,101]
(in millions of dollars)[a]

YEAR	SIC 3341	SIC 3353
1982	146.4	260.4
1983	54.4	296.9
1984	116.7	359.3
1985	103.0	348.0
1986	58.2	439.4
1987	62.6	439.2
1988	67.1	524.0
1989	108.3	551.9
1990	103.9	681.3
1991	72.2	567.2
1992	154.5	418.3
1993	109.8	241.4
1994	103.2	272.9
1995	95.7	378.8
1996	90.3	400.2

[a]Nominal dollars

operating conditions a recycling company will make no money for ten months, and then have a month or so of high financial return.[102] Companies tend to streamline their operations by closing smaller plants and enlarging others.

2.5.4 BALANCE SHEETS AND INCOME STATEMENTS

The only data that have been compiled to date characterizing the industry's balance sheets and income statements is from D&B's Industry Norms and Key Business Ratios. This source has the limitation of providing data for all companies in a particular SIC, therefore, not disaggregating companies that are involved in secondary aluminum operations from those that are not. Table 2-11 displays some of the key ratios that can be calculated from the typical balance sheets and income statements of all firms classified in SIC's 3341 and 3353 for 1992. Tables 2-12 through 2-15 show key financial ratios for the typical firm in SIC 3341, 3353, 3363, 3365, 5015, 5093, and 4953 for 1997.

2.6 MARKET OUTLOOK

The previous chapters indicate that the secondary aluminum industry is currently characterized as having both significant problems, such as the tight profit margins due to the excess supply and the recent Asian recession, and notable cause for optimism, such as the increased environmental consciousness on the part of U.S. businesses and consumers. This chapter presents the supply, demand, and price projections that are available from the literature as well as analysis of recent trends in the industry. These projections are important because the economic impact analysis of the MACT standards is conducted for the fifth year following promulgation of the regulation.

2.6.1 PRODUCT DEMAND

The U.S. Bureau of Mines predicts that both domestic and world secondary aluminum

TABLE 2-11. KEY BUSINESS RATIOS FOR SIC'S 3341 AND 3353 FOR 1992[103]

BUSINESS RATIO	MEASURES	SIC 3341			SIC 3353		
		UQ	M	LQ	UQ	M	LQ
Current (total current assets divided by total current liabilities)	Solvency	3.1	1.5	1.2	2.9	1.7	1.2
Assets to sales (total assets divided by annual net sales)	Efficiency of use of assets	19.1	33.6	51.5	33.6	52.9	115.7
Return on sales (net profit after taxes divided by annual net sales)	Profitability	4.0	1.8	0.4	7.9	2.1	0.6
Return on assets (net profit after taxes divided by total assets)	Profitability	10.7	5.5	1.2	7.2	2.9	0.6

TABLE 2-12. KEY BUSINESS RATIOS FOR SIC'S 3341 AND 3353 FOR 1997[104]

BUSINESS RATIO	MEASURES	SIC 3341			SIC 3353		
		UQ	M	LQ	UQ	M	LQ
Current (total current assets divided by total current liabilities)	Solvency	2.1	1.5	1.3	3.5	1.9	1.4
Assets to sales (total assets divided by annual net sales)	Efficiency of use of assets	23.1	33.1	53.9	59.1	85.3	103.0
Return on sales (net profit after taxes divided by annual net sales)	Profitability	5.1	1.8	0.4	6.0	5.3	1.8
Return on assets (net profit after taxes divided by total assets)	Profitability	7.4	3.9	1.6	11.2	6.1	2.7

TABLE 2-13. KEY BUSINESS RATIOS FOR SIC'S 3363 AND 3365 FOR 1997[105]

BUSINESS RATIO	MEASURES	SIC 3363			SIC 3365		
		UQ	M	LQ	UQ	M	LQ
Current (total current assets divided by total current liabilities)	Solvency	3.6	1.8	1.2	3.3	2.1	1.4
Assets to sales (total assets divided by annual net sales)	Efficiency of use of assets	36.6	45.5	56.9	30.8	43.7	69.6
Return on sales (net profit after taxes divided by annual net sales)	Profitability	4.7	2.1	0.4	6.9	3.0	1.2
Return on assets (net profit after taxes divided by total assets)	Profitability	9.0	4.7	1.2	15.8	8.0	2.6

TABLE 2-14. KEY BUSINESS RATIOS FOR SIC'S 3363 AND 3365 FOR 1997[106]

BUSINESS RATIO	MEASURES	SIC 3363			SIC 3365		
		UQ	M	LQ	UQ	M	LQ
Current (total current assets divided by total current liabilities)	Solvency	3.6	1.8	1.2	3.3	2.1	1.4
Assets to sales (total assets divided by annual net sales)	Efficiency of use of assets	36.6	45.5	56.9	30.8	43.7	69.6
Return on sales (net profit after taxes divided by annual net sales)	Profitability	4.7	2.1	0.4	6.9	3.0	1.2
Return on assets (net profit after taxes divided by total assets)	Profitability	9.0	4.7	1.2	15.8	8.0	2.6

TABLE 2-15. KEY BUSINESS RATIOS FOR SIC'S 4953, 5015 AND 5093 FOR 1997[107]

BUSINESS RATIO	SIC 4953			SIC 5015			SIC 5093		
	UQ	M	LQ	UQ	M	LQ	UQ	M	LQ
Current	2.2	1.3	0.8	4.4	2.7	1.7	3.1	1.8	1.1
Assets to sales	37.2	55.1	114.5	23.3	32.9	57.1	18.7	28.2	41.8
Return on sales	9.3	3.5	0.2	3.8	3.3	1.6	3.9	1.4	0.3
Return on assets	12.6	4.2	(1.1)	15.1	7.9	3.9	10.7	4.1	0.8

Note: UQ - represents the ratio for the firm whose ratio falls at the mid-point between the ratios for the median firm in the industry and the firm with the best ratio in the industry;

M - represents the ratio for the firm whose ratio falls at the mid-point of all ratios for this industry;

LQ - represents the ratio for the firm whose ratio falls at the mid-point between the ratios for the median firm in the industry and the firm with the worst ratio in the industry.

industries should continue to expand. For the short term, they view the increasing acceptance of aluminum beverage cans in foreign countries leading to a more rapid growth rate in secondary aluminum recovery in overseas markets than the United States where the aluminum beverage can already dominates the market. However, as more and more aluminum is used in products with longer life cycles, such as automobiles, they expect that more scrap will enter the market for recovery, increasing secondary production levels in both the domestic and world markets of the future.[108] In general, it is expected that the average annual increase in U.S. secondary aluminum demand through the year 2000 will be greater than that in the primary aluminum industry.

Industry analysts believe that a call for additional weight reduction in automobiles will translate into a substantial increase in aluminum use for vehicles, particularly for castings and perhaps for extrusions. Although plastics will be a direct competitor of aluminum for this business, one industry analyst notes that a significant advantage that aluminum currently has is that it is recyclable, whereas many types of plastics are not. Projections for the amount of aluminum per car for the year 2000 center around 200 pounds (up from an estimated 160 pounds per car). One industry analyst projects that the initial increase in the amount of aluminum going into cars will come from the primary sector. This he believes because once aluminum goes into a car, it will not be recycled for 10 to 15 years. One industry official estimates that approximately two-thirds of all the aluminum going into the automobile industry currently is secondary aluminum, but expects to see that figure drop to less than one-third by the year 2000, and rebound back up to better than three-fourths by 2010.[109]

The three largest domestic automakers, Chrysler Corporation, Ford Motor Co., and GM, announced the formation of the Vehicle Recycling Partnership (VRP) to research and promote the recovery and reuse of materials from junked cars. According to the companies, the partnership was expected to propose methods for increasing the amount of recycled materials used in autos and trucks as well as recovering more from the vehicles. The automakers also stated that the partnership was expected to look into developing industry guidelines in such areas as materials selection and compatibility, bonding methods, and materials, painting, and design for disassembly. Research in these areas reportedly would be carried out in the laboratories of the three automakers, and by other industries, universities, and research institutes.[110]

General Motors Corporation has seen its annual aluminum consumption rise by around 40 percent over the last five years. About half the total consists of outside purchased castings made from secondary aluminum, plus another 300 million lbs of secondary or scrap purchased for GM's in-house casting operations, and close to 400 million lbs in the form of aluminum wheels, wrought raw material and fabricated products.[111]

2.6.2 CAPACITY DEMAND

The large increase in the use of scrap is due primarily to the recycling of aluminum beverage containers. This increase in the use of scrap has placed greater demands on smelters to improve quality. As the demand for aluminum scrap and the use of imported ingot increases, the demand for aluminum melting capacity will increase.

2.6.3 RAW MATERIAL OR PROCESS CHANGES

Any secondary aluminum industry raw material or process changes that may take place in the near future could affect the amount of secondary aluminum consumed in the U.S. In addition, any technological changes in the use of secondary aluminum's substitutes, for example, innovations in the use of plastics for automotive applications, will affect the level of secondary aluminum demand. The following qualitatively describes a few recent innovations in the secondary aluminum industry. A brief discussion of implications for the industry is provided.

A recent patented process developed by Alcan recycles dross without the need for a salt flux, which is required in the conventional dross treatment process. This innovation may reduce the cost of recycling dross, thereby increasing the supply of recycled dross-derived secondary aluminum.

Alcoa reports a new process for handling non-segregated scrap which results in a low-lithium secondary ingot. This new process may broaden the market for secondary aluminum ingot due to the resulting lithium reduction in the ingot.[112]

Additionally, a new aluminum can sheet plant has the ability to use 70 percent recycled content -- almost 20 percent higher than the industry average. This innovation may have a substantial positive effect on the amount of secondary aluminum used in the can sheet production sector of the industry.

A new technology called continuous casting is being used by Quanex and ACX technologies. In traditional secondary operations, scrap is remelted and cast into ingot. The ingot is then remelted and cast into some form of mill product, primarily sheet. This new technology skips the middle step in which the aluminum is cast into ingot. The scrap can be melted and cast directly into sheet saving a great deal in both labor and energy costs. This technology is well positioned to displace much of the secondary recovery being performed by secondary producers and within the operations of the integrated producers.[113]

2.6.4 GROWTH

According to the Aluminum Association, net shipments of aluminum ingot and mill products increased 2.9 percent in 1998 to 23,189 million pounds. Domestic shipments increased 4.4 percent during the same period when compared to the previous year. Overall aluminum shipments have grown at a rate of 3.6 percent for the last ten years.[114] The leading sectors for aluminum demand continued to be transportation, containers and packaging, building and construction, electrical market applications, and machinery and equipment in 1998. Production applications for aluminum by North American automakers in 1999 are expected to climb more than 5 percent, one of the largest gains for the industry thus far. Bob Wagner, manager of nonferrous metals at Ford Motor Company believes the prospect for aluminum and other nonferrous materials used in automotive applications is very bright.[115]

The beginning of 1999 saw a depressed aluminum market. In the first quarter of 1999, aluminum prices fell to the lowest levels since the 1990 recession. However, the period since has shown recovery with prices moving upward due to a strengthening of the world economy. If the recovery continues in the world markets, consumption of aluminum should rise after 2000 with prices improving accordingly.[116] Reynolds Metal Company anticipates demand growth of 5 percent per year after the global economy completes its recovery in 2000 and 2001.[117]

2.6.5 PRICE PROJECTIONS

Trends in the price of secondary aluminum have historically tended to follow the movements in the price of primary aluminum which is cyclical in nature. No specific price projections were found for either secondary aluminum or scrap. The following forecast was found in the literature which pertain to overall aluminum and scrap prices.

According to Yale Brandt, vice chairman of Reynolds Metals Company, the amount of scrap available will increase as the first- and second-generations of aluminum-intensive vehicles enter the recycling stream. This will keep the price of scrap from rising steeply and pushing up aluminum auto parts costs. In addition, prices will continue to depend on the overall total world supply-demand equation for all aluminum.[118]

Prices have rebounded more than 10 percent from a record low in the first quarter of 1999. Market observers believe the Western aluminum markets may be still be in an oversupply situation with only the possibility of production cutbacks offering a potential for sustained increases in price. Domestic demand is expected to remain positive. Scrap processors are expected to find scrap supplies extremely competitive.

2.6.6 IMPORTS AND EXPORTS

According to Jorn DeLinde, director of ferroalloys at Resource Strategies, "Lack of growth in export markets has not only dampened the U.S. recovery rate to a level far less robust than those of the 1980's, but it has also negatively impacted U.S. metals sellers who are exporting less and competing with more importers. The inability of US metal sellers to insulate themselves from the rest of the world is apparent to anyone who has to compete with China's exports. While many external conditions have undermined U.S. metals producers, some uncontrollable factors are starting to benefit them. For example, the value of the U.S. dollar and the economic problems in Japan and Europe have made the U.S. into a preferred location for new business investment. More businesses are recognizing that the economic ills of Japan and Europe are not just cyclical, but, in fact, structural."[119]

3.0 ECONOMIC METHODOLOGY

3.1 INTRODUCTION

The purpose of this chapter is to outline the economic methodology used in this analysis. Baseline values used in the partial equilibrium analysis are presented, and the analytical methods used to conduct the following analyses are described individually in this chapter:

- Partial equilibrium model used to compute post-control price, output, and trade impacts;
- Economic surplus changes;
- Labor and trade impacts; and
- Financial impacts.

3.2 MARKET MODEL

The framework for the analysis of economic impacts on the secondary aluminum industry is a partial-equilibrium model. A partial-equilibrium analysis is an analytical tool often used by economists to analyze the single market model. This method assumes that some variables are exogenously fixed at predetermined levels. The goal of the partial-equilibrium model is to specify market supply and demand, estimate the post-control shift in market supply, estimate the change in market equilibrium (price and quantity), and predict plant closures. This section presents the framework of the partial equilibrium model, baseline equilibrium conditions, the calculation of the supply curve shift, and the methodology used to calculate impacts on trade, facility closures, and labor inputs. The baseline inputs for the secondary aluminum industry are also presented.

3.2.1 Partial-Equilibrium Analysis

A partial-equilibrium analysis was used to estimate the economic impacts of the chosen regulatory option (the MACT floor) for the secondary aluminum industry. For modeling purposes, it was assumed that this industry is operating in a perfectly competitive market. Perfectly competitive industries are characterized by the following conditions: the presence of many sellers; production of a homogeneous product; a small market share owned by each firm in the industry; freely available information regarding prices, technology, and profit opportunities; freedom of entry and exit by firms in the industry; and competing sellers which are not considered as a threat to market share by other firms in the industry.[120] The implication of an assumption of perfect competition to this analysis is that perfect competition constrains firms in the industry to be price takers due to the absence of the market power necessary to affect market price. Firms which operate in a perfectly competitive industry are also assumed to minimize costs. Although the secondary aluminum industry does not strictly meet all of the criteria for perfect competition, the market does have many buyers and sellers. The assumption of a competitive market is reasonable for analytical purposes.

3.2.2 Market Demand and Supply

The baseline, or pre-control levels for the secondary aluminum market, is defined with a domestic market demand equation, a domestic market supply equation, a foreign supply equation (imports), and a foreign demand equation (exports). It is assumed that each of these markets will clear, or achieve an equilibrium. The following equations identify the market demand, supply, and equilibrium conditions for each affected industry:

$$Q^{D_d} = \alpha P^{\varepsilon}$$

$$Q^{D_f} = \delta P^{\varepsilon}$$

$$Q^{S_d} = \beta P^{\gamma}$$

$$Q^{S_f} = \rho P^{\gamma}$$

$$Q = Q^{D_d} + Q^{D_f} = Q^{S_d} + Q^{S_f}$$

where:

Q^{Dd}	=	the quantity of the secondary aluminum demanded by domestic consumers annually,
Q^{Df}	=	the quantity of the secondary aluminum demanded by foreign consumers and produced by domestic producers annually (or exports),
Q^{Sd}	=	the quantity of secondary aluminum produced by domestic supplier(s) annually,
Q^{Sf}	=	the quantity of secondary aluminum produced by foreign suppliers and sold in the United States annually (or imports),
P	=	the price of secondary aluminum,
ϵ	=	the price elasticity of demand for secondary aluminum, and
γ	=	the price elasticity of supply for secondary aluminum.

The constants, α, δ, β, and ρ, are parameters estimated by the model, which are computed such that the baseline equilibrium price is normalized to one. The market specification assumes that domestic and foreign supply elasticities are the same, and that domestic and foreign demand elasticities are identical. These assumptions are necessary, since data were not readily available to estimate the price elasticity of supply for foreign suppliers and the price elasticity of demand for foreign consumers.

3.2.3 Market Supply Shift

The domestic supply equation shown above may be solved for the price, *P*, of secondary aluminum, respectively, to derive an inverse supply function that serves as the baseline supply function for the industry. The inverse domestic supply equation for the industry is as follows:

$$P = (Q^{S_d}/\beta)^{\frac{1}{\gamma}}$$

A rational profit maximizing business firm will seek to increase the price of the product it sells by an amount that recovers the capital and operation costs of the regulatory control requirements over the useful life of the emission control equipment. This relationship is identified in the following equation:

$$\frac{[(C \cdot Q) - V]}{S} = k$$

where:

C	=	the increase in the supply price,
Q	=	output,
V	=	a measure of annual operating and maintenance control costs,
S	=	a capital recovery factor (includes annual depreciation and a return on undepreciated capital), and
k	=	the investment cost of emission controls.

Thus, the model assumes that secondary aluminum facilities will seek to increase the product supply price by an amount, C, that equates the investment costs in control equipment, k, to the present value of the net revenue stream (revenues less expenditures) related to the equipment: Solving the equation for the supply price increase, C, yields the following equation:

$$C = \frac{kS}{Q} + \frac{V}{Q}$$

Estimates of the annual operation and maintenance control costs and of the investment cost of emission controls, V and k, respectively, were obtained from engineering studies conducted by an engineering contractor for EPA and are based on 1994 price levels. Production levels reflect values at the time the EPA industry survey was conducted. The variables for the capital recovery factor S is computed as follows:

$$S = \frac{r(1 + r)^T}{[(1 + r)^T - 1]}$$

where:

r = the discount rate faced by producers, which is assumed to be 7 percent, and

T = the life of the emission control equipment, which is 20 years for most of the proposed emission control equipment.

Emission control costs will increase the supply price for secondary aluminum by an amount equivalent to the per unit cost of the annual recovery of investment costs plus the annual operating costs of emission control equipment, or C_i (i denotes the number of affected facilities in the industry). The baseline product cost curve for secondary aluminum is unknown because production costs for the individual facilities are unknown. Therefore, an assumption is made that the affected facilities in each industry with the highest per unit control costs are marginal in the post-control market. In other words, those firms with the highest per unit control costs also have the highest per-unit pre-control production costs. This is a worst-case scenario model assumption for price and quantity impacts that may not be the case in reality. The assumption, however, results in the upper bound of possible price and quantity impacts occurring as the result of regulation. Based upon this assumption, the post-control supply function can be expressed as follows:

$$P = (Q^{S_d}/\beta)^{\frac{1}{\gamma}} + C\,(C_i\,,\ q_i)$$

where:

$C(C, q_i)$	=	a function that shifts the supply function to reflect the incurrence of control costs,
C_i	=	the vertical shift that occurs in the supply curve for the ith facility to reflect the increased cost of production in the post-control market, and
q_i	=	the quantity produced by the ith facility producing secondary aluminum.

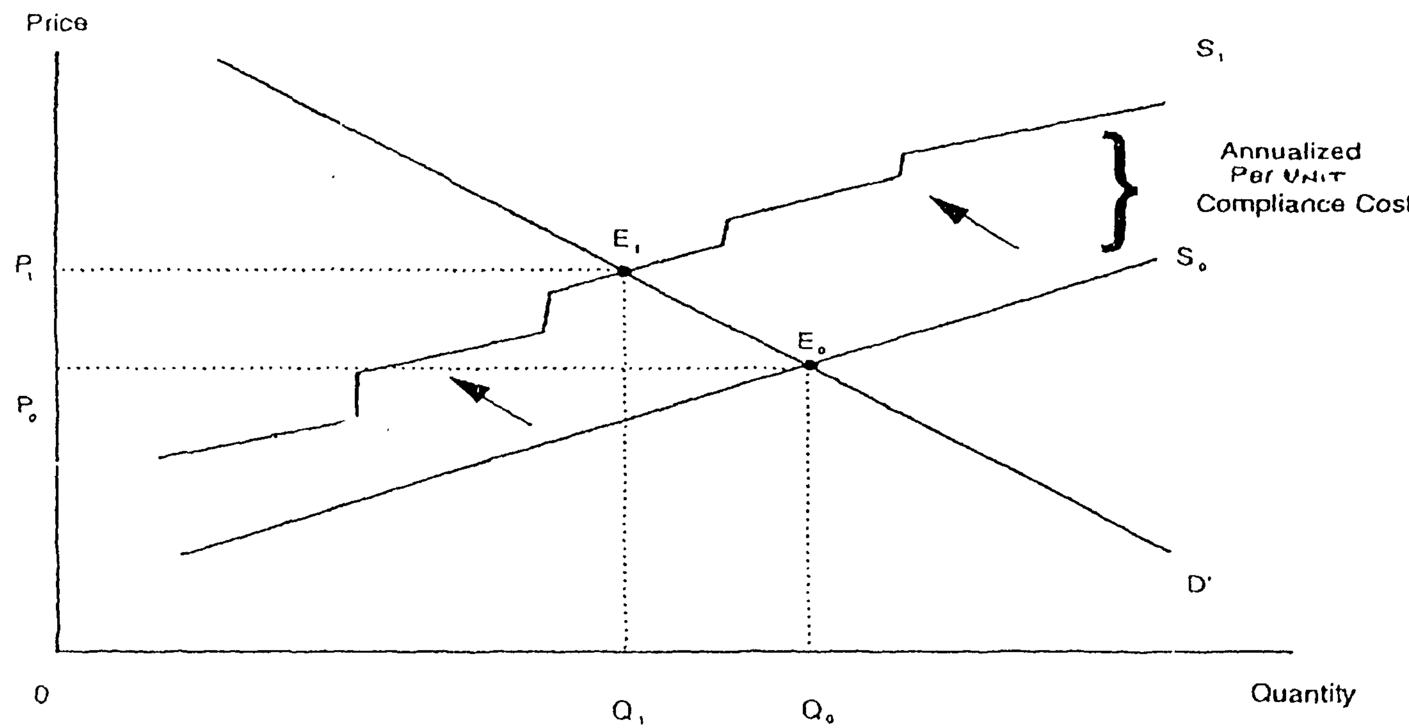
This shift in the supply curve is shown graphically in Figure 3-1.

3.2.4 Impact of the Supply Shift on Market Price and Quantity

The impact of the control standards on market equilibrium price and output is derived by solving for the post-control market equilibrium and comparing the new equilibrium price and quantity to the baseline equilibrium conditions. Since post-control domestic supply is assumed to be segmented, or a step function, a special algorithm was developed to solve for the post control market equilibrium. The algorithm first searches for the segment in the post-control supply function at which equilibrium occurs, and then solves for the post-control market price that clears the market.

Since the market-clearing price occurs where the sum of domestic demand and foreign demand of domestic production equals post-control domestic supply plus foreign supply, the

FIGURE 3-1. ILLUSTRATION OF POST-NESHAP MODEL



algorithm simultaneously solves for the following post-control variables:

- Equilibrium market price;
- Equilibrium market quantity;
- Change in the value of domestic production or revenues to producers;
- Quantity supplied by domestic producers;
- Quantity supplied by foreign producers (imports);
- Quantity demanded (domestic production) by foreign consumers (exports); and
- Quantity demanded by domestic consumers.

The changes in these equilibrium variables are estimated by comparing baseline equilibrium values to post-control equilibrium values.

3.2.5 Trade Impacts

Trade impacts are reported as the change in the volume of exports, imports, and net exports (exports minus imports). The price elasticity of demand for each of the products has been assumed to be identical for foreign and domestic consumers, and the price elasticity of supply is presumed the same for foreign and domestic producers. As the volume of imports rises and the volume of exports falls, the volume of net exports will decline.

The following algorithms are used to compute the trade impacts of the proposed regulatory alternative:

$$\Delta Q^{S_f} = Q_1^{S_f} - Q_0^{S_f}$$

$$\Delta Q^{D_f} = Q_1^{D_f} - Q_0^{D_f}$$

$$\Delta NX = \Delta Q^{D_f} - \Delta Q^{S_f}$$

where:

ΔQ^{Sf}	=	the change in the volume of imports,
ΔQ^{Df}	=	the change in the volume of exports, and
ΔNX	=	the volume change in net exports.

The subscripts 1 and 0 refer to the post- and pre-control equilibrium values, respectively, and all other variables have been previously identified.

3.2.6 Plant Closures

It is assumed that a facility will close if its post-control supply price exceeds the post-control market equilibrium price. Closures in this analysis relate to facilities. In the event the firm owns multiple facilities or has diversified interests, the firm itself may not shut down. however, an individual facility owned by the firm may close.

3.2.7 Changes in Economic Welfare

Regulatory control requirements will result in changes in the market equilibrium price and quantity of secondary aluminum produced and sold. These changes in the market equilibrium price and quantity will affect the welfare of consumers of products manufactured by secondary aluminum producers, producers of secondary aluminum and secondary aluminum products, and society as a whole. The methods used to measure these changes in welfare are described below.

3.2.7.1 Changes in Consumer Surplus

Consumers will bear a loss in consumer surplus, or a dead-weight loss, associated with the reduction in the amount of secondary aluminum sold due to higher prices charged for this product. This loss in consumer surplus represents the amount consumers would have been willing to pay over the pre-control price for production eliminated. Additionally, consumers will have to pay a higher price for post-control output. This consumer surplus change for domestic consumers is defined as the ΔCS_d, as follows:

$$\Delta CS_d = \int_{Q_1^{D_d}}^{Q_0^{D_d}} (Q^{D_d}/\alpha)^{\frac{1}{\epsilon}} \, dQ^{D_d} + P_1 Q_1^{D_d} - P_0 Q_0^{D_d}$$

The change in consumer surplus is an estimate of the losses of surplus incurred by domestic consumers only. Although both domestic and foreign consumers may suffer a loss in surplus as a result of emission controls, this study focuses on the change in domestic consumer surplus only. The variable, ΔCS_d, represents the change in domestic consumer surplus that results from the change in market equilibrium price and quantity occurring after the incurrence of regulatory control costs. Figure 3-2 depicts the loss in consumer surplus.

3.2.7.2 Change in Producer Surplus

The change in producer surplus is composed of two elements. The first element relates to output eliminated as the result of emission controls. The second element is associated with the change in price and cost of production for the new market equilibrium quantity. The total change in producer surplus is the sum of these two elements. Figure 3-2 depicts graphically the change in producer surplus resulting from this regulation.

The lower output levels resulting from emission control costs cause producers to suffer a welfare loss in producer surplus. Affected facilities which continue producing after the incurrence of control costs realize a welfare gain on each unit of production produced attributable to the incremental increase in the market price. Producers will also experience a decrease in welfare per unit of production relating to the increased capital costs and operating cost of emission controls. The total change in producer surplus is specified by the following equation:

$$\Delta PS = [P_1\, Q_1^{S_d} - P_0 Q_0^{S_d} - \int_{Q_1^{S_d}}^{Q_0^{S_d}} (Q/\beta)^{\frac{1}{\gamma}}\, dQ - \sum_{i=1}^{M} C_i\, q_i]$$

Since domestic surplus changes are the object of interest, the welfare gain experienced by foreign producers due to higher prices is not considered. This procedure treats higher prices paid for imports as a dead-weight loss in consumer surplus. Higher prices paid to foreign producers represent simply a transfer of surplus from the United States to other countries from a world economy perspective, but a welfare loss from the perspective of the domestic economy.

3.2.7.3 Total Economic Costs

The total economic costs of the regulations are the sum of the changes in consumer surplus and producer surplus. This relationship is defined in the following equation:

$$EC = \Delta CS_d + \Delta PS$$

where:

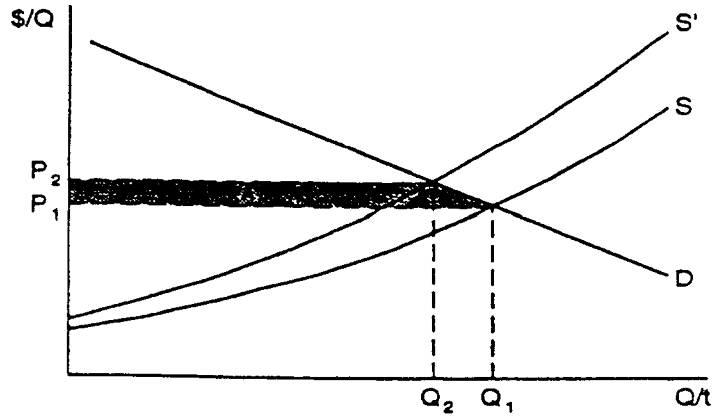
4   EC = the economic cost of the controls.

All other variables have been previously defined.

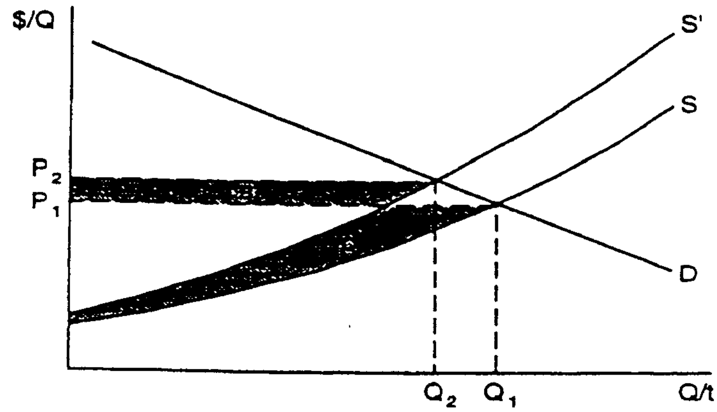
3.2.8 Labor Input Impact

The estimate of the labor market impact associated with the standard is based on the baseline input-output ratios and the estimated changes in domestic production. The labor market impacts are measured as the number of jobs lost due to domestic output reductions. The

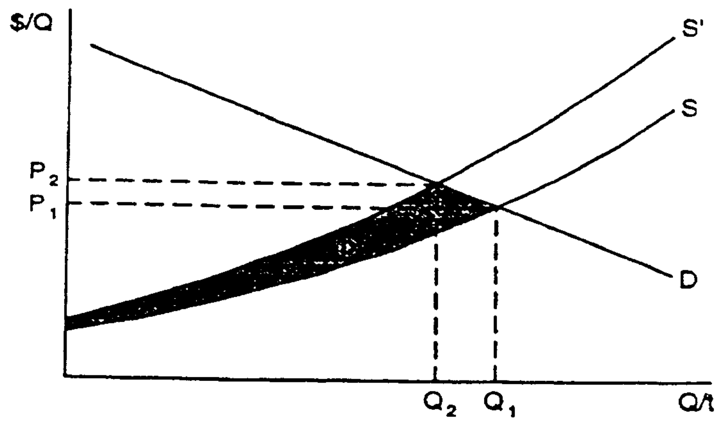
FIGURE 3-2. PRODUCER AND CONSUMER SURPLUS CHANGES



(a) Change in Consumer Surplus with Regulation



(b) Change in Producer Surplus with Regulation



(c) Net Change in Economic Welfare with Regulation estimated number of job losses are a function of the change in level of production that is anticipated to occur as a result of the emission controls. Employment information was provided in the EPA information collection request for this regulation. Based on data in the information collection request, secondary aluminum facilities have, on average, approximately 275 employees per facility. Extrapolating this estimate to the industry, results in a total employment estimate of 23,650 employees. The change in employment level is estimated as follows:

$$\Delta L = [L_0 * \%\Delta Q^{Sd}]$$

where:

ΔL	=	the change in the employment level expressed in terms of number of workers,
L_0	=	the total number of secondary aluminum employees,
Q^{Sd}	=	Domestic supply.

3.2 BASELINE INPUTS

The partial equilibrium model used in this analysis requires, as data inputs, baseline values for variables and parameters that have been previously described to characterize the secondary aluminum industry. These data inputs include the number of domestic facilities currently in operation, the annual capacity per facility, and the relevant control costs per facility. Table 3-1 lists the variable and parameter inputs to the model for the secondary aluminum industry.

In Table 3-1 the baseline parameters and variables used to characterize baseline market conditions are listed. Baseline market price data are based upon information published by the American Metals Market.[121] Production data are based upon model plant production and the number of model plants assumed for this industry. [122] Imports and exports of secondary aluminum are estimated using import and export ratios for SIC 3341 and 3353 obtained from the United

States International Trade Commission and applied to the secondary aluminum domestic production.[123] The prices shown are stated in cents per pound and industry output is stated in millions of tons produced annually. The price elasticities of supply and demand were estimated econometrically and are discussed in Section 3.3 Industry Supply and Demand Elasticities.

A discount rate of 7 percent is assumed for the analysis as a surrogate for the actual rates in the economy. The 7 percent social discount rate is consistent with the most current United States Office of Management and Budget (OMB) guidance.[124] The equipment life of 20 years was obtained from the engineering study of emission control costs conducted by an engineering contractor for EPA. This equipment life is applicable for most of the pollution control equipment considered in the analysis. The number of employees employed in the secondary aluminum industry was calculated from data obtained from the Secondary Aluminum information collection request.[125]

3.3 INDUSTRY SUPPLY AND DEMAND ELASTICITIES

3.3.1 Introduction

Demand and supply elasticities are crucial components of the partial equilibrium model used to quantify the economic impact of regulatory control cost measures on the affected secondary aluminum industry. The price elasticity of demand was unavailable in the literature for secondary aluminum, specifically. However, an estimate of the price elasticity of demand for the overall aluminum metal (primary and secondary) was available. Since the only published elasticity estimate relates to demand for the overall metal and was published in 1979, econometric estimates of the price elasticity of demand and the price elasticity of supply are

TABLE 3-1. BASELINE INPUTS FOR THE SECONDARY ALUMINUM INDUSTRY

Variable/Parameter	Amount
Price (P_0)[1]	74.71
Domestic Output, (Q_0^{Sd})[2]	12.8
Imports, (Q_0^{Sf})[3]	1.338
Exports, (Q_0^{Df})[3]	1.341
Demand Elasticity (ϵ)	-0.34
Supply Elasticity (γ)	2.33
Equipment life (T)	20
Labor (Number of workers)[4]	23,650

NOTES: [1] Cents per pound (1994$)

[2] Millions of tons per year

[3] The import ratio and export ratio are based upon 1994 import and export ratios for SIC 3341 and 3353

[4] Number of workers estimated for the secondary aluminum industry are based on the EPA Information Collection Request

estimated for this analysis. The following sections present the analytical approach, and the data employed to estimate the price elasticities of demand and supply used in the partial equilibrium analysis. The techniques utilized to estimate the price elasticity of demand and supply are consistent with economic theory and, at the same time, utilize the data available.

3.3.2 Price Elasticity of Demand

The price elasticity of demand, or own-price elasticity of demand, is a measure of the sensitivity of buyers of a product to a change in price of the product. The price elasticity of demand represents the percentage change in the quantity demanded resulting from each 1 percent change in the price of the product.

The only published estimates of the elasticity of demand for aluminum are for the overall metal industry. No distinctions were found in the literature between the primary and secondary aluminum price elasticity of demand estimates, nor between the elasticities of the various end-use sectors for aluminum. Given the many substitutes for aluminum, an important concept to consider is the cross-price elasticity of demand for aluminum with its substitute materials. One estimate located of the cross-price elasticity of demand for aluminum with steel was --2.07.[126] The existence of substitutes for aluminum such as steel are a relevant consideration for secondary market impacts in the economic impact analysis.

Because of the likelihood that the substitution of aluminum with one of its alternatives (e.g., steel) would require a process change, it is likely that the response of demand to price changes in the overall aluminum industry would be relatively minor in the short-term; long-run responses would likely be greater. The results of a study published in 1979 confirms this supposition. This study found that the aluminum price elasticities of demand were -0.13 in the short-run, and -0.80 in the long-run.[127] The market impacts associated with the published long run estimate of the price elasticity of demand of -0.80 are addressed in a sensitivity analysis in Appendix A.

3.3.2.1 Approach

Secondary aluminum is used as intermediate products to produce final goods. The demand for secondary aluminum is therefore derived from the demand for these final products. Information is provided in Chapter 2 concerning the end uses of aluminum. According to the information contained in Chapter 2, secondary aluminum is used primarily as an input in the packaging, construction, and transportation sectors. One primary use for aluminum is in cans that are used to package beverages such as beer and soft drinks.

The assumption was made that firms using secondary aluminum as input into their productive processes seek to maximize profits. The profit function for these firms may be written as follows:

$$\max_{Q,\, I} \pi = P_{FP} * f(Q, I) - (P * Q) - (P_{OI} * I)$$

where:

π	=	profit,
P_{FP}	=	the price of the final product or end-use product,
$f(Q, I)$	=	the production function of the firm producing the final product,
P	=	the price of the secondary aluminum,
Q	=	the quantity input use of secondary aluminum,
P_{OI}	=	a vector of prices of other inputs used to produce the final product, and
I	=	a vector of other inputs used to produce the final product.

All other variables have been previously defined.

The solution to the profit function maximization results in a system of derived demand equations for secondary aluminum. The derived demand equations are of the following form:

$$Q = g(P,\ P_{FP},\ P_{OI})$$

A multiplicative functional form of the derived demand equation is assumed because of the useful properties associated with this functional form. The functional form of the derived demand function is expressed in the following formula:

$$Q = AP^{\beta}P_{FP}^{\beta_{FP}}$$

where:

β	=	the price elasticity of demand for the secondary aluminum, and
β_{FP}	=	the final product price elasticity with respect to the use of the secondary aluminum.

All other variables have been previously defined. β, β_{FP}, and A are parameters to be estimated by the model. β represents the own-price elasticity of demand. The price of other inputs (represented by P_{OI}) has been omitted from the estimated model, because data relevant to these inputs were unavailable. The implication of this omission is that the use of secondary aluminum production is fixed by technology.

The market price and quantity sold of secondary aluminum are simultaneously determined by the demand and supply equations. For this reason, it is advantageous to apply a systems estimator to obtain unbiased and consistent estimates of the coefficients for the demand equations.[128] Two-stage least squares (2SLS) is the estimation procedure used in this analysis to estimate the demand equations for secondary aluminum. Two-stage least squares uses the information available from the specification of an equation system to obtain a unique estimate for each structural parameter. The predetermined, or exogenous, variables in the demand and supply equations are used as instruments. The supply-side variables used to estimate the demand functions include: the real capital stock variable for SIC code 3341, a technology time trend (t), real GDP, and the weighted-average price index for the cost of labor and materials for SIC code 3341($P_{.LM}$).

3.3.2.2 Data

Data relevant to the econometric modeling of the price elasticity of demand for secondary aluminum including the variable symbol, units of measure, and variable descriptions are listed in Table 3-3. Consistent time series data for the period 1975 through 1993 were obtained. Price data for No 380 Alloy and secondary aluminum production data were obtained from the American Metals Market[129] and the Aluminum Association[130], respectively. The Annual Survey of Manufactures publishes price indices for the final products of interest (soft drinks, beer, and metal cans and containers). Data relative to the supply-side variables were also obtained from the Annual Survey of Manufactures.[131] Finally, real GDP and the GDP deflator were obtained from the Bureau of Economic Analysis.[132]

3.3.2.3 Statistical Results

SAS Release 6.12 for Windows was used to estimate econometric estimates of the price elasticity of demand. Two-stage least square econometric models were estimated for the secondary aluminum industry using the price of soft drinks, beer, and metal cans and containers as the end-use products, respectively, and the methods and models discussed. The models using the price of soft drinks and beer, respectively, as the final products were not successful. The coefficient for the own-price variable in each model was not statistically different from zero. The model results using the price of metal cans and containers as the final product price is reported in Table 3-4. Standard errors are shown in parenthesis. Each of the coefficients reported has the anticipated sign and is statistically significant.

The price elasticity of demand estimate for secondary aluminum reflects that the demand for secondary aluminum is inelastic. Regulatory control costs are more likely to be paid by consumers of products with inelastic demand when compared to products with elastic demand.

TABLE 3-2. DATA INPUTS FOR THE ESTIMATION OF DEMAND EQUATIONS FOR THE SECONDARY ALUMINUM INDUSTRY

Variable		Unit of Measure	Description
1.	Time Trend - t	-	-
2.	Price (Alloy No. 380) - P[1]	price per pound	Annual Average Price
3.	Sales Volume of Secondary Aluminum - Q[2]	thousands of metric tons	Quantity sold of secondary aluminum
4.	Price Final Goods: - P_{FP}		-
	a. Bottled and Canned Soft Drinks and Carbonated Waters[3]	index	SIC code 2086
	b. Malt Beverages[3]	index	SIC code 2082
	c. Metal Cans and Containers[3]	index	SIC code 3411
5.	Cost of Material Inputs[3]	index	SIC code 3341
6.	Price index for Material Inputs[3]	index	SIC code 3341
7.	Production Worker Wages[3]	millions of $1987	SIC code 3341
8.	Production Worker Hours[3]	thousands of labor man hours	SIC code 3341
9.	Real Capital Stock[3]	millions of $1987	SIC code 3341
10.	Implicit Price Deflator[4]	index	
11.	Real Gross Domestic Product[4]	millions of $1987	

NOTES: 1. American Metals Market.
2. Aluminum Association.
3. Annual Survey of Manufactures.
4 United States Bureau of Economic Analysis.

TABLE 3-3. DERIVED DEMAND COEFFICIENTS

Secondary Aluminum	
Own Price β^1 Secondary Aluminum	-0.34 (0.185)
End-Use $\beta_{FP}{}^1$ Metal Cans and Containers	0.69 (0.207)
Model F Value Probability > F	19.548 0.0001
Adjusted R-Square	0.6733

NOTES: Standard errors are shown in parenthesis.

all other things held constant. Price increases for products with inelastic price elasticity of demand lead to revenue increases for producers of the product. Thus, one can predict that price increases resulting from implementation of regulatory control costs will lead to an increase in revenues for the secondary aluminum industry.

A degree of uncertainty is associated with this method of demand estimation. The estimation is not robust since the model results vary depending upon the instruments used in the estimation process. For this reason, a sensitivity analysis of the price elasticity of demand estimates is presented using a range of elasticities. A lower estimate that differs by minus one standard deviation from that utilized in the analysis of -0.16. The estimate reported in the literature for the overall aluminum of -0.80 is used for the upper bound. The results of the sensitivity analysis are reported in Appendix A.

3.3.3 Price Elasticity of Supply

The price elasticity of supply, or own-price elasticity of supply, is a measure of the responsiveness of producers to changes in the price of a product. The price elasticity of supply indicates the percentage change in the quantity supplied of a product resulting from each 1 percent change in the price of the product.

3.3.3.1 Model Approach

Published sources of the price elasticity of supply using current data were not readily available. For this reason, an econometric analysis of the price elasticity of supply for the secondary aluminum was conducted. The approach used to estimate the price elasticity of supply makes use of the production function. The theoretical methodology of deriving a supply elasticity from an estimated production function will be briefly discussed with the industry production function defined as follows:

$$Q^S = f(L,K,M,t)$$

where:

Q^S	=	output or production
L	=	the labor input, or number of labor hours,
K	=	real capital stock,
M	=	the material inputs, and
t	=	a time variable to reflect technology changes.

In a competitive market, market forces constrain firms to produce at the cost minimizing output level. Cost minimization allows for the duality mapping of a firm's technology (summarized by the firm's production function) to the firm's economic behavior (summarized by the firm's cost function). The total cost function for a secondary aluminum facility is as follows:

$$TC = h(C,K,t,Q^S)$$

where:

TC	=	the total cost of production, and
C	=	the cost of production (including cost of materials and labor).

All other variables have been previously defined.

This methodology assumes that capital stock is fixed, or a sunk cost of production. The assumption of a fixed capital stock may be viewed as a short-run modeling assumption. This assumption is consistent with the objective of modeling the adjustment of supply to price changes after implementation of controls. Firms will make economic decisions that consider those costs of production that are discretionary or avoidable. These avoidable costs include production costs, such as labor and materials, and emission control costs. In contrast, costs associated with existing capital are not avoidable or discretionary. Differentiating the total cost function with respect to Q^S derives the following marginal cost function:

$$MC = h'(C,K,t,Q^S)$$

where MC is the marginal cost of production and all other variables have been previously defined.

Profit maximizing competitive firms will choose to produce the quantity of output that equates market price, P, to the marginal cost of production. Setting the price equal to the preceding marginal cost function and solving for Q^S yields the following implied supply function:

$$Q^s = (P, P_L, P_M, K, t)$$

where:

P	=	the price of secondary aluminum,
P_L	=	the price of labor, and
P_M	=	the price of materials input.

All other variables have been previously defined.

An explicit functional form of the production function may be assumed to facilitate estimation of the model. For this analysis, the Cobb-Douglas, or multiplicative form, of the production function is postulated. The Cobb-Douglas production function has the convenient property of yielding constant elasticity measures. The functional form of the production function becomes:

$$Q_t = A\ K_t^{\alpha_K}\ t^{\lambda}\ L_t^{\alpha_L}\ M_t^{\alpha_M}$$

where:

Q_t	=	output or production in year t,
K_t	=	the real capital stock in year t,
L_t	=	the quantity of labor hours used in year t,

M_t	=	the material inputs in year t, and
A, α_K, α_L, α_M, λ	=	parameters to be estimated by the model.

This equation can be written in linear form by taking the natural logarithms of both sides of the equation. Linear regression techniques may then be applied. Using the approach described, the implied supply function may be derived as:

$$\ln = \beta_0 + \gamma \ln P + \beta_2 \ln K + \beta_3 \ln P_L + \beta_4 \ln P_M + \beta_5 \ln t$$

where:

P_L	=	the factor price of the labor input,
P_M	=	the factor price of the material input, and
K	=	fixed real capital.

The β_i and γ coefficients are functions of the α_i, the coefficients of the production function. The supply elasticity, γ, is equal to the following:

$$\gamma = \frac{\alpha_L + \alpha_M}{1 - \alpha_L - \alpha_M}$$

It is necessary to place some restrictions on the estimated coefficients of the production function in order to have well-defined supply function coefficients. The sum of the coefficients for labor and materials should be less than one. Coefficient values for α_L and α_M that equal to one result in a price elasticity of supply that is undefined, and values greater than one result in negative supply elasticity measures. For these reasons, the production function is estimated with the restriction that the sum of the coefficients for the inputs equal one. This is analogous to assuming that the secondary aluminum industry exhibits constant returns to scale, or is a long-run constant cost industry. This assumption seems reasonable on an *a priori* basis and is not inconsistent with the data.

3.3.3.2 Estimated Model

The estimated model reflects the production function for secondary aluminum, using annual time series data for the years from 1958 through 1994. The following model was estimated econometrically:

$$\ln Q_t = \ln A + \alpha_K \ln K + \lambda \ln t + \alpha_L \ln L + \alpha_M \ln M$$

where each of the variables and coefficients have been previously defined.

3.3.3.3 Data

The data used to estimate the model are enumerated in Table 3-5. This table contains a list of the variables included in the model, the units of measure, and a brief description of the data. The data for the price elasticity of supply estimation model includes: the value of domestic shipments in millions of dollars; the price index for value of domestic shipments (the value of domestic shipments deflated by the price index represent the quantity variable, Q_t or the dependent variable in the analysis); a technology time variable, t; real net capital stock, K_t in millions of dollars; the number of production labor man-hours, L_t; the material inputs in millions of dollars, M_t; and the price index for value of materials. Data to estimate the production function for the secondary aluminum industry exclusively were largely unavailable; therefore, data for SIC code 3341 (Secondary Smelting and Refining of Nonferrous Metals) is utilized for each of the variables previously enumerated with the exception of the time variable.

The capital stock variable was the most difficult variable to quantify for use in the econometric model. Ideally, this variable should represent the economic value of the capital stock actually used by each facility to produce secondary aluminum for each year of the study. The most reasonable data for this variable would be the number of machine hours actually used

TABLE 3-4. DATA INPUTS FOR THE ESTIMATION OF THE PRODUCTION FUNCTION FOR THE SECONDARY ALUMINUM INDUSTRY

Variable	Unit of Measure	Description
Q_t	Millions of dollars	The value of shipments for SIC code 3341 deflated by the price index for value of shipments[1]
t	Years	technology time trend
K_t	Millions of 1987 dollars	Real capital stock for SIC code 3341[1]
L_t	Thousands of labor man hours	Production worker hours for SIC code 3341[1]
M_t	Millions of dollars	Dollar value of material input for SIC code 3341 deflated to real values using the materials price index[1]

NOTES. [1]Annual Survey of Manufactures.

to produce secondary aluminum each year. These data are unavailable. In lieu of machine hours data, the dollar value of net capital stock in constant 1987 prices, or real net capital stock, is used as a proxy for this variable. However, these data are imperfect in two ways. First, the data represent accounting valuations of capital stock rather than economic valuations. This aberration is not easily remedied, but is generally considered unavoidable in most studies of this kind. The second flaw involves capital investment that is used in production of secondary nonferrous metals other than secondary aluminum. Although aluminum represents the most significant metal accounted for in SIC 3341, it is not possible to segregate data for aluminum versus other metals. Thus the assumption is made that the production processes of secondary nonferrous metals are highly correlated with the productive process of secondary aluminum. This assumption represents a limitation of the analysis.

3.3.3.4 Statistical Results

SAS Release 6.12 for Windows was used to estimate econometric estimates of the price elasticity of supply for the secondary aluminum industry. A restricted least squares estimator was used to estimate the coefficients of the production function model. A log-linear specification was estimated with the sum of the α_i restricted to unity. This procedure is consistent with the assumption of constant returns to scale. The model was further adjusted to correct for first-order serial correlation using the Yule-Walker estimation procedure. The results of the estimated model are presented in Table 3-6. All of the coefficients have the expected sign, but only the capital stock and materials coefficients are significantly different from zero with a high degree of confidence.

TABLE 3-5. ESTIMATED SUPPLY MODEL COEFFICIENTS FOR THE SECONDARY ALUMINUM INDUSTRY

Variable	Estimated Coefficients[1]
t time	-0.04559 (0.0301)
K_t Capital stock	0.30073 (.0.0707)
L_t Labor	-0.00677 (0.0155)
M_t Materials	0.70604 (0.0696)

NOTES: [1]Standard errors are shown in parenthesis.

The coefficients for real capital and materials have the anticipated signs and are significant at a high level of confidence. The labor coefficient does not have the anticipated sign and does not test significantly different from zero. Using the estimated coefficients in Table 3-6 and the formula for supply elasticity shown under Section 3.3.3.1, *Model Approach*, the price elasticity of supply for secondary aluminum is derived to be 2.33. The calculation of statistical significance for this elasticity measure is not a straightforward calculation since the estimated function in non-linear. No attempt has been made to assess the statistical significance of the estimated elasticity. The corrections for serial correlation and the restricted model results yield inaccurate standard measures of goodness of fit (R^2). However, the model that is unrestricted and unadjusted for serial correlation has an R^2 of 0.79.

3.3.3.5 Limitations of the Supply Elasticity Estimates

The estimated price elasticity of supply for the secondary aluminum industry reflects that the industry in the United States will increase production of secondary aluminum products by 2.33 percent for every 1.0 percent increase in the price of these products. The preceding methodology does not directly estimate the supply elasticities for secondary aluminum due to a lack of necessary data. The assumption implicit in the use of this price elasticity of supply estimate is that the supply elasticity of secondary aluminum will not differ significantly from the price elasticity of supply for all products classified under SIC code 3341.

The uncertainty of the supply estimate is acknowledged. The results of a sensitivity analysis of the price elasticity supply is included in Appendix A for a high and low estimate of the price elasticity of supply of 1.33 and 3.33, respectively.

3.4 FINANCIAL IMPACT ANALYSIS

It is necessary to estimate the impact of the emission controls on the affected firms' financial performance after investment in emission control equipment. The financial impact analysis was conducted on a model plant basis due to lack of sufficient firm-specific financial data. However, model plant data evaluated at the firm level have been analyzed to estimate the financial impact of the regulation to firms within the industry.

The measure of the financial impact of the regulation used in this analysis is the cost-to-sales ratio. Cost-to-sales ratio refers to the change in annualized control costs divided by the revenues of a particular good or goods being produced in the process for which additional pollution control is required. It can be estimated for either individual firms or as an average for some set of firms such as affected small firms. While it has different significance for different market situations, it is a good rough gauge of potential impact. If costs for the individual (or group) of firms are completely passed on to the purchasers of the good(s) being produced, it is an estimate of the price change (in percentage form after multiplying the ratio by 100). If costs are completely absorbed by the producer, it is an estimate of changes in pretax profits (in percentage form after multiplying the ratio by 100). The distribution of costs-to-sales ratios across the whole market, the competitiveness of the market, and profit-to-sales ratios are among the obvious factors that may influence the significance of any particular cost-to-sales ratio for an individual facility.

Due to the number of facilities and variety of processes used in this industry, model plants were developed to categorize facilities based on possible combinations of processes that are performed. Sixteen model plants were created and annual compliance costs were calculated for each one. The individual facilities were then assigned to the model plant that most closely fit their process structure, and the annual compliance cost for that model plant was used in calculating the company's cost/sales ratio. Model plant revenues were estimated based upon the estimated model plant annual production and the average 1994 price of secondary aluminum alloy A-380 or estimated 1994 price of remelt secondary aluminum ingot. [133, 134, 135] In addition to model plant cost/sales ratios, these ratios were developed for a sample of firms anticipated to be impacted by the regulation. Actual sales data were available for a sample of firms in the aluminum die casting industry, the aluminum foundries and firms owning and operating sweat furnaces. Using these data and estimated model plant annualized costs, cost/sales ratios were developed.

4.0 CONTROL COSTS, ENVIRONMENTAL IMPACTS, COST EFFECTIVENESS, AND ESTIMATES OF ECONOMIC COSTS

4.1 INTRODUCTION

Inputs to the model outlined in the previous chapter include market data summarized in Chapter 2.0 and control cost estimates provided by the EPA. This chapter summarizes the cost inputs used in this EIA that were provided on a model plant basis for the affected facilities. Environmental impacts associated with the proposed regulatory alternative are also presented in this chapter. These impacts reflect estimates of emission reductions anticipated to result for this regulation. Finally, estimates of the cost-effectiveness and economic costs of the proposed regulation are shown.

4.2 CONTROL COST ESTIMATES

Control cost estimates and emission reductions were provided by EPA's engineering contractor on a model plant basis for each of the affected facilities. The model plants are made up of a series of model processes each of which is designed to represent processes found in the industry as determined from an industry survey. For each model process at each model plant, the baseline level of control is defined as uncontrolled, partially controlled, or fully controlled relative the Maximum Achievable Control Technology (MACT) floor level of emission control. In order to comply with a MACT standard, each model plant is assumed to need emission control equipment equal to MACT floor technology. Depending on the baseline level of control, plants may need to install an entire emission control system or may only need to update an existing system (e.g., add a lime injection system to an existing baghouse). EPA estimates that some furnaces can meet the proposed emission limits by using pollution prevention/work practices rather than installing emission controls. For some of these furnaces, a monitoring option would consist of a program for inspecting and testing the level of contaminants in the scrap. The cost impacts include the estimated cost of such a scrap inspection and sampling procedure for these furnaces.

The emission processes for which costs were estimated include: crushing and shredding; thermal chip drying; scrap drying/delaquering/and de-coating; furnace operations (including melting; holding; fluxing); in-line fluxing; sweating; and dross cooling. The costs were estimated for existing emission sources and potential new sources. New source costs represent the control of new process units and equipment built (or reconstructed or replaced) in the first 5 years after promulgation. For the secondary aluminum industry, it was assumed that new facilities planned and built in the near future will primary be built as replacement facilities for currently existing sources. Thus on a net basis, the cost estimates assume no growth in industry production in the near future beyond the current level of production. This assumption seems reasonable considering the current economic environment worldwide.

Table 4-1 presents the model plant and national annualized cost estimates for the secondary aluminum NESHAP.[136] Emission control costs are the annualized capital and annual operating and maintenance costs of controls based on the assumption that all affected facilities install controls. Capital costs for this regulation are estimated to be approximately $105.4 million. Since capital costs relate to emission control equipment that will be utilized over a period of years, this cost is annualized or apportioned to each year of the anticipated equipment life. The annual capital costs include annual depreciation of equipment plus the cost of capital associated with financing the capital equipment over its useful life. A seven percent discount rate or cost of capital is assumed for this regulation. The total national annualized costs for implementing the regulation are expected to be approximately $76.7 million including the costs of monitoring, recordkeeping and reporting. All costs are shown in 1994 dollars.

4.3 ENVIRONMENTAL IMPACTS AND COST EFFECTIVENESS

Baseline emissions for each model plant are estimated on the basis of measured emissions from existing emission controls. Emissions to the atmosphere after implementation of the

TABLE 4-1. CONTROL COST ESTIMATES FOR MODEL PLANTS AND NATIONWIDE COST ESTIMATES FOR THE SECONDARY ALUMINUM NESHAP
(thousands of 1994 dollars)

Model Plants	Capital Model Plant Costs	Annualized Model Plant Cost	Number of Plants	Total Capital Costs	Total Annualized Costs
1	$805	$380	31	$24,960	$11,766
2	950	362	10	9,500	3,621
3	1,833	702	7	12,832	4,911
4	2,944	1,203	9	26,492	10,829
5	1,441	851	10	14,409	8,510
6	976	671	7	6,833	4,696
7	198	134	6	1,188	807
8	0	0	6	0	0
MRR for Model Plants 1 - 8		0			3,885
Sweat Furnace 1	0	0.7	200	0	133
Sweat Furnace 2	0	0.7	450	0	299
Sweat Furnace 3	9.2	23.5	1,000	9,167	23,489
Die Casting 1	9	4.1	11	0	46
Die Casting 2	0	4.1	90	0	364
Die Casting 3	0	4.1	59	0	241
Foundry 1	0	4.1	612	0	2,489
Foundry 2	0	4.1	153	0	622
Nationwide Total	N/A	N/A		$105,381	$76,708

MACT standard are assumed to be equal to the proposed emission limits for each regulated source within the industry. Emission reductions at each model plant are estimated as the difference between emissions with existing controls in place and emissions to the atmosphere after adding the required emission controls. Where test data are incomplete, emission reductions are based on assumed control efficiencies or projections of measured efficiency at plants with similar processes.

The estimated emission reductions are based on the assumption that plants reduce emissions to a level equal to the proposed emission limit. Table 4-2 contains a summary of emission reductions for individual model plants and for the nation.[137] Emission reductions are shown in total and for hazardous air pollutants (HAPs). The estimated total HAP emission reductions are 12,382.8 tons per year, and total emission reductions of approximately 15,567.9

TABLE 4-2. ENVIRONMENTAL IMPACTS AND COST EFFECTIVENESS

	Emission Reductions by Plant (tons/yr)		Emission Reductions Nationwide (tons/yr)		Cost Effectiveness (1994$/ton)	
Model Plants	Total	HAP	Total	HAP	All Pollutants	HAP
1	60.4	53.0	1873.95	1643.75	$6,279	$7,158
2	106.0	106.0	1060.5	1060.5	$3,414	$3,414
3	210.9	143.3	1476.3	1002.9	$3,327	$4,897
4	539.0	407.2	4851.2	3664.9	$2,232	$2,955
5	467.9	349.8	4679.2	3498.2	$1,819	$2,433
6	226.0	216.1	1582.0	1512.5	$2,968	$3,105
7	7.43	0	44.6	0	$18,094	NA
8	0	0	0	0	0	NA
Total Nationwide			15,567.9	12,382.8	$2.900	$3,645

NA - not applicable

tons per year are anticipated. Cost effectiveness of this regulation is calculated by dividing the annualized costs of the regulation by the estimated emission reductions. The cost effectiveness of this regulation is estimated to be $2,900 per ton of total emissions reduced and $3,645 per ton of HAP reduction. Table 4-3 presents the total baseline emissions, controlled emissions, and emission reductions by emission type.

TABLE 4-3. BASELINE EMISSIONS AND EMISSION REDUCTIONS

Emissions	Baseline Emissions	Controlled Emissions	Emission Reductions	Percent Reductions
Particulates (tons/yr)	9,378	6,193	3,185	34.0
Hydrogen Chloride (tons/yr)	16,902	4,530	12,372	73.2
Chlorine (tons/yr)	1,098			
Total Hydrocarbons (tons/yr)	4,169			
Dioxins/Furans (lb/yr)	1.19	0.25	0.94	79.0
HAP Metals (ton/yr)	64.4	24.1	40.3	62.5
Polycyclic Organic Matter POM (tons/yr)	41	31	10	24.4
Total (tons/yr)	31,589	15,982	15,607	49.4
Total HAPs (tons/yr).	18,106	5,684	12,422	68.6

* Includes sweat furnaces that are area sources.

4.4 ESTIMATE OF ECONOMIC COSTS

Air quality regulations affect society's economic well-being by causing a reallocation of productive resources within the economy. Resources are allocated away from the production of goods and services (secondary aluminum) to the production of cleaner air. Estimates of the economic costs of cleaner air require an assessment of costs to be incurred by society as a result of emission control measures. By definition, the economic costs of pollution control are the opportunity costs incurred by society for productive resources reallocated in the economy to pollution abatement. The economic costs of the regulation can be measured as the value that society places on goods and services not produced as a result of resources being diverted to the production of improved air quality. The conceptually correct valuation of these costs requires the identification of society's willingness to be compensated for the foregone consumption opportunities resulting from the regulation. In contrast to the economic cost of regulation, emission control costs consider only the direct cost of emission controls to the industry affected by the regulation. Economic costs are a more accurate measure of the costs of the regulation to society than an engineering estimate of compliance costs. However, compliance cost estimates provide an essential element in the economic analysis.

Economic costs are incurred by consumers, producers, and society at large as a result of pollution control regulations. These costs are measured as consumer surplus and producer surplus. Consumer surplus is a measure of well-being or the welfare of consumers of a good and is defined as the difference between the total benefits of consuming a good and the market price paid for the good. Pollution control measures will result in a loss in consumer surplus due to higher prices paid for secondary aluminum and to the deadweight loss in surplus caused by reduced output of secondary aluminum in the post-control market.

Producer surplus is a measure of producers welfare that reflects the difference between the market price charged for a product and the marginal cost of production. Pollution controls will result in a change in producer surplus that consists of three components. These changes include surplus gains relating to increased revenues experienced by firms in the secondary aluminum industry due to higher post-control prices, surplus losses associated with increased costs of production for annualized emission control costs, and surplus losses due to reductions in post-control output. The net change in producer surplus is the sum of these surplus gains and losses.

The sum of the change in consumer surplus and producer surplus constitutes the economic costs of the regulation to society. Since a market impact analysis was conducted for the secondary aluminum smelting industry, estimates are provided for changes in consumer surplus and producer surplus for this industry (regulatory impacts associated with Model Plants 1-6). Engineering cost estimates are used as a proxy for the economic costs of the regulation applicable to secondary aluminum dross reclamation facilities, sweating furnaces, die casters, and foundries. Table 4-4 summarizes the estimates of economic costs associated with the regulatory alternative for the secondary aluminum production NESHAP smelting industry. The estimated economics costs of this regulation $75.5 million (1994$).

TABLE 4-4. ANNUAL ECONOMIC COST ESTIMATES FOR THE SECONDARY ALUMINUM REGULATION

Description	Amount (millions of 1994$)
Loss in Consumer Surplus (Secondary Aluminum Smelting)	$ (123.1)
Net Gain in Producer Surplus (Secondary Aluminum Smelting)	75.3
Total Loss in Surplus or Estimate of Economic Costs (Secondary Aluminum Smelting)	$ (47.8)
Engineering Cost Estimates for Die Casting, Sweating Furnaces, Foundries and Aluminum Dross Reclamation	$ (27.7)
Estimate of Economic Costs of the Regulation	$ (75.5)

( ) indicate losses or costs

5.0 PRIMARY ECONOMIC IMPACTS AND FINANCIAL IMPACT ANALYSIS

5.1 INTRODUCTION

Estimates of the primary economic impacts resulting from implementation of the secondary aluminum NESHAP and the results of the financial impact analysis are presented in this chapter. Primary impacts include changes in the market equilibrium price and output levels, changes in the value of shipments or revenues to domestic producers, and plant closures. The financial impact analysis assesses the ability of affected firms to raise capital and the impacts of control costs on firm profitability.

5.2 ESTIMATES OF PRIMARY IMPACTS

The partial equilibrium model is used to analyze the market outcome of the regulation for the secondary aluminum smelting and refining industry. As outlined in Chapter 3 of this report, the purchase of emission control equipment will result in an upward vertical shift in the domestic supply curve for the secondary aluminum smelting and refining market. The height of the shift is determined by the cash flow required to offset the per unit increase in production costs. Since the control costs vary for each of the model plants, the post-control supply curve is segmented, or a step function. A worst case assumption was necessary, because the underlying production costs for each facility are unknown. The facilities with the highest control costs per unit of production were assumed to also have the highest pre-control per unit cost of production. Thus, firms with the highest per unit cost of emission control are assumed to be marginal in the post-control market.

Foreign demand and supply are assumed to have the same price elasticities as domestic demand and supply, respectively. The export and import ratios for the model are based upon the export and import ratios for 1994 for SIC 3341 and 3353. Foreign and domestic post-control supply are added together to form the total post-control market supply. The intersection of this post-control supply with market demand will determine the new market equilibrium price and quantity in the secondary aluminum smelting and refining industry.

Table 5-1 presents the primary impacts predicted by the partial equilibrium model. The anticipated per ton price increase of $9.63 equates to less than a 1 cent per pound increase in the price of secondary aluminum. The percentage increase in price anticipated as a result of this regulation is 0.64 percent. Domestic production is expected to decrease by 51 thousand tons annually or by 0.40 percent.

The value of domestic shipments, or revenues, for domestic producers is expected to increase by 0.24 percent. Economic theory predicts that revenue increases are expected to occur when prices are increased for products which have inelastic price elasticity of demand, holding all other factors constant. This revenue increase results because the percentage increase in price is greater than the percentage decrease in quantity for goods with inelastic demand.

It is anticipated that there will be between zero to one closure as a result of this regulation. Firms that have post-control supply prices that exceed the market equilibrium price are assumed to close or cease to produce secondary aluminum. This assumption is consistent with the theory of perfect competition which presumes that all firms in the industry are price takers. In reality, firms with the highest per unit control costs may not have the highest underlying cost of production as postulated in the analysis. This is a worst-case assumption that is likely to bias the impact results and as a result, overstate the number of plant closures and other adverse effects of the emission controls. A sensitivity analysis assuming that the market experiences the average per unit cost of emission control costs for all model plants is presented in Appendix A. All primary market impacts are diminished with this assumption. Specifically, no facility closures are predicted with the average per unit cost of control assumption.

Of further note is the uncertainty associated with the estimates of facility-level production quantities and national production. Model plant estimates were used in this analysis that were based upon data obtained from the EPA information collection requests. The national secondary aluminum smelting and refining production is based upon the model plant estimates and the estimated number of facilities nationwide. Published production data estimates were assumed to understate nationwide production in this industry since much of the products produced are used for captive market purposes rather than sold directly into the marketplace. Since much of secondary aluminum smelting and refining production is not sold as an end-use product but rather used as an input to produce other end-use products by the secondary aluminum producer, the EPA information collection data are assumed to be a more accurate source of production data.

TABLE 5-1. SUMMARY OF PRIMARY ECONOMIC IMPACTS OF THE SECONDARY ALUMINUM NESHAP

	Estimated Impacts[4]			
	Price Increases[1]	Production[2]	Value of Domestic Shipments[3]	Facility Closures
Amount	9.63	(0.051)	46.54	0-1
Percentage	0.64	(0.40)	0.24	

NOTES: [1]Prices are shown in dollars per ton (1994 dollars). Equates to a price increase of less than one cent per pound.
[2]Annual production quantities are shown in millions of tons.
[3]Values of domestic shipments are shown in millions of 1994 dollars.
[4]Brackets indicate decreases or negative values.

The estimated primary impacts reported for the secondary aluminum industry depend upon the set of parameters used in the partial equilibrium model. Two of the parameters, the price elasticity of demand and the price elasticity of supply, have some degree of estimation uncertainty. For this reason, a sensitivity analysis was conducted. The results of these analyses are presented in Appendix A. Sensitivity analyses were performed for low- and high-end estimates of demand and supply elasticities, respectively. In general, the sensitivity analysis shows that the estimated primary impacts are relatively insensitive to reasonable changes in the price elasticity of demand and price elasticity of supply estimates.

5.3 FINANCIAL IMPACT ANALYSIS

The financial impact analysis involves examining cost-to-sales ratios. Model plant estimates of production and the 1994 average market price of Secondary Aluminum No. 380 alloy (or an estimated price for 1994 of remelt secondary aluminum ingot, as applicable) were used to estimate annual revenues per model plant. Actual company revenue data were used in the analysis, where available.

The emission control costs for each model plant reported in Chapter 4 of this document are used in the analysis. An assumption concerning the emission control costs for sweat furnaces merits discussion. Cost-to-sales ratios have been estimated assuming annualized emission control costs of $675 per sweat furnace for each of the sweat furnace model plants including sweat furnace model plant 3. (Note that annualized costs of $23,489 are shown for sweat furnace model plant 3 on Table 4-1.) As indicated in the EPA Cost Analysis for Sweat Furnace Operations[138], firms currently operating sweat furnaces installed without an afterburner (sweat furnace model plant 3) have been experiencing an operating cost advantage relative to firms operating sweat furnaces installed with the afterburner (sweat furnace model plant 1 and 2), ceteris paribus. These lower costs of operation are the result of the differential in the capital cost of a sweat furnace with and without afterburners, respectively. Specifically, the purchase price of a sweat furnace with afterburners included is more than triple the capital costs of those installed without an afterburner (on a comparable productive capacity basis). Lower equipment costs equate to additional profits for these firms, all other factors remaining equal. Thus those firms required by the regulation to install sweat furnace afterburners will simply experience costs comparable to those firms currently operating sweat furnaces equipped with afterburners. The cost advantage will simply disappear for any firm required to install afterburners as a result of this regulation. Therefore, it is reasonable to assume that all firms operating sweat furnaces will experience similar emission control costs as a result of this regulation.

Cost-to-sales ratio refers to the change in annualized control costs divided by the sales revenue of a particular good or goods being produced in the process for which additional pollution control is required. It can be estimated for either individual firms or as an average for some set of firms such as affected small firms. While it has different significance for different market situations, it is a good rough gauge of potential impact. If costs for the individual (or group) of firms are completely passed on to the purchasers of the good(s) being produced, it is an estimate of the price change (in percentage form after multiplying the ratio by 100). If costs are completely absorbed by the producer, it is an estimate of changes in pretax profits (in percentage form after multiplying the ratio by 100). The distribution of costs to sales ratios across the whole market, the competitiveness of the market, and profit to sales ratios are among the obvious factors that may influence the significance of any particular cost-to-sales ratio for an individual facility.

Table 5-2 summarizes the cost-to-sales ratios for each model plant and for the average facility affected by the regulation. The cost-to-sales ratios are less than 1 percent for each model plant other than model plant 7. The cost-to-sales ratios range from less than 0.01 percent to 1.08 percent for aluminum die casting model plant 1 and aluminum dross reclamation model plant 7, respectively. The average cost-to-sales ratio for the industry is 0.53 percent for aluminum smelting and refining model plants (1-6). The magnitude of these financial ratios indicates that the regulation will not impose a significant financial impact on firms in the aluminum smelting and refining, aluminum dross reclamation, aluminum die casting, and aluminum foundry industries or for firms owning and operating aluminum sweat furnaces.

TABLE 5-2. MODEL PLANT COST-TO-SALES RATIOS OF THE SECONDARY ALUMINUM NESHAP [139] [140] [141]

Model Plant	Cost-to-Sales Ratio (%)
1- Aluminum Smelting and Refining	0.70
2- Aluminum Smelting and Refining	0.35
3- Aluminum Smelting and Refining	0.82
4- Aluminum Smelting and Refining	0.71
5- Aluminum Smelting and Refining	0.13
6- Aluminum Smelting and Refining	0.07
Average 1-6 Aluminum Smelting and Refining	0.53
7- Aluminum Dross Reclamation	1.08
8- Aluminum Dross Reclamation	0.07
Sweat Furnace 1	0.16
Sweat Furnace 2	0.06
Sweat Furnace 3	0.08
Die Casting 1	<0.01
Die Casting 2	0.01
Die Casting 3	0.04
Foundry 1	0.17
Foundry 2	0.04

Actual sales data were available for a number of aluminum die casting, aluminum foundries, and firms owning or operating aluminum sweat furnaces. Cost-to-sales ratios were estimated for these sample firms and the result of this analysis is shown in Table 5-3. As this table shows, cost-to-sales ratios are well below 1 percent for each of the affected industries. This indicates that the economic impact of the regulation to firms in these industries is not likely to be significant.

TABLE 5-3. COST-TO-SALES RATIOS USING ACTUAL ALUMINUM DIE CASTERS, ALUMINUM FOUNDRIES AND FIRMS POTENTIALLY OWNING AND OPERATING ALUMINUM SWEAT FURNACES[142, 143, 144, 145]

Secondary Aluminum Industry	Cost-to-Sales Ratio (%)
Aluminum Die Casting Industry:	
Wards Business Directory (62 firms)	0.04
Dun & Bradstreet (57 firm average)	0.08
NACDA data	0.03
Aluminum Foundry Industry:	
Wards Business Directory (31 firms)	0.03
Dun & Bradstreet (39 firm average)	0.11
Firms Potentially Owning and Operating Aluminum Sweat Furnaces:	
Wards Business Directory (134 firms)	<0.01
Dun & Bradstreet (807 firm average)	0.03

5.4 LIMITATIONS

Several qualifications of the primary impact results presented in this chapter are required. A single national market for a homogenous product is assumed in the partial equilibrium analysis for the secondary aluminum smelting and refining industry. Secondary aluminum is not a perfectly homogenous product market and product differentiation does exist. There may also be some regional trade barriers that would protect individual secondary aluminum producers. In the analysis, the assumption is made that the facilities represented by model plants with the highest per unit control costs are marginal in the post-control market. This assumption presumes that the facility with the highest per unit cost of emission controls also has the highest cost average per unit of production, and the cost to the marginal facility is the cost that will influence the market outcome. The highest per unit control costs are estimated to significantly exceed the average per unit cost of control for the proposed regulation. The result of the foregoing list of qualifications is overstatement of the impacts of the chosen alternative on the market equilibrium price and quantity, revenues, and plant closures. Finally, some facilities may find it profitable to expand production in the post-control market. This would occur when a firm found its post-control incremental unit costs to be smaller than the post-control market price. Expansion by these firms would result in a smaller decrease in output and increase in price than would otherwise occur.

This analysis does not fully recognize the unique characteristics of the interrelationship between the production of secondary aluminum and primary aluminum. Due to data, time, and resource constraints, the secondary aluminum market analysis does not directly model the market impact of the secondary aluminum NESHAP on the scrap, primary aluminum, and secondary aluminum markets and the interrelationship between these markets. As discussed in the industry profile section of this report, secondary aluminum and primary aluminum are very close demand substitutes, with each product being interchangeable for end-use market purposes in many cases. The interrelationship between secondary and primary aluminum is further complicated by the fact that the production of aluminum directly impacts the supply of secondary aluminum since recycled aluminum or scrap is a significant input into the production of secondary aluminum. From the demand perspective, the existence of primary aluminum is likely to make demand more elastic for secondary aluminum, ceteris paribus. The proposed regulation will lead to a decrease in the supply of secondary aluminum and an increase in the demand for primary aluminum, all other factors held constant. This would result in an increase in the market equilibrium price of primary aluminum and an increase in the quantity demanded. Since scrap originating from primary and secondary aluminum products are recycled, the market impact of an increase in the market equilibrium quantity of primary aluminum is to increase the supply of recycled aluminum. In contrast, a decrease in the market equilibrium quantity supplied of secondary aluminum potentially decreases the supply of scrap or recycled aluminum. These factors will have offsetting effects, and the timing and magnitude of the impact of the proposed regulation on the scrap market is uncertain. In order to estimate the market consequences of secondary market impacts for the scrap market, more detailed information concerning the origin of scrap and the vintage of recycled scrap is needed. Such data are not readily available. Since the primary market impacts of the regulation for the secondary aluminum industry are estimated to be minimal with price and quantity changes of less than 1 percent, secondary impacts on the scrap and primary aluminum markets are likely to be minimal also.

The results of the sensitivity analysis of demand and supply elasticities are reported in Appendix A. For the price elasticity of demand, an upper bound of -0.80 is used in the sensitivity analysis. This elasticity is the estimate found in the literature for the overall aluminum metal (primary and secondary aluminum). An estimate of -0.16 is used as a lower bound price elasticity of demand in the sensitivity analysis, and this estimates represents a decrease of one standard deviation from the estimate used in the analysis. These results show less adverse impacts on producers when demand is less elastic, or when supply is less elastic, in terms of reduction in market output and reduction in value of domestic shipments. The results of the economic analysis are relatively insensitive to reasonable variations in the price elasticity of demand or the price elasticity of supply inputs.

Baseline data limitation also exist in the analysis and lend uncertainty to the primary market impacts reported. The baseline market price used in the analysis for secondary smelting and refining is the price of No. A-380 alloy. The market price used for aluminum dross reclamation and aluminum sweat furnaces is an aluminum remelt ingot price obtained from a producer. These prices are used as a surrogate for the market price of all secondary aluminum produced from smelting and refining and from sweat furnaces and aluminum dross furnaces, respectively. No. A-380 alloy is a mid-range priced secondary aluminum alloy and a representative estimate of the market price of the product. However, secondary aluminum products are differentiated and the market price of different types of aluminum do differ. Market consumption and production data reported in public data sources do not reflect captive production in the market and thus could not be used for the analysis. Data from the EPA information collection request were used to estimate annual production in the market based upon the assumption that these data are more reflective of production in the market than published sources of data. Since there is uncertainty about the baseline market equilibrium price and quantity in the secondary aluminum market, there is also uncertainty about annual revenues for the industry that are a function of the market price and production sold in the market during the base year.

The financial impact analysis also has limitations. Model plant data were used in the analysis due to the lack of publicly available financial data. To the extent that annual sales revenue of firms in the industry differs from the estimates based on model plant production and the price of No. A-380 secondary aluminum alloy or aluminum remelt ingot, the cost-to-sales ratios may be understated or overstated.

5.5 SUMMARY

In general, the primary market impacts of this regulation are expected to be minimal with price increases and production decreases of less than one percent for the aluminum smelting and refining industry. A market price increase of 0.64 percent and domestic production decrease of 0.49 percent are predicted. Revenues or the value of domestic shipments for the industry are expected to increase by 0.24 percent. The increase in the value of shipments results because the price elasticity of demand for secondary aluminum is inelastic. Products that demonstrate inelastic price elasticity of demand are characterized by larger percentage price increases than production percentage decreases occurring when prices are increased. For products with inelastic demand, a price increase leads to increases in revenue or value of shipments. Individual facilities within the industry may experience revenue increases or decreases, but on average the industry revenues are anticipate to increase slightly with this regulation. Potentially, zero to one facility may possibly close as a result of the regulation. Financial impacts, as measures by cost-to-sales ratios for the firms in the aluminum smelting and refining industry, aluminum dross reclamation facilities, aluminum die casting industry, aluminum foundries, and firms owning and operating aluminum sweat furnaces are minimal. These data suggest that firms within these industries will not experience significant economic impacts as a result of this regulation.

6.0 SECONDARY ECONOMIC IMPACTS

6.1 INTRODUCTION

In addition to impacts on price, production, and revenue, implementation of emission controls is likely to have secondary impacts on the labor market, international trade, substitute markets such as the primary aluminum industry, and regional effects. The potential changes in employment, balance of trade, and substitute market impacts for industries such as the primary aluminum industry, and regional impact distribution are presented individually below.

6.2 LABOR MARKET IMPACTS

The estimated labor impacts associated with the NESHAP are based on the results of the partial equilibrium analyses of the secondary aluminum industry, and are reported in Table 6-1. The number of workers employed by firms in this industry is estimated to decrease by up to 94 workers as a result of the emission controls. These job losses are considered transitional in nature. The estimated loss in number of workers results primarily from projected reductions in levels of production reported in Chapter 5 for the secondary aluminum industry. Gains in employment anticipated to result from operation and maintenance of control equipment have not been included in the analysis due to the lack of reliable data. Estimates of employment losses do not consider potential employment gains in industries that produce substitute products such as the primary aluminum industry. Similarly, losses in employment in industries that use secondary aluminum as inputs or in industries that provide complement goods are not considered. The changes in employment reflected in this analysis are only direct employment losses due to estimated reductions in domestic production of secondary aluminum.

TABLE 6-1. SUMMARY OF SECONDARY IMPACTS OF THE SECONDARY ALUMINUM INDUSTRY

	Estimated Impacts[1]		
Secondary Aluminum	Labor Input[2]	Foreign Trade[3]	
		Imports	Exports
Amount	(94)	0.020	(0.003)
Percentage	(0.40%)	1.51%	(0.22%)

NOTES: [1]Brackets indicate decreases or negative values.
[2]Indicates estimated reduction in number of jobs.
[3]Reduction in import and exports in millions of tons

The loss in employment is relatively small in terms of number of job displacements. The magnitude of predicted job losses directly results from the relatively small estimated decrease in production and the relatively low labor intensity in the secondary aluminum industry.

6.3 FOREIGN TRADE

The implementation of the NESHAP will increase the costs of production for domestic secondary aluminum producers relative to foreign producers, all other factors being equal. This change in the relative price of imports will cause domestic imports of secondary aluminum to increase and domestic exports of secondary aluminum to decrease. The overall balance of trade for secondary aluminum (based upon the net exports for SIC 3341 and 3353 is slightly positive (exports exceed imports slightly). The NESHAP is likely to cause the balance of trade to become slightly negative. The estimated impacts on net exports for the secondary aluminum industry is to decrease net exports by 0.023 million tons per year. This includes an increase in imports of approximately 1.51 percent or 0.020 million tons and a decrease in exports of approximately 0.22 percent or 0.003 million tons per year. The predicted changes in imports and exports are reported in Table 6-1.

6.4 REGIONAL IMPACTS

No significant regional impacts are expected to result from implementation of the NESHAP. Since the estimated economic impacts of the regulation are anticipated to be minimal, the effect of the regulation is not expected to adversely impact one region of the country relative to another.

6.5 SUBSTITUTE PRODUCT MARKETS

The industry profile section of this report outlines substitutes for aluminum that include glass, plastics, magnesium, steel, copper, wood, titanium, graphite, paper, and fiber epoxies. The degree of substitutability of these products for aluminum depends upon end-use product. For example, plastic and glass are substitutes for aluminum when used as beverage containers. To the extent that the price of secondary aluminum increases as a result of this regulation, the substitute markets may experience increases in demand as consumers of aluminum substitute these products for aluminum. As discussed in Chapter 5, the primary impacts of the secondary aluminum NESHAP are anticipated to be minimal with predicted price increases of less than 1 percent. Thus, impacts on secondary substitute markets are likely to be minimal as well.

The aluminum market consists of primary aluminum and secondary aluminum production. As previously discussed, the interrelationship between these products is somewhat unusual. Primary and secondary aluminum are substitute products from a demand standpoint for most end-use applications. Additionally, primary and secondary aluminum production directly impacts the stock of scrap aluminum which is an input into the production of secondary aluminum. Increases in the price of secondary aluminum are predicted to occur as a result of this regulation. To the extent secondary aluminum prices do increase, an increase in the demand for primary aluminum will likely occur. This increase in demand will lead to a higher market equilibrium price and an increase in the quantity of primary aluminum produced and sold. As discussed in Section 5.4, the impact of this regulation on the market for scrap is uncertain. The increase in the market equilibrium quantity of primary aluminum produced will potentially increase the quantity of scrap available for recycling and secondary aluminum production, ceteris paribus. However, the decrease in market equilibrium quantity of secondary aluminum may potentially decrease the supply of scrap. These impacts are offsetting and the ultimate market impacts are unknown. The magnitude of the primary market impacts of the regulation to the secondary aluminum market are minimal with price and quantity changes of less than one percent predicted. Based upon these findings, it is reasonable to assume that the secondary market impacts to the primary aluminum and scrap markets will be minimal also.

6.6 LIMITATIONS

The estimates of the secondary impacts associated with the emission controls are based on changes predicted by the partial equilibrium model for the secondary aluminum industry. The limitations described in Section 5.4 of the previous chapter are also applicable to the secondary economic impacts reported in this chapter. As previously noted, the employment losses do not consider potential employment gains for operating the emission control equipment. It is important to note that the potential job losses predicted by the model are only those which are attributable to the estimates of production losses in the secondary aluminum industry. Likewise, the gains or losses in markets indirectly affected by the regulations, such as substitute product markets, complement products markets, or markets that use secondary aluminum as an input to production, have not been considered, except as specifically discussed previously. Baseline trade balance data for the secondary aluminum market were unavailable in the literature. In lieu of this information, import and export ratios for SIC 3341 and 3353 were assumed for the secondary aluminum market. To the extent that these trade ratios do not reflect baseline imports and exports of secondary aluminum, the estimated trade impacts may be overstated or understated.

6.7 SUMMARY

The estimated secondary economic impacts are relatively small. As many as 94 job losses may occur nationwide. A decrease in exports of secondary aluminum of 0.20 percent and an increase in imports of 1.51 percent annually is predicted. The secondary aluminum NESHAP will likely result in an increase in the demand for primary aluminum and other substitutes. This increase in demand for primary aluminum will result in an increase in market equilibrium price and output of primary aluminum, ceteris paribus. No significant regional impacts are anticipated.

7.0 POTENTIAL SMALL BUSINESS IMPACTS

7.1 INTRODUCTION

The Regulatory Flexibility Act (RFA) generally requires an agency to prepare a final regulatory flexibility analysis unless the agency certifies that the final rule will not have a significant economic impact on a substantial number of small entities. The RFA was amended on March 29, 1996 when the President signed the Small Business Regulatory Enforcement Fairness Act (SBREFA) into law. The SBREFA strengthened the RFA analytical and procedural requirements in making these small business determinations.

The EPA analyzed the potential impact of the proposed rule on small entities. The results of the analysis for the proposed rule and the method used by the EPA to perform the analysis of impacts on small entities are discussed in the preamble to the proposed rule (64 FR 6946, February 11, 1999). In response to comments on the proposed rule that the EPA understated the number of small businesses that would be affected by the rule, the EPA refined its small business impacts analysis to include information concerning sweat furnaces, aluminum die casting facilities, and aluminum foundries.

7.2 SMALL BUSINESS CLASSIFICATION

The Small Business Administration (SBA) sets size standards for small entities at the 4-digit Standard Industrial Code (SIC) level. These standards are set based on either company-wide employment or annual receipts. The appropriate size standard used to determine whether a particular firm is identified as a small entity is based on the SIC code that defines the firm's activities. For this rule, firms producing in SIC 3334 (primary production of aluminum), 3341 (secondary smelting and refining of nonferrous metals), 3353 (aluminum sheet, plate, and foil), 3354 (aluminum extruded products), 3363 (aluminum die-casting), 3365 (aluminum foundries), 4953 (refuse systems), 5015 (motor vehicle parts-used), and 5093 (scrap and waste materials) may be affected by the regulation. The size standards for a small entity for each SIC are shown in Table 7-1.

TABLE 7-1. SECONDARY ALUMINUM NESHAP AFFECTED INDUSTRIES AND SMALL BUSINESS CRITERIA

Standard Industrial Classification Code	Small Business Criteria
3334 Primary Aluminum Production	less than 1,000 employees
3341 Secondary Smelting and Refining of Nonferrous Metals	less than 500 employees
3353 Aluminum Sheet, Plate, and Foil	less than 750 employees
3354 Aluminum Extruded Products	less than 750 employees
3363 Aluminum Die-Casting	less than 500 employees
3365 Aluminum Foundries	less than 500 employees
4953 Refuse Systems	less than $6 million in annual sales revenues
5015 Motor Vehicle Parts - Used	less than 100 employees
5093 Scrap and Waste Materials	less than 100 employees

7.2.1 Secondary Aluminum Producers

Secondary aluminum producers may produce products classified in SIC 3334, 3341, 3353, and 3354. Firms producing products classified primarily in SIC 3334 (primary aluminum production) are considered small businesses when these companies employ less than 1000 employees. According to this definition, firms producing principally in the primary aluminum industry are large companies.[146] Firms producing primarily in SIC 3341, 3353 and 3354 are considered small when these companies employ less than 500, 750, and 750 employees, respectively. Since many firms engage in production of products in more than one SIC, the limit of 750 employees was applied as the small business standard to all firms producing in SIC 3341, 3353 and 3354. This approach results in a greater number of firms designated as small entities.

The EPA received responses to an information collection request from 135 facilities producing products in SIC 3334, 3341, 3353, and 3354[125]; however, it is thought that there are in excess of 400 facilities which produce these products. To define the small business entities, the 135 facilities were matched to their parent companies. It was determined that 32 of these companies may be impacted by this regulation and meet the SBA definition of a small business entity (less than 750 employees).[147] [148]

7.2.2 Aluminum Die Casting, Aluminum Foundries, and Firms Owning Aluminum Sweat Furnaces

There are 320 aluminum die casting companies and approximately 1530 aluminum foundries currently operating domestically. The vast majority of these firms are small businesses employing less than 500 employees. No small businesses within the aluminum die casting companies or aluminum foundries have been specifically identified that are impacted by the final rule under applicability as defined. Only large businesses have come forward with information regarding applicability of the standard(s) to their operations. Based on that information, we have performed a small business analysis based on a probable over-estimate of the number of small businesses within these industry sectors that may be affected by the final rule. (Docket A-92-61).

It is estimated that around 1650 sweat furnaces are operated by businesses in the United States. These firms may be subject to this rule. Firms owning sweat furnaces are primarily small businesses. Data specific to the aluminum die casting, aluminum foundries, and firms owning sweat furnaces were obtained from industry associations and public sources.[149, 150, 151]

7.3 METHODOLOGY

The analysis of small business impacts for the secondary aluminum industry will focus on a comparison of compliance costs as a percentage of sales (cost/sales ratio). Other methods that can be used to determine whether impacts will be significant are the comparison of compliance costs to production costs or to capital available to small firms, and an analysis on the potential for closure. However, the information necessary to make such comparisons are generally considered proprietary by small business firms.

Cost/sales ratio refers to the change in annualized control costs divided by the sales revenues of a particular good or goods being produced in the process for which additional pollution control is required. It can be estimated for either individual firms or as an average for some set of firms such as affected small firms. While it has different significance for different market situations, it is a good rough gauge of potential impact. If costs for the individual (or group) of firms are completely passed on to the purchasers of the good(s) being produced it is an estimate of the price change (in percentage form after multiplying the ratio by 100). If costs are completely absorbed by the producer it is an estimate of changes in pretax profits (in percentage form after multiplying the ratio by 100). The distribution of costs/sales ratios across the whole market, the competitiveness of the market, and profit to sales ratios are among the obvious factors that may influence the significance of any particular cost/sales ratio for an individual facility.

Due to the number of facilities and variety of processes used in this industry, model plants were developed to categorize facilities based on possible combinations of processes that are performed. Sixteen model plants were created and annual compliance costs were calculated for each one.[152] The individual facilities were then assigned to the model plant that most closely fit their process structure, and the annual compliance cost for that model plant was used in calculating the company's cost/sales ratio.

Two alternative approaches were used to estimate the sales revenues for the affected small businesses. One approach uses actual sales data where available. With this approach actual sales data were used to compute cost/sales ratios for affected entities. The second approach recognizes that actual sales data were unavailable for many affected firms. In lieu of the actual sales data, model plant revenues were calculated based upon the estimated model plant annual production and the average 1994 price of secondary aluminum alloy A-380 or an estimate of the1994 price for remelt secondary aluminum ingot, as appropriate.[153,154,155,156,157]

The individual facilities were then assigned to the model plant that most closely fit their process structure, and the annual compliance cost for that model plant was used in calculating the company's cost/sales ratio. If actual sales data were available at the company level, this figure was divided by the model plant annual compliance cost to get a cost/sales ratio for the company. Model plant cost/sales ratios were calculated as an estimate of the impact for companies where actual sales data were unavailable.

7.4 SMALL BUSINESS IMPACTS

Cost/sales data were developed using actual revenue data for small businesses potentially affected by the rule. Specifically, cost/sales ratios were estimated using the actual revenue data for 26 secondary aluminum companies, 53 aluminum die casting firms, 22 aluminum foundries, and 65 firms that may own and operate sweat furnaces. As shown in Table 7-2, cost/sales ratios for secondary aluminum firms average 0.74 percent. Nineteen firms had cost/sales ratio below 1 percent. Seven secondary aluminum firms had ratios above 1 percent, but less than 3 percent.

The cost/sales ratios estimated using actual sales data for the aluminum die casting industry, the aluminum foundry industry, and firms potentially owning sweat furnaces were each below 1 percent. The average cost/sales ratios were 0.04, 0.04 and 0.01 percent for the die casting companies, aluminum foundries, and firms potentially owning sweat furnace respectively.

TABLE 7-2. SECONDARY ALUMINUM NESHAP COMPANY-SPECIFIC COST TO SALES RATIOS FOR AFFECTED SMALL BUSINESSES

Cost/Sales Ratio	Number of Small Companies in Each Cost to Sales Range
Secondary Aluminum Industry	
0.00%-0.99%	19
1.00%-1.99%	5
2.00%-2.99%	2
Mean cost to sales ratio=0.74%	Total = 26 firms
Mean Cost to Sales Ratio	**Number of Small Companies Evaluated**
Aluminum Die Casting Industry	
0.04%	53 firms
Aluminum Foundry Industry	
0.04%	22 firms
Firms Owning Sweat Furnaces	
0.01%	65 firms

Cost/sales ratios for each of the model plants calculated with model plant cost and revenue estimates are shown in Table 7-3. As this table shows, cost/sales ratios based on model plant revenue and cost data yield ratios of less than 1 percent for all model plants other than model plant 7. The cost/sales ratio for model plant 7 is 1.08 percent.

A cost/sales ratio of 3 percent is considered an indicator of the potential for significant impact for a firm in the affected industries. This significance criterion estimate is based upon a review of typical profit to sales ratios for the affected SIC codes.[158] The cost/sales estimates based upon actual revenue data and model plant revenue data fall below 3 percent for all affected entities. Based upon this analysis, it is reasonable to assume that small entities will not be significantly impacted by this regulation.

TABLE 7-3. SECONDARY ALUMINUM NESHAP COST TO SALES RATIOS ASSUMING MODEL PLANT COST AND REVENUE DATA

Model Plant	Model Plant Cost to Sales Ratio (%)
1	0.70
2	0.35
3	0.82
4	0.71
5	0.13
6	0.07
7	1.08
8	0.07
Sweat Furnace 1	0.16
Sweat Furnace 2	0.06
Sweat Furnace 3	0.08
Die Casting 1	<0.01
Die Casting 2	0.01
Die Casting 3	0.04
Foundry 1	0.17
Foundry 2	0.04

APPENDIX A
SENSITIVITY ANALYSIS

A-1 INTRODUCTION

The market model used to estimate primary and secondary market impacts of the secondary aluminum NESHAP is subject to uncertainties. Two of the model parameters, the price elasticity of demand and the price elasticity of supply, have some degree of estimation uncertainty. Additionally, the per unit cost of emission controls that will be marginal, and thus influence market price and output changes is also not known with precision. The purpose of the sensitivity analyses contained in this Appendix is to quantify these uncertainties in terms of market impact results.

A-2 SENSITIVITY OF THE MODEL ESTIMATES OF THE PRICE ELASTICITY OF DEMAND AND THE PRICE ELASTICITY OF SUPPLY

The sensitivity analysis contained in this Appendix explores the degree to which the results presented earlier in this report are sensitive to the estimates of the price elasticities of demand and supply which were used as inputs to the model. The analysis of the price elasticity of demand will presume that the supply elasticity is 2.33 as hypothesized in the partial equilibrium model. Alternatively, the sensitivity analysis of the price elasticity of supply will assume that the demand elasticity estimate -0.34 postulated in the model of remains unchanged for each.

The results presented in this Appendix are based upon a low-end price elasticities of demand estimate that differs by one standard error from that used in the model. For the high-end estimate, a published estimate of the price elasticity of demand for aluminum (primary and secondary aluminum) is utilized. Table A-1 presents the alternative measures of price elasticities of demand and the price elasticity of supply.

TABLE A-1. PRICE ELASTICITY OF DEMAND AND PRICE ELASTICITY OF SUPPLY ESTIMATES

	Elasticity Measure	High Estimate	Low Estimate
Demand	-0.34	-0.80	-0.16
Supply	2.33	3.33	1.33

TABLE A-2. SENSITIVITY ANALYSIS FOR ESTIMATED PRIMARY IMPACTS: LOW-END AND HIGH-END PRICE ELASTICITY OF DEMAND AND SUPPLY SCENARIOS[1]

	Market Price Change (%)	Market Output Change (%)	Change in the Value of Shipments (%)	Facility Closures
Price elasticity of demand				
Low estimate	0.69	(0.29)	0.40	0-1
High estimate	0.55	(0.62)	(0.07)	0-1
Price elasticity of supply				
Low estimate	0.59	(0.30)	0.28	0-1
High estimate	0.67	(0.49)	0.18	0-1

NOTES: [1] Brackets indicate decreases or negative values.

The results of the sensitivity analysis relative to the demand elasticity estimates and supply elasticities are presented in Table A-2. The results of the low-end and high-end demand elasticity scenarios differ very little from the reported model results presented in Chapter 5. The signs of the changes in price, quantity, and value of shipments are generally unchanged. The change in the value of shipments becomes negative assuming a high elasticity of demand estimates. The relative size of the changes are not significantly different under the alternative assumptions of elasticity. The results of this analysis tend to present relatively more favorable results for the affected industries with less elastic demand and less favorable with more elastic demand. Similarly, the results with the low-end and high-end elasticity of supply estimates do not differ significantly from the model results discussed in Chapter 5. More favorable results occur when the price elasticity of supply is less elastic and less favorable with more elastic supply. In summary, the results of the sensitivity analyses of elasticity estimates do not indicate that the model results are sensitive to reasonable changes in the price elasticities of demand or supply. This conclusion provides support for greater confidence in the reported model results.

A-3 SENSITIVITY ANALYSIS OF THE PER UNIT COSTS OF EMISSION CONTROLS

A partial equilibrium model is used to estimate primary and secondary market impacts of the secondary aluminum NESHAP. The assumption is made in the model that the firm experiencing the highest per unit cost of emission control also has the highest pre-control cost of production. As the highest cost producer, this firm is marginal in the industry or the firm likely to have the most significant impacts as a result of the regulation. This assumption leads to greater price and quantity changes estimates in the model than alternative assumptions. In reality, this assumption may not be the case. To determine the sensitivity of the primary market impacts to this assumption, an additional analysis was conducted. This analysis postulates that the average cost of emission controls (or per unit cost) is the costs that is relevant in the marketplace. The results of this analysis are reported in Table A-3.

In general, the primary and secondary market impacts are significantly lowered when the assumption is made that each facility faces the same industry average per unit emission control costs. The primary market impacts and the secondary market impacts of this alternative average cost secondary model are presented in Table A-3. No facility closures are predicted when identical average control costs are assumed. Impacts on price, output, and domestic value of shipment (or revenue) decreases for the industry are less than 1 percent. Employment losses decline to 29 for this industry and trade effects are minor. Based upon the results of this analysis, it is reasonable to conclude that the regulatory impacts are minimal when the assumption is made that all producers face identical average per unit emission control costs.

TABLE A-3. SENSITIVITY ANALYSIS FOR ESTIMATED PRIMARY AND SECONDARY MARKET IMPACTS RELATIVE TO THE INDUSTRY AVERAGE COSTS OF EMISSION CONTROLS

Primary Market Impacts	Amount
Change in Market Price (%)	0.20
Change in Domestic Output (%)	(0.12)
Change in the Value of Shipments (%)	0.07
Facility Closures (number of facilities)	0
Secondary Market Impacts	
Labor Market Decreases (number of workers)	29
Increases in imports (%)	0.46
Decreases in exports(%)	(0.07)

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