December 1993

Steel Pickling: A Profile

Draft Report

Prepared for

John Robson
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Cost and Economic Impact Section
Research Triangle Park, NC 27711

EPA Contract Number 68-D1-0143
RTI Project Number 35U-5681-58 DR

EPA Contract Number
68-D1-0143

RTI Project Number
35U-5681-58 DR

Steel Pickling: A Profile

Draft Report

December 1993

Prepared for

John Robson
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Cost and Economic Impact Section
Research Triangle Park, NC 27711

Prepared by

Tyler J. Fox
Craig D. Randall
David H. Gross

Center for Economics Research
Research Triangle Institute
Research Triangle Park, NC 27709

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION 1
INTRODUCTION

Steel pickling is part of the finishing process in the production of certain steel products in which oxide and scale are removed from the surface of strip steel, steel wire, and some other forms of steel, by dissolution in acid. A solution of either hydrogen chloride (HCl) or sulfuric acid is generally used to treat carbon steel products, while a combination of hydrofluoric and nitric acids is often used for stainless steel. Steel pickling and the associated process of acid regeneration result in the emission of hazardous air pollutants (HAPs). Currently, the U.S. Environmental Protection Agency (EPA) is preparing National Emission Standards for Hazardous Air Pollutants (NESHAP) to apply to existing and new steel pickling facilities and associated acid regeneration plants under the authority of Section 112 of the Clean Air Act.

The U.S. has 103 steel pickling facilities operating currently.[1] Many, but not all, are integrated into iron and steel manufacturing plants. In an ancillary process, spent HCl pickle liquor, which contains iron chloride plus HCl solution is converted by a spray oxidation process into a marketable iron oxide product plus HCl solution that can be recycled for the pickling operation. Ten facilities perform acid regeneration in the U.S., including two independently operated plants and eight process lines operating in conjunction with steel pickling facilities.[2] Emissions from most existing pickling and regeneration facilities are currently well controlled.

For 1991, steel pickling facilities reported a capacity utilization rate of 76.5 percent with total annual production

of 43.8 million tons of steel.[3] A large number of steel products are subjected to acid pickling, including sheet and strip, bars, rods, wires, and tubes. All of these products can be classified as steel mill products. The American Iron and Steel Institute (AISI) estimated 1991 U.S. shipments of steel mill products at 78.8 million tons.[4] Although statistics on the percentage of total steel mill products processed by pickling operations are not available, we can infer from the above data that roughly 55 percent of all steel mill products in 1991 were pickled.

This profile begins by characterizing the supply side of the steel industry including the steel pickling process and its relation to other stages of production in manufacturing steel, the factors of production in pickling operations, product characteristics, and costs of production for steel pickling operations. We next characterize the demand side by concentrating on the desired characteristics of steel mill products and their primary consumers. The organization of the steel industry is then presented, including a detailed description of U.S. steel pickling facilities and the firms that own these plants. Finally, we present historical statistics on the U.S. production and consumption of steel mill products, as well as on foreign trade of steel mill products.

U.S. Environmental Protection Agency. Information Collection Request (ICR) Database. 1993.

U.S. Environmental Protection Agency. Information Collection Request (ICR) Database. 1993.

U.S. Environmental Protection Agency. Information Collection Request (ICR) Database. 1993.

American Iron and Steel Institute (AISI). Annual Statistical Report. 1992.

SECTION 2
THE SUPPLY SIDE OF THE INDUSTRY

In this section, we describe the steel pickling process and its relation to the entire steel manufacturing process. This section also discusses the major by-products and coproducts of steel pickling, mainly the regeneration of spent acid. The section also provides a discussion of steel products as well as the costs of steel production and acid pickling.

2.1 STEEL PRODUCTION

Figure 2-1 shows the entire set of operations involved in producing finished steel, which includes five major groups of activities: coking, sintering, ironmaking, steelmaking, and final rolling and finishing.

Coking involves heating coal in the absence of air and results in the separation of the noncarbon constituents of the coal from the product coke, which is principally carbon. Coke is used as a fuel and source of carbon monoxide in the blast furnace during iron-making. Sintering is the process that agglomerates fine ore particles into a porous mass for input to the blast furnace. This process was developed to make use of the coke fines, iron ore fines, and recovered blast furnace flue dust.[5]

During ironmaking, molten iron is produced by reducing iron ore in the blast furnace. In this process, elemental iron is separated by reduction from the oxygen with which it is combined in iron ore. Thus, the iron in molten form is separated from the nonmetallic part of the ore and from impurities such as sulfur and manganese.[6]

Figure 2-1. Basic flow diagram of iron and steel production.

The next activity, steel making from molten iron or scrap, or both, involves removing relatively small amounts of impurities from the metallic input through oxidation. Molten iron is saturated with carbon and contains undesirable amounts of silicon, manganese, phosphorus, and sulfur, all of which most be removed in the steel-making operation.[7] The three furnace types currently employed in steelmaking are the open hearth furnace, the basic oxygen converter, and the electric arc furnace. Integrated steelmakers primarily employ the open

hearth and basic oxygen furnaces, where oxidation purifies the metallic inputs of molten iron and steel scrap. Nonintegrated steelmakers rely on the electric arc furnace because the metallic input is all scrap.

The final activity, rolling and finishing, converts molten steel into semifinished and finished steel products. As shown in Figure 2-2, acid, or steel, pickling is an intermediate process in this final activity of steel production. Rolling and finishing steel involves the operations shown in Figure 2-2, which take molten steel from the steel-making furnaces and produce the range of shapes and sizes the particular mill markets. This stage of production is perhaps the most complicated of all because of the vast number of possible products, the array of process units used to produce any particular product, the different operating practices possible with each process unit, and the difficult relations between residuals generation and operating practice for each unit.[8] The following discussion leaves the complicated issues of this stage of production and focuses on the steel pickling process itself.

2.2 STEEL PICKLING

During the hot rolling or heat treating of steel, oxygen from the atmosphere reacts with the iron in the surface of the steel to form a crust that is made up of a mixture of iron oxides. The presence of oxide (or scale) on the surface of the steel is objectionable when the steel is to be subsequently shaped or cold-rolled and coated. Numerous methods have been used to remove iron oxides from metal surfaces. These methods include abrasive blasting, tubling, brushing, acid pickling, salt bath descaling, alkaline descaling, and acid cleaning. The preferred method in steel production is steel pickling.

Figure 2-2. Basic flow diagram of steel rolling and finishing.

The following characteristics of steel products imparted through the pickling process (i.e., removal of oxide and other scale from its surface) are responsible for the use of steel pickling:

- lengthens die life, eliminates irregular conditions, and promotes surface smoothness of the finished product.
- permits proper alloying or adherence of metallic coatings and satisfactory adherence when a nonmetallic coating or paint is used.
- prevents lack of uniformity and eliminates surface irregularities during cold reduction of steel sheet and strip.[9]

Table 2-1 provides a summary of the inputs and residuals of both HCl acid and sulfuric acid steel pickling processes for carbon steel strip. This discussion focuses on carbon steel pickling operations using HCl acid. HCl acid is one of the 189 toxic air pollutants that are subject to the NESHAP. HCl acid pickling is a chemical process that uses an HCl acid solution (pickle liquor) to dissolve iron oxides from the surface of a metal without any significant attack on the steel itself. HCl acid is also used to clean light rust or to activate metal surface before plating; however, this type of operation is not considered a pickling operation because its acid concentration, temperature, and usage rate, as well as emission potential, are lower than that of typical pickling operations.

2.2.1 Hydrochloric Acid Pickling

Starting in 1964, numerous steel pickling facilities changed from sulfuric acid to hydrochloric acid. Besides the advantage of lower costs, HCl pickling offers faster and cleaner pickling, lower acid consumption and greater utilization of the acid, less steam consumption and reduced quantities of waste pickle liquor, greater versatility and

more uniform product quality than sulfuric acid pickling.[10]

TABLE 2-1. PICKLING OF HOT-ROLLED CARBON STEEL STRIP PRIOR TO COLD ROLLING[11]

Inputs and Residuals	Unit	Hydrochloric Acid	Sulfuric Acid
Metal	tons		
Strip in (including scale)		1.0	1.0
Strip out		0.98	0.99
Utilities and other inputs			
Electricity	kWh	18.2	18.2
Mill water	10^3 gal.	0.32	0.50
Makeup acid	lb.		
Sulfuric acid (25% solution)		N.A.	184
Hydrochloric acid (17% solution)		299	N.A.
Labor	hours	0.23	0.23
Residuals			
Spent acid	lb.	345	195
Iron	lb.	36.4	11.2
Free acidity[a]	lb.	2.8	20.3
Total acidity[a]	lb.	67.9	40.3
Sulfate	lb.	N.A.	38.7
Chloride	lb.	48.2	N.A.
Acid rinse water	10^3 gal.	0.32	0.50
Iron	lb.	0.50	1.60
Free acidity[a]	lb.	0.96	2.89
Total acidity[a]	lb.	1.85	5.75
Sulfate	lb.	N.A.	5.52
Chloride	lb.	1.31	N.A.

However, the only significant disadvantage of HCl acid is its volatility, which is greater than that of sulfuric acid. When iron oxides dissolve in HCl acid, the ferrous salt and water are formed according to the following reaction mechanism:

$$Fe_2O_3 + Fe + 6HCl \Rightarrow 3\,FeCl_2 + 3H_2O$$
$$Fe_3O_4 + Fe + 8HCl \Rightarrow 4FeCl_2 + 4H_2O$$
$$FeO + 2HCl \Rightarrow FeCl_2 + H_2O$$

HCl acid also reacts with the base steel by the following mechanism:

$$Fe + 2HCl \Rightarrow FeCl_2 + H_2$$

Therefore, an inhibitor is usually added to the acid solution to inhibit or lessen acid attack on the steel itself while permitting preferential attack on the iron oxides. The rate of pickling is affected by several variables, including the base steel constituents, the type of adherence of oxides, acid concentration and ferrous chloride concentration in the solution, temperature of the solution, agitation, time of immersion, and the presence of inhibitors.[12] Pickling rate increases as acid concentration or temperature increases. As pickling continues, free HCl depletes and ferrous chloride builds up in the pickle liquor to an extent that pickling cannot be accomplished effectively and the quality of the treated metal surface deteriorates. At that point, the pickle liquor is discharged from the pickling tank to a storage tank, and the pickling tank is replenished with fresh acid solution. Acid transfer is done either continuously or in a batch mode.

The HCl steel pickling operations are characterized by the form of metal processed and the type of pickling process used. The forms of steel pickled include coils, rod, wire, pipe, and metal parts of various shapes. The pickling

processes include continuous, noncontinuous, and batch modes. Continuous pickling processes are used for coils, rod, wire, and pipe in the sense that the steel material is connected end-to-end and continuously run through the pickling tanks. The noncontinuous process, also called push-pull, is usually used for coils and is an operation in which each coil is threaded through the pickling tanks separately. The batch process is used for rod or wire in coils, pipes, and metal parts in the sense that the material is dipped into the pickling tank for a certain period of time until the scale is dissolved. Every pickling process is followed by a rinse stage to remove HCl residue.

The following sections describe the types of pickling processes generally found in the industry. The information is based on the Chapter 3 of the Background Information Document (BID) for the Steel Pickling NESHAP provided by the RTI engineers.[13]

2.2.1.1 Continuous Pickling

2.2.1.1.1 Coils. Continuous pickling lines for coil are capable of handling coils that are welded head to tail. The entry section comprises a coil conveyor, one or two uncoilers, one or two processors, one or two shears, and a welder. Processors are integral with the uncoiling equipment and consist of a mandrel, hold-down roll, and a series of smaller diameter rolls. As the strip is flexed through the processor, some cracking occurs in the scale layer. Proper trimming and welding of the strips is essential to avoid strip breaks in the line. The section prior to the pickling tanks uses bridles for tensioning the strip, a strip accumulator for strip storage, and a temper mill to crack the scale on the surface of the strip.

Most continuous pickling for coils is done in a series of horizontal pickling tanks. The sizes of the pickling tanks are based on pickling the strip under certain operating conditions. The pickling section is usually several hundred

feet long and divided into three or four horizontal pickling tanks. Virgin or regenerated acid is added to the last pickling tank with or without makeup water; then the pickle solution cascades to the first pickling tank over weirs between tanks and counter-current to the moving direction of the strip. To allow a short pickling time at high line speed, the pickling liquor is maintained at 180 °F or higher by live steam injection or by internal or external heat exchange. A rinse section follows the pickling section to remove acid residue from the strip surface with fresh water. A drier follows the rinse section to dry the rinsed strip with heated air. The exit end of the line usually includes an exit strip accumulator, steering rolls, a strip inspection station, dual side trimmers, an oiler, and one or two recoilers.

In some modern lines the pickling solution is contained in shallow tanks, and although they comprise a cascade system, the solution in each tank is recirculated through an external heat exchanger and a storage tank. During an extended line stop the pickling solution can be drained into storage tanks to prevent acid attack on strip. For older lines, strip lifters are provided to lift the strip from the acid solution during an extended stop.

2.2.1.1.2 Tube, Rod, and Wire. Continuous pickling operations for tube, rod, and wire can be grouped together because the dimensions of their pickling sections and the gas flow rates in the enclosed capture systems are similar yet smaller than those of coil pickling operations. The difference among the three operations is that multiple wires are simultaneously treated in a process line at most rod and wire facilities and a single tube is treated in a process line at tube facilities. Continuous tube pickling prepares a clean surface on a continuously welded tube before cold drawing or tube reducing to preserve the life of a die or before final galvanizing. Similarly, continuous rod pickling removes oxide or scale from a continuous rod before drawing to preserve the

life of a die. Once a rod is drawn through a die, it is called wire. Continuous wire pickling prepares a clean wire surface for subsequent coating such as galvanizing.

In the continuous pickling process for tube, rod, and wire, the steel products are continuously pulled through an acid solution and rinsed to remove acid residues. In continuous pickling of wire or rod, several strands of wire or rod are uncoiled from payoff reels, simultaneously pickled in one or two shallow pickling trays, rinsed in a following rinse tray to remove acid residues, then followed by drawing or coating. Depending on the size of the material, fewer than ten rods or as many as 40 wires may be processed at the same time. Pickle liquor is replenished to and drained from pickling trays continuously.

In continuous pickling processes for tubes, a welded tube is immersed in an enclosed pickling trough that is placed in a covered empty tank. Pickle liquor is replenished at the trough and overflows from the trough through drainage holes to an external tank, where the pickle liquor is drained to spent acid storage tanks. Depending on the temperature of the incoming steel material, the pickle liquor may need to be cooled or heated for effective pickling. Heating can be done by live steam injection or by external heat exchange, and cooling can be done by external heat exchange.

2.2.1.2 Push-Pull Pickling. Push-pull pickling lines primarily handle coils and have mechanical arrangements similar to horizontal continuous pickling lines for coil except that push-pull lines do not have welders at the entry sections nor storage areas for the strips. Therefore, each coil is threaded through the process line separately. The pickling tanks of a push-pull line are generally shorter than those of a continuous line because the line speed during pickling (from about 250 to 660 fpm) is usually slower than that of a continuous line. Other operating procedures of a push-pull line are similar to those of a continuous line. The

pickle liquor is usually maintained at 180 °F or higher by external heat exchangers. A rinse section follows the pickling section to remove acid residue from the strip surface with fresh water.

2.2.1.3 Batch Pickling. In the batch pickling process, the steel is immersed in an acid solution for 10 to 30 minutes until the scale or oxide film is removed, lifted from the bath, allowed to drain, then rinsed by subsequent immersion in one or more rinse tanks or by spraying. Steel rod and wire in coil form (up to 3,000 lb) can be pickled in a batch operation. Tubes or flat sheets can be batch pickled, but the sheets must be held vertical and physically separated to improve acid contact. Generally, the acid solution is maintained at ambient temperature for surface cleaning or etching and at an elevated temperature for oxide removal.

Typical HCl concentrations in the batch pickling process range from 12 percent at the beginning of a fresh batch to 4 percent before acid replacement. A fresh batch of acid solution is prepared; then the pickling is performed until the iron concentration of the acid solution reaches the maximum allowable concentration (about 13 percent by weight) or until the free HCl becomes insufficient for proper scale removal. Acid and iron concentrations are monitored by the operator a few times a day.

When the acid solution is no longer effective, the spent acid is drained or pumped to storage tanks and a new batch of acid solution prepared. For surface cleaning or etching, immersion time ranges from 5 to 15 minutes with the acid bath at ambient temperature. For oxide or scale removal, the immersion time may range from 10 to 30 minutes and the acid bath may be heated to 120 °F. Heating is done by live steam sparging or internal heat exchange.

2.2.1.4 Emissions from Steel Pickling. Emissions from pickling process lines are generated in the pickling and rinse tanks, and to a lesser degree, from acid transfer operations.

Unlike most other stationary source operations, emissions from pickling lines are almost independent of the quantity of product being processed. Acid emissions depend largely on acid bath surface area, temperature concentration, ventilation rate (for operations with hoods or covers and ventilation systems), and degree of agitation. Agitation is affected by heating, acid flow, and steel movement through the bath. Bath area is affected by the width of the steel being pickled (but not by its thickness) and by line speed for continuous lines (the higher the line speed, the longer the line). With even continuous lines operating in intermittent fashion (utilization rates of about 50 percent to 80 percent), but with acid baths emitting HCl continuously, emission rates based on weight of steel processed may be misleading.

No explicit federal air regulations exist for steel pickling operations using HCl. However, because some acid mist may be released, states may choose to apply federal particulate standards based on ambient air quality considerations. Among the states, those that regulate HCl pickling emissions do so primarily on a case-by-case basis. Permits are issued after an existing control device is tested, and the results of the test help to set particulate and HCl emission limitations. States that regulate in this manner include Indiana and Illinois. States that regulate HCl in a similar manner include Tennessee and Utah. Pennsylvania permits require facilities to operate in a manner consistent with good operating and maintenance practices, but without specific emission limits, while Texas requires only that opacity from scrubber exhausts not exceed 20 percent.

2.2.2 Acid Regeneration of Waste Pickle Liquor

The major by-product of the steel pickling process is the waste pickle liquor (WPL) or spent acid. The spent acid may be managed in several ways: (1) hauling it away by a processing company that converts ferrous chloride to ferric

chloride and sells the product as a precipitant to wastewater treatment plants; (2) treating it on-site with caustics and hauling the resultant sludge away; (3) regenerating it by an acid regeneration process on site, or at an off-site facility, and reusing the regenerated acid; (4) recovering the free acid by several commercially available recovery systems; and (5) injecting it by deep well injection.

The selection of the WPL management alternatives is determined by the governing state or local regulations, the amount of WPL generated, the proximity of processing or disposal facilities, space availability, and costs. As state or local regulations become more stringent, deep well injection will phase out and will be replaced by other alternatives. One of the WPL management alternatives, the acid regeneration process, has a potential of emitting significant quantities of HCl and Cl2.

The spray roasting acid regeneration process dominates the current market. Only one of the ten existing acid regeneration facilities uses a fluidized bed roasting process, which was built in 1974. These two acid regeneration processes are similar in chemical reaction principles but are different in roaster designs and the quality of iron oxide produced.

2.2.2.1 Spray Roaster Regeneration Process

Spray roaster regeneration plants, such as those operated by Magnetics International Inc. (MII) and USS-Posco Industries, are able to recover 95 percent of the HCl acid and collect the iron oxides for sale to industrial consumers. MII's plant can process 80 gallons of liquor per minute and produce 20,000-30,000 tons of iron oxide per year. At a price of $100 to $150 per ton, oxide sales can generate $3 million to $4.5 million per year, in addition to the value of the recovered HCl acid. The Fe_2O_3 is sold in powder form to industrial consumers and is used mainly by magnetics,

electronics, ceramics, and pigment makers.[14]

Incoming WPL, at 2 to 4 percent HCl, is first stored in storage tanks. WPL from the storage tanks first comes in contact with hot flue gas from the spray roaster in a venturi preconcentrator where HCl in the hot flue gas is scrubbed with the WPL, which becomes concentrated pickle liquor (CPL). Concentrated pickle liquor is pumped to the spray roaster and atomized through spray nozzles. The droplets fall through the rising hot gases in the roaster, and ferrous chloride in the droplets reacts with oxygen and water vapor to form ferric oxide (Fe2O3) and HCl. Heat for the reaction is provided by natural gas burners mounted in the lower cylindrical section of the roaster. The burners tangentially inject hot gas at 1,200 °F into the roaster. As the hot gas rises, it is cooled by the reactions, and leaves the roaster top at approximately 700 °F. Chlorine is a nondesirable by-product from the oxidation process, which is formed when too much excess air is provided for the reaction. Chlorine residue may show up in the product (iron oxide) or in the emissions.

Iron oxide is removed from the bottom of the roaster and transferred into a storage bin. The storage bin is usually equipped with a pulse-jet fabric filter (baghouse) on top to prevent the escape of dust, and the collected dust is returned to the bin.

From the roaster, flue gas containing HCl either passes through a cyclone to separate heavier metal oxide particles or proceeds directly to the venturi preconcentrator, where the flue gas is cooled and cleaned by direct contact with fresh WPL plus recirculated CPL. Entrained CPL droplets are removed from the preconcentrator and returned to the roaster feed tank, while the HCl laden gas is scrubbed in one or two absorbers. The absorber is a counter-current packed tower where process water is sprayed across the top of the packing while HCl laden gas flows upward and contacts the scrubbing solution. The scrubbing solution absorbs HCl from the gas to

produce regenerated acid containing approximately 18 percent HCl by weight. Regenerated acid is pumped from the bottom of the absorber to storage tanks.

2.3 TYPES OF STEEL

All steels are classified as either carbon or alloy steel. Within the alloy classification, however, variations in both the chemical composition of the product and the manner in which it is processed yield steels with special properties. As a result, steel products can be grouped into three grades: carbon steels, alloy steels, and stainless steels. Table 2-2 provides information on U.S. shipments of steel mill products by carbon, alloy, and stainless grades for 1992.

2.3.1 Carbon Steels

Carbon steels accounted for more than 93 percent of total steel mill product shipments in 1992. Carbon steels are those containing very small amounts of alloying elements--not more than 1.65 percent manganese, 0.6 percent silicon, and 0.6 percent copper--with a carbon content of 0.03 percent to 1.7 percent. Low carbon steels, with 0.08 percent to 0.35 percent, are used primarily for flat-rolled products because of the ease with which they can be formed and welded. Machines, auto bodies, most structural steel for buildings, and ship hulls are among the products made from carbon steels.[15]

2.3.2 Alloy Steels

In 1992, alloy steels accounted for roughly 5 percent of total steel mill product shipments. Alloy steels are steels containing specific percentages of vanadium, molybdenum, or other elements, as well as larger amounts of manganese, silicon, and copper than carbon grades contain. The major alloy grades are the full alloy series, silicon electrical

sheets and strip, tool, and high-strength, low-alloy steels. The greater strength, corrosion-resistance, and special electrical attributes of the alloy steels contribute to their use in the auto industry, construction, industrial machinery and equipment, and electrical equipment.[16]

2.3.3 Stainless Steels

Stainless steels accounted for less than 2 percent of total steel mill product shipments in 1992. Some 70 to 75

TABLE 2-2 SHIPMENTS OF STEEL MILL PRODUCTS BY GRADE: 1992

Steel Mill Products	Carbon Tons	Percent of total	Tons	Percent of total	Tons	Percent of total	Tons	Percent of total
Ingots and steel for casting	116,522	0.2%	89,906	2.2%	8,802	0.6%	215,230	0.3%
Blooms, slabs, billets	1,801,534	2.4%	395,784	9.7%	58,016	3.8%	2,255,334	2.7%
Wire rods	4,386,843	5.7%	94,961	2.3%	29,522	1.9%	4,511,326	5.5%
Total Semi-Finished	6,304,899	8.2%	580,651	14.2%	96,340	6.4%	6,981,890	8.5%
Structural Shapes (3" & over)	5,064,393	6.6%	16,290	0.4%	-	-	5,080,683	6.2%
Steelpiling	453,823	0.6%	-	-	-	-	453,823	0.6%
Plates-Cut Lengths	3,921,319	5.1%	345,096	8.4%	95,181	6.3%	4,361,596	5.3%
Plates-In Coils	2,658,022	3.5%	3,246	0.1%	79,021	5.2%	2,740,289	3.3%
Total Shapes and Plates	12,097,557	15.8%	364,632	8.9%	174,202	11.5%	12,636,391	15.4%
Rails	440,577	0.6%	-	-	-	-	440,577	0.5%
Railroad accessories	122,405	0.2%	-	-	-	-	122,405	0.1%
Total Rails and Accessories	562,982	0.7%	-	-	-	-	562,982	0.7%
Bars-Hot rolled	4,110,037	5.4%	1,660,000	40.5%	35,792	2.4%	5,805,829	7.1%
Bars-Size light shapes	1,119,318	1.5%	-	-	-	-	1,119,318	1.4%
Bars-Reinforcing	4,780,828	6.2%	-	-	-	-	4,780,828	5.8%

TABLE 2-2. SHIPMENTS OF STEEL MILL PRODUCTS BY GRADE: 1992 (Continued)

Steel Mill Products	Carbon Tons	Percent of total	Tons	Percent of total	Tons	Percent of total	Tons	Percent of total
							(continued)	
Bars-Cold finished	1,146,819	1.5%	211,321	5.2%	99,501	6.6%	1,457,641	1.8%
Total Bars	11,157,002	14.6%	1,871,321	45.6%	135,293	8.9%	13,163,616	16.0%
Tool Steel	-	-	63,910	1.6%	-	-	63,910	0.1%
Pipe and tubing-Standard Pipe	1,061,963	1.4%	-	-	-	-	1,061,963	1.3%
Pipe and tubing-Oil country goods	737,161	1.0%	241,950	5.9%	-	-	978,751	1.2%
Pipe and tubing-Line	1,110,228	1.4%	-	-	-	-	1,110,228	1.3%
Pipe and tubing-Mechanical	523,694	0.7%	266,079	6.5%	-	-	789,773	1.0%
Pipe and tubing-All other	211,750	0.3%	13,699	0.3%	31,854	2.1%	257,303	0.3%
Total Pipe and Tubing	3,644,796	4.8%	521,368	12.7%	31,854	2.1%	4,198,018	5.1%
Wire-Drawn and/or Rolled	814,882	1.1%	60,470	1.5%	24,458	1.6%	899,810	1.1%
Black plate	229,849	0.3%	-	-	-	-	229,849	0.3%
Tin plate	2,714,959	3.5%	-	-	-	-	2,714,959	3.3%
Tin free steel	903,923	1.2%	-	-	-	-	903,923	1.1%
Tin coated sheets	77,795	0.1%	-	-	-	-	77,795	0.1%
Total Tin Mill Products	3,926,526	5.1%	-	-	-	-	3,926,526	4.8%

TABLE 2-2. SHIPMENTS OF STEEL MILL PRODUCTS BY GRADE: 1992 (Continued)

Steel Mill Products	Carbon Tons	Percent of total	Tons	Percent of total	Tons	Percent of total	Tons	Percent of total
							(continued)	
Sheets-Hot rolled	13,185,573	17.2%	106,542	2.6%	68,806	4.5%	13,360,921	16.2%
Sheets-Cold rolled	11,977,157	15.6%	11,578	0.3%	703,568	46.5%	12,692,303	15.4%
Sheets & strip-Galvanized	10,588,626	13.8%	-	-	-	-	10,588,626	12.9%
Sheets and strip-All other	1,348,551	1.8%	435,091	10.6%	-	-	1,783,642	2.2%
Strip-Hot rolled	484,920	0.6%	56,556	1.4%	8,092	0.5%	549,568	0.7%
Strip-Cold rolled	531,782	0.7%	28,881	0.7%	271,671	17.9%	832,334	1.0%
Total Sheets and Strip	38,116,609	49.7%	638,648	15.6%	1,052,137	69.5%	39,807,394	48.4%
Total Net Shipments	76,625,253	100.0%	4,101,000	100.0%	1,514,284	100.0%	82,240,537	100.0%

percent of the stainless grades are chromium or nickel steels, which are highly resistant to rust and corrosion. In addition, certain of the stainless grades have unusual strength and resistance to temperature changes, factors that have led to their growing use in the aerospace industry. In addition, their corrosion resistance makes them useful for the petrochemical industry for pipes and tanks and the medical industry for surgical equipment.[17]

2.4 COSTS OF PRODUCTION

The costs of steel production are classified as either unavoidable (sunk) or avoidable. The former category includes costs to which the firm is committed and that must be paid regardless of any future actions of the firm. The second category, avoidable costs, describes any costs that are foregone by ceasing production at the plant. These costs can be further refined to distinguish between costs that are independent of the production level (avoidable fixed) and those that vary with the level of production (avoidable variable). These three categories of costs are described below:

- Nonavoidable fixed costs: the costs associated with the decision to open a manufacturing plant.
- Avoidable fixed costs: the recurring costs associated with the decision to operate the manufacturing plant.
- Avoidable variable costs: the costs associated with the decision to operate the plant at a given level of production.

The decision to open a new plant must be evaluated based on the costs included in all three categories above. However, for existing facilities, nonavoidable costs are sunk and do not affect the owner's decision to continue operating. “Breakeven” is the capacity utilization rate at which costs

are recovered given prices and cost in each period. Table 2-3 shows the actual and breakeven operating rates for U.S. major mills from 1981 to 1986. As shown, breakeven rates varied from roughly 65 to 80 percent from 1984 to 1986, after a period of wide fluctuation from 1981 to 1983.

2.4.1 Nonavoidable Fixed Costs

Nonavoidable fixed costs include most, if not all, capital costs as well as long-term materials contracts and capacity investments. These expenses are the fixed start-up costs that are incurred regardless of the level of production or whether the plant operates at all. For example, debt incurred to construct a steel manufacturing plant must be repaid regardless of the plant's production plan and even if the plant closes prior to full repayment, unless the range of viable alternatives includes declaring bankruptcy by the owners.

Hogan reports that the development of the electric arc furnace reduced the barrier of entry into the steel industry. In 1987, the integrated mill, with a blast furnace and basic-oxygen converters, required a large investment of at least $1 billion for a million-ton plant, whereas a nonintegrated mill (minimill), with electric arc furnace, required a capital investment as little as $55 million.[18]

Heidtman Steel Products Inc., a flat-rolled steel service center based in Toledo, Ohio, spent $12-million on building its steel pickling and processing plant in Sparrows Point, Maryland. The state-of-the-art HCl acid pickling line has an annual capacity of approximately 360,000 tons of flat-rolled coil steel resulting in an estimated new capacity cost of $33.33 per ton of steel processed.[19] Assuming a 20-year life of the newly installed pickling line and an interest rate of 8 percent, the estimated cost is $3.40 per ton of installed pickling capacity.

TABLE 2-3. U.S. MAJOR MILL ACTUAL AND "BREAK-EVEN" OPERATING RATES BY QUARTERS--1981 TO 1986 (PERCENT)

		Operating Rates	
Year	Quarter	Actual	Breakeven
1981	Q1	84	55
	Q2	85	42
	Q3	75	34
	Q4	62	60
1982	Q1	57	97
	Q2	47	115
	Q3	42	125
	Q4	36	124
1983	Q1	52	103
	Q2	60	90
	Q3	57	85
	Q4	59	75
1984	Q1	74	78
	Q2	77	67
	Q3	58	64
	Q4	54	70
1985	Q1	67	78
	Q2	70	67
	Q3	64	70
	Q4	63	72
1986	Q1	72	80
	Q2	68	70
	Q3	50	65
	Q4	72	77

Note: "Break-even" is the capacity utilization rate at which costs are recovered given prices and cost in each period.

2.4.2 Avoidable Fixed Costs

Avoidable fixed costs include rent and building overhead costs, some administrative fees, insurance payments, property

taxes, and depreciation. These expenses are the recurring fixed costs that are due when the plant is in operation regardless of the level of production.

Also included in these costs are the capital expenditures for environmental control purposes. The U.S. International Trade Commission reports that these capital expenditures (related mainly to the 1990 Clean Air Act amendments and water quality standards in the Great Lakes region) continued to account for a significant portion of total capital expenditures in 1991 and 1992.[20] Environmental capital expenditures by carbon and alloy steel producers accounted for roughly 14 percent of total capital expenditures in each year. Furthermore, spending on air quality control dominated total environmental capital expenditures, accounting for 63 percent in 1992 and 81 percent in 1991.[21]

2.4.3 Avoidable Variable Costs

Avoidable variable costs, or production costs, are influenced by a number of factors including plant location, plant age and level of modernization, production process, availability of raw materials, and labor. As shown earlier in Table 2-1, the main variable inputs used in the pickling of 1 ton of hot-rolled carbon steel strip (including scale) prior to cold rolling are electricity, mill water, makeup acid (either sulfuric or hydrochloric), and labor.

Table 2-4 provides the production costs of U.S. producers for hot-rolled products during fiscal year 1990 through 1992.[22] For 1992, the total production cost for pickling and oiling was only 2.4 percent of total production costs of hot-rolled products. Similarly, the contribution of pickling and oiling costs to total production costs of hot-rolled products was 2.6 percent for both 1990 and 1991. The average cost of pickling and oiling per ton of output is calculated as $8.11 for 1990, $8.09 for 1991, and $7.27 for 1992.

TABLE 2-4. PRODUCTION COSTS OF U.S. PRODUCERS ON THEIR OPERATIONS PRODUCING HOT-ROLLED PRODUCTS, FISCAL YEARS 1990-92[23]

Item	1990	1991	1992
	Quantity (10^3 short tons)		
Hot-rolled	46,355	40,681	44,587
Steelmaking			
Basic oxygen process	41,200	37,300	42,149
Electric furnace	2,524	1,967	2,034
Casting			
Ingot	11,954	7,695	4,836
Continuous	34,313	34,142	40,565
Trade sales	16,689	15,699	16,199
Company transfers	29,483	25,083	28,217
	Value ($\$10^3$)		
Cokemaking	1,491	1,346	1,179
Ironmaking	4,022	3,558	4,093
Steelmaking			
Basic oxygen process	***	***	***
Electric furnace	***	***	***
Other	***	***	***
Casting			
Ingot	388	225	114
Continuous	946	985	1,205
Purchased slabs/ingots	297	243	289
Purchased	0	0	0
Hot-strip rolling with ingot breakdown	1,542	1,317	1,406
Pickling and oiling	376	329	324
Shearing	0	0	0
Other	***	***	***
Total production cost	14,133	12,830	13,615
Change in finished goods inventory	(33)	14	(6)
Total production cost and inventory change	14,100	12,843	13,608

(continuedUnit production cost (per short term)

TABLE 2-4. PRODUCTION COSTS OF U.S. PRODUCERS ON THEIR OPERATIONS PRODUCING HOT-ROLLED PRODUCTS, FISCAL YEARS 1990-92 (continued)

Item	1990	1991	1992
Steelmaking			
Basic oxygen process	$***	$***	$***
Electric furnace	***	***	***
Casting			
Ingot	32.47	29.34	23.80
Continuous	27.57	28.86	29.69
Trade sales	326.04	333.77	324.14
Company transfers	293.68	303.13	296.19

Note: *** indicates that data not available.

2.4.3.1 Labor. Table 2-5 shows the hourly earnings and total employment cost per hour for employees in the U.S. steel industry from 1967 to 1992. Total employment cost per employee is calculated as the sum of total payroll cost per hour (earnings, holiday, and vacation pay) and employee benefits cost per hour. As shown in Table 2-5, total employment cost has consistently been one and a half times hourly earnings throughout the past decade. This trend should continue and the difference become larger as the health care cost component of employee benefits increases in the future. Table 2-6 displays average hourly earnings for production workers in the primary metals industry (SIC 33) by state for 1990 through 1992. Based on the data in Table 2-6, no significant disparities in labor costs appear across steel producing states or regions.

2.4.3.2 HCl Acid. The U.S. merchant market for HCl is going through difficult times. Tight HCl supplies and climbing prices are the results of the high cost of chlorine. Interestingly, one of the normally stable factors now appears

TABLE 2-5. HOURLY LABOR COSTS IN THE UNITED STATES STEEL INDUSTRY: 1967-1990[24,25]

Year	Average Hourly Earnings ($)		Total Employment Cost ($/hour)
	BLS	AISI[a]	AISI[b]
1967	3.62	3.66	4.76
1968	3.82	3.86	5.03
1969	4.09	4.12	5.38
1970	4.22	4.24	5.68
1971	4.57	4.57	6.26
1972	5.15	5.22	7.08
1973	5.56	5.69	7.68
1974	6.38	6.55	9.08
1975	7.11	7.23	10.59
1976	7.86	8.00	11.74
1977	8.67	8.91	13.04
1978	9.70	9.98	14.30
1979	10.77	11.02	15.92
1980	11.84	12.11	18.45
1981	13.11	13.43	20.16
1982	13.96	14.06	23.78
1983	13.40	13.63	22.21
1984	13.53	13.73	21.30
1985	13.98	14.27	22.81
1986	14.53	14.63	23.24
1987	14.54	14.53	23.71
1988	14.72	14.70	24.65
1989	15.00	15.00	24.62
1990	15.59	15.73	25.62
1991	16.21	16.56	27.64
1992	16.87	17.45	29.57

[a] BLS data exclude office, clerical, and supervisory personnel.

[b] Calculated as the sum of total payroll cost per hour (earnings and holiday and vacation pay) and employee benefits costs per hour).

TABLE 2-6. AVERAGE HOURLY EARNINGS FOR PRODUCTION WORKERS IN PRIMARY METALS INDUSTRY BY STATE: 1990-1992[a,26]

State	1990	1991	1992
Alabama	11.98	12.54	12.96
Arizona	13.23	12.68	12.30
Arkansas	10.34	10.71	11.21
California	13.38	14.23	14.85
Connecticut	11.35	11.58	11.79
Florida	9.85	10.52	10.55
Georgia	10.92	10.79	11.44
Illinois	13.21	13.40	13.75
Indiana	15.27	15.80	16.21
Iowa	13.33	13.37	13.80
Kentucky	13.88	14.39	14.46
Maryland	15.84	16.57	17.56
Massachusetts	11.13	11.59	12.04
Michigan	14.77	14.86	15.08
Minnesota	11.24	11.93	12.60
Missouri	11.32	12.36	12.64
New Hampshire	11.06	11.41	12.06
New Jersey	11.48	11.99	12.54
New York	12.85	13.19	13.71
North Carolina	10.48	11.02	11.49
Ohio	14.55	15.08	15.87
Oklahoma	11.04	10.70	10.83
Oregon	12.59	12.92	13.48
Pennsylvania	13.21	13.69	14.43
Rhode Island	10.32	10.23	10.81
Tennessee	11.94	12.02	12.05
Texas	11.36	11.51	11.94
Utah	12.96	13.55	14.12
Virginia	10.83	10.86	11.31
Washington	13.24	13.78	14.19
West Virginia	14.45	14.84	15.52

Wisconsin	11.04	11.54	11.91
National avg.	12.33	12.68	13.11

[a] Estimates are measured in current dollars.

to be in flux.[27] That is the share of HCl supply to the merchant market contributed by companies that produce the acid as a coproduct of other chemical manufacturing operations and those that produce it by burning elemental chlorine with hydrogen.

Traditionally, the HCl supply from coproduct producers such as Dow Chemical is dependent on the overall chemical business. When production of other lines such as fluorocarbons, isocyanate, and vinyl chloride monomer (VCM) drops, HCl supply drops. These producers of HCl have raising prices to the level of $90 to $100 per ton in the past few months. Some coproducers do not consider HCl a viable market and simply deep well the acid, in effect keeping it off the merchant market. According to Dow, the major consumer market for HCl are steel pickling (21 percent), oil field acidizing (21 percent), chemical manufacturing (20 percent), food products (18 percent), industrial cleaning (10 percent), and metals production (5 percent).[28]

Russell, Clifford S. and Vaughan, William J. 1976. Steel Production: Processes, Products, and Residuals. Baltimore MD: Johns Hopkins University Press. p. 24.

Russell, Clifford S. and Vaughan, William J. 1976. Steel Production: Processes, Products, and Residuals. Baltimore MD: Johns Hopkins University Press. pp. 25-26.

Russell, Clifford S. and Vaughan, William J. 1976. Steel Production: Processes, Products, and Residuals. Baltimore MD: Johns Hopkins University Press. pp. 104-105.

Russell, Clifford S. and Vaughan, William J. 1976. Steel Production: Processes, Products, and Residuals. Baltimore MD: Johns Hopkins University Press. pp. 104-105.

The Making, Shaping and Treating of Steel, 10th edition. Association of Iron and Steel Engineers. Pittsburgh, PA. 1985.

The Making, Shaping and Treating of Steel, 10th edition. Association of Iron and Steel Engineers. Pittsburgh, PA. 1985.

11. Russell, C.S. and W.J. Vaughn. Steel Production: Processes, Products, and Residuals. Baltimore, Johns Hopkins University.

The Making, Shaping and Treating of Steel, 10th edition. Association of Iron and Steel Engineers. Pittsburgh, PA. 1985. p. 1084.

Chapter 3 of the Background Information Document (BID) for the Steel Pickling NESHAP provided by the RTI engineers

Iron Age. March, 1993. "Getting out of a picklish situation." 9(3):18-21.

Standard & Poor's Industry Surveys. 1992. Steel and Heavy Machinery: Basic Analysis. p. S-25.

Standard & Poor's Industry Surveys. 1992. Steel and Heavy Machinery: Basic Analysis. p. S-25.

Standard & Poor's Industry Surveys. 1992. Steel and Heavy Machinery: Basic Analysis. p. S-25.

Hogan, William T. 1987. Minimills and Integrated Mills: A Comparison of Steelmaking in the United States. Lexington, Mass.:D.C. Heath and Company.

American Metal Market. June 27, 1989. "Heidtman Steel breaks ground for its fourth pickling facility." 97(124):3.

Certain Flat-Rolled Carbon Steel Products from Argentina, Australia, Austria, Belgium, Brazil, Canada, Finland, France, Germany, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Poland, Romania, Spain, Sweden, and the United Kingdom: Volume II: Information Obtained in the Investigation. (Publication 2664). U.S. International Trade Commission. August 1993. p. 20.

Certain Flat-Rolled Carbon Steel Products from Argentina, Australia, Austria, Belgium, Brazil, Canada, Finland, France, Germany, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Poland, Romania, Spain, Sweden, and the United Kingdom: Volume II: Information Obtained in the Investigation. (Publication 2664). U.S. International Trade Commission. August 1993. Tables 17 and 18.

Certain Flat-Rolled Carbon Steel Products from Argentina, Australia, Austria, Belgium, Brazil, Canada, Finland, France, Germany, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Poland, Romania, Spain, Sweden, and the United Kingdom: Volume II: Information Obtained in the Investigation. (Publication 2664). U.S. International Trade Commission. August 1993. Table 29.

23. U.S. International Trade Commission. August 1993 (Volume II). P. I-73.

24. Annual Statistical Report, 1992. American Iron and Steel Institute; cost per hour. National Research Council. The Competitive Status of the U.S. Steel Industry.

25.

26. U.S. Department of Labor, Bureau of Labor Statistics, SIC 33. January 1990-1993.

Chemical Week. June 16, 1993. HCL as complex as ever: tightness can't last." 152(23):67-68.

Chemical Week. June 16, 1993. HCL as complex as ever: tightness can't last." 152(23):67-68.

SECTION 3
THE DEMAND SIDE OF THE STEEL INDUSTRY

This section characterizes the demand side of the market for steel mill products. We describe the characteristics, uses and consumers of steel mill products, and the substitution possibilities in consumption.

3.1 PRODUCT CHARACTERISTICS

As Lancaster describes, goods are of interest to the consumer because of the properties or characteristics they possess; these characteristics are taken to be an objective, universal property of the good.[29] Therefore, the demand for a commodity is not simply for the good itself but also for a set of characteristics and properties that is satisfied by a particular commodity.

The characteristics of steel mill products provide certain attributes that are desired in manufacturing numerous products like motor vehicles, machinery and equipment, appliances, and containers. In deciding which materials to consume, manufacturers consider both economic and technical factors. Economic factors include price, transformation and installation cost, and maintenance and operation cost. Technical factors include physical properties such as density, tensile strength, durability, thermal conductivity, versatility, and appearance.

3.2 USES AND CONSUMERS OF STEEL

The demand for steel can be characterized as a derived

demand in that steel consumption is driven by the consumption of products that use steel as a raw material in production. The demand for products and services such as motor vehicles, construction, machinery and equipment, shipbuilding, household appliances, and utilities is instrumental in determining the demand for steel products. Because steel has a wide range of applications, trends in its consumption reflect the trends in the U.S. economy as a whole. In particular, the demand for steel is closely tied to construction activity and conditions in the automotive industry.

Table 3-1 shows steel shipments by market classification, or consumer groups, from 1982 to 1992.[30] Consumers of steel can be divided into two broad categories: industrial consumers and nonindustrial consumers. The industrial consumer group comprises a number of industries that most directly determine the level of demand for steel. These industries include the automobile, agriculture and mining, heavy machinery and equipment, appliance, construction, transportation, oil and gas, and other industries. As Table 3-1 shows, the largest industrial markets served by the steel mill industry in 1992 were construction, including maintenance and contractors' products (14.9 percent), motor vehicles (13.5 percent), and producer durables (11.2 percent), which includes steel for converting and processing, independent forgers, industrial fasteners, machinery, equipment and tools, and electrical equipment.

Nonindustrial consumers are primarily steel service centers, included with nonclassified shipments in the "other" category of Table 3-1. Steel service centers generally perform four different functions in the U.S. market:

- act as broker between buyer and the U.S. or foreign steel producer without taking possession of the product;
- act as a buying broker ordering specified products on behalf of customers taking possession of the product and shipping to the customer;

TABLE 3-1. SHIPMENTS OF STEEL BY MARKET CLASSIFICATION: 1982-1992[31]

	1982		1983		1984		1985		1986		1987	
Agriculture and mining[a]	1.3	1.9%	1.0	1.4%	1.0	1.3%	0.9	1.3%	0.9	1.3%	1.0	1.3%
Construction	9.7	13.9%	10.0	14.7%	10.2	13.8%	11.2	15.4%	10.6	15.1%	11.0	14.4%
Consumer durables[b]	3.1	4.5%	3.3	4.8%	3.2	4.4%	2.9	4.0%	3.1	4.3%	3.0	3.9%
Containers and Packaging	5.1	7.3%	4.5	6.7%	4.4	5.9%	4.1	5.6%	4.1	5.8%	4.4	5.7%
Motor vehicles[c]	10.5	15.1%	12.3	18.2%	12.9	17.5%	13.0	17.7%	11.9	16.9%	11.3	14.8%
Oil and Gas Industry	3.1	4.5%	1.3	1.9%	2.0	2.7%	2.0	2.8%	1.0	1.5%	1.5	1.9%
Producer durables[d]	10.0	14.3%	10.3	15.2%	11.6	15.8%	10.7	14.7%	10.8	15.4%	12.9	16.9%
Transportation[e]	1.6	2.3%	1.4	2.1%	2.0	2.6%	1.4	2.0%	1.1	1.5%	1.0	1.3%
Exports	1.0	1.4%	0.5	0.8%	0.4	0.6%	0.5	0.7%	0.5	0.7%	0.5	0.7%
Other[f]	24.2	34.8%	23.1	34.1%	26.2	35.5%	26.2	35.9%	26.4	37.5%	30.0	39.2%
TOTAL	69.6	100.0%	67.6	100.0%	73.7	100.0%	73.0	100.0%	70.3	100.0%	76.7	100.0%

	1988		1989		1990		1991		1992	
Agriculture and mining	1.1	1.3%	1.1	1.3%	1.3	1.5%	0.9	1.2%	0.9	1.1%
Construction	12.1	14.4%	11.5	13.7%	12.1	14.3%	11.5	14.5%	12.2	14.9%
Consumer durables	3.0	3.6%	3.0	3.6%	2.8	3.2%	2.3	3.0%	2.4	3.0%
Containers and Packaging	4.4	5.3%	4.5	5.3%	4.5	5.3%	4.3	5.4%	4.0	4.8%
Motor vehicles	12.6	15.0%	11.8	14.0%	11.1	13.1%	10.0	12.7%	11.1	13.5%
Oil and Gas Industry	1.5	1.8%	1.2	1.4%	1.9	2.2%	1.4	1.8%	1.5	1.8%
Producer durables	15.0	17.8%	14.3	17.0%	15.6	18.4%	13.5	17.1%	14.6	17.8%
Transportation	1.5	1.8%	1.6	1.9%	1.5	1.7%	1.2	1.6%	1.3	1.6%
Exports	1.2	1.5%	3.2	3.8%	2.5	2.9%	4.5	5.7%	2.7	3.3%
Other	31.5	37.6%	32.0	38.0%	31.9	37.5%	29.2	37.1%	31.6	38.4%
TOTAL	83.8	100.0%	84.1	100.0%	85.0	100.0%	78.9	100.0%	82.3	100.0%

[a] Agriculture and mining includes mining, quarrying, and agriculture.
[b] Consumer durables include appliances, other domestic and commercial equipment, ordinance, and other military.

[c] Motor vehicles include automotive, construction (including maintenance), contractors' products.
[d] Producer durables include steel for converting and processing industrial forgers, industrial fasteners, machinery, industrial equipment and tools, and electrical equipment.
[e] Transportation includes rail transportation, ship building, aircraft, and aerospace.
[f] Other includes steel service centers and distributors, non-classified.

- act as distributors by buying and inventorying products that are commercial quality and reselling to U.S. customers in the merchant market; and

- act as processors that purchase products, perform further processing like forming, and then resell the product to U.S. customers.[32]

Steel service centers and distributors accounted for 25.9 percent of steel shipments in 1992.[33]

Figure 3-1 illustrates the share of steel consumption for 1982 and 1992 by the major market classifications. The relative distribution of consumption has not changed much over the past decade. Steel service centers (subsumed within the "other" category) continue to be the largest consumer of steel followed by industries within the producer durables category, construction industry, and the automotive industry.

3.3 SUBSTITUTION POSSIBILITIES IN CONSUMPTION

Because the demand for steel is a derived demand, discussing substitute materials is necessary to understand the markets for steel products. Empirical evidence suggests that the demand for steel is relatively inelastic with respect to price due, in part, to the varied end products that result from using substitute materials in manufacturing and other applications. Table 3-2 presents demand elasticities for various carbon steel products for consuming industries like automotive and construction where the product is used in large quantities. The demand elasticity estimates displayed in the table are in the inelastic range. However, the same study indicates that demand for high-priced specialty products, such as cold-finished bars and certain tin mill products, is more elastic with price elasticities of demand greater than -1.[34] Recently, however, steel producers have had to contend with fierce competition from such substitute materials as plastics, aluminum, glass, and ceramics. Wood and cement compete with

steel products in construction, whereas aluminum, plastics,

Figure 3-1. Share of steel consumption for 1982 and 1992 by major market classifications.

TABLE 3-2. ESTIMATED DEMAND ELASTICITIES FOR VARIOUS CARBON STEEL PRODUCTS[35]

Consuming Industry/Carbon Steel Product	Own-Price Demand Elasticity
Automotive	
Hot-rolled bars	-0.07
Hot-rolled sheet and strip	-0.44
Hot-rolled sheet and strip	-0.28
Construction	
Structurals	-0.73
Hot-rolled bars	-0.47
Plates	-0.19
Container and Packaging	
Tin mill products	-0.70

and advanced composites compete with steel in the automotive and container industries. In this section we discuss substitution materials for steel in the beverage can, containers, and automobile markets.

3.3.1 Beverage Cans

In 1961, the steel industry enjoyed 100 percent of the beverage can market; however, by 1991, steel's share of the beverage can market had dropped to 4 percent, while aluminum's share had grown to 96 percent.[36] Standard and Poor's Industry Survey states that the prospects for steel regaining a significant share of the beverage can market are slim. First, the cost of converting production lines makes switching to steel from aluminum unattractive, even when the cost of steel is depressed. Secondly, prices of aluminum ingot and aluminum for can sheet are very low at present. Moreover, large inventories and continued high output of aluminum from the

former Soviet Union are expected to keep the price of aluminum ingot low in 1993. This situation is in great contrast to the one that prevailed in 1989, when can manufacturers contemplated switching to steel because of aluminum's high prices.[37]

3.3.2 Containers

In 1974, the most recent peak, steel shipments to the container industry totaled 8.2 million tons. By 1991, however, total steel shipments to this industry had dropped to 4.3 million tons—a 47.6 percent decline.[38] Substituting aluminum has prevented steel from improving its share in the container market, although steel's share of the container market has stabilized since 1985. Steel still dominates the food container market, but this segment may decline on a secular basis because of the growing consumer preference for frozen foods and the increased use of microwave ovens.[39]

3.3.3 Automobiles

3.3.3.1 Plastics. The increased use of plastics in cars has eroded the commanding position that steel had occupied in this large and critical market. Pressure to increase fuel efficiency has compelled automakers to reduce the weight of their cars; substituting plastics for steel decreases the car's weight. From the automaker's point of view, plastics have certain advantages over steel. Not only are they lighter, but their production costs are lower as well. Although on a pound-for-pound basis plastics cost more than steel, assembled and finished plastic bodies are generally less expensive than comparable metal parts because tooling costs are substantially lower. Additionally, one plastic part can take the place of several steel parts that must be welded or bolted together. The results include labor and weight savings and enhanced aerodynamic properties. Plastics have replaced steel in such applications as dashboards, fenders,

and inner panels.[40]

Steel still enjoys several advantages over plastics, including lower material cost, higher production speed, paintability, and superior surface finish. Furthermore, steelmakers have successfully produced thinner, lighter weight steels for auto panels and parts. In addition, plastics are problematic in high-temperature applications, and they are difficult to recycle, whereas steel is one of the most recyclable materials.[41]

Over the long term, plastics' contribution to fuel savings, combined with its corrosion resistance and design flexibility, poses a strong threat to steel. In the near term, however, the substitution rate of plastics for steel should begin to plateau because of plastics' inability to be recycled and because the steel industry is continuously introducing improved products. American Metals Market reported in October 1992 that Ford dropped plans to bring out a plastic-intensive model in its F-Series pickup truck line for the 1996 model year. Ford engineers cited cost considerations and the improvement in steel product prices as factors in the company's decision to retain steel. Furthermore, the article noted that GM planned to substitute steel for plastics in its next generation of front-wheel drive minivans beginning with the 1996 or 1997 model year.[42]

3.3.3.2 Aluminum. In the auto market, aluminum poses a more formidable threat to steel than plastics. Aluminum is an extremely attractive alternative to steel because it is recyclable, corrosion resistant, much lighter in weight, and has lower tooling costs. From an environmental point of view, aluminum's recyclability makes it a compelling substitute for steel, while its weight advantage contributes to increased fuel efficiency for the typical passenger car. Current applications for aluminum include engine blocks, castings, bumpers, hoods, and wheels.[43] In the near term, Standard & Poor's estimates that aluminum applications in automobiles

will grow by about 3.0 percent annually, thereby eroding steel's position gradually.[44]

Lancaster, Kelvin J. A New Approach to Consumer Theory. Journal of Political Economy. 74:132-157. 1966.

American Iron and Steel Institute (AISI). Annual Statistical Report, 1992. Table 12.

31. American Iron and Steel Institute. Annual Statistical Report. 1992.

Certain Flat-Rolled Carbon Steel Products from Argentina, Australia, Austria, Belgium, Brazil, Canada, Finland, France, Germany, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Poland, Romania, Spain, Sweden, and the United Kingdom: Volume II: Information Obtained in the Investigation. (Publication 2664). U.S. International Trade Commission. August 1993. pp. I-48 to I-49.

American Iron and Steel Institute (AISI). Annual Statistical Report, 1992. Table 12.

The Competitive Status of the U.S. Steel Industry: A Study of the Influences of Technology in Determining International Industrial Competitive Advantage. National Research Council. Washington DC, National Academy Press. 1985.

35. The Competitive Status of the U.S. Steel Industry: A Study of the Influences of Technology in Determining International Industrial Competitive Advantage. National Research Council. Washington, D.C. National Academy Press. 1985.

Standard & Poor's Industry Surveys. 1992. Steel and Heavy Machinery: Basic Analysis. p. S-18.

Standard & Poor's Industry Surveys. 1992. Steel and Heavy Machinery: Basic Analysis. p. S-18.

Standard & Poor's Industry Surveys. 1992. Steel and Heavy Machinery: Basic Analysis. p. S-18.

Standard & Poor's Industry Surveys. 1992. Steel and Heavy Machinery: Basic Analysis. p. S-18.

Standard & Poor's Industry Surveys. 1992. Steel and Heavy Machinery: Basic Analysis. p. S-19.

Standard & Poor's Industry Surveys. 1992. Steel and Heavy Machinery: Basic Analysis. p. S-19.

Standard & Poor's Industry Surveys. 1992. Steel and Heavy Machinery: Basic Analysis. p. S-19.

Standard & Poor's Industry Surveys. 1992. Steel and Heavy Machinery: Basic Analysis. p. S-19.

Standard & Poor's Industry Surveys. 1992. Steel and Heavy Machinery: Basic Analysis. p. S-19.

SECTION 4
INDUSTRY ORGANIZATION

4.1 MARKET STRUCTURE

Market structure is of interest because of the effect it has on the behavior of producers and consumers. A market is generally considered the locus where producers and consumers interact to trade goods and services. Economic theory usually takes the market as given; however, when considering regulatory impacts, the analyst must define the products and producers that constitute the markets. The products of interest here are steel products that are pickled during their manufacture, and the number of producers included in the analysis is determined by the geographic bounds of the market.

4.1.1 Steel Products

As mentioned in Section 2, steel is divided into two distinct types: carbon (including light alloy) and alloy steel. The market for carbon steel products accounted for over 93.2 percent of total production of steel mill product by tonnage in 1992. The carbon steel products category is further subdivided into types such as flat-rolled, plate, and tubular products. These divisions highlight the differentiation across steel products. Generally, consumers do not demand a standard type of steel product. Instead, specific products are required to meet consumers' needs. Because many different product categories are produced and consumed across the U.S., steel is not a homogeneous product (see Appendix Tables A-1 through A-5 for a complete and detailed listing of steel mill products by SIC code).

4.1.2 Steel Producers

Steel producers are generally classified as either integrated or nonintegrated mills. Integrated mills are usually large capital-intensive facilities that possess both steelmaking facilities (e.g., coke ovens, blast furnaces, and basic oxygen furnaces) and rolling and finishing mills. The range of products produced by integrated mills is extensive, although most are carbon steel products. Nonintegrated mills include so called "minimills" and "converters." Minimills typically produce steel by melting recycled scrap metal in electric arc furnaces, involving much less capital investment than required for integrated steelmaking. Steel converters, or processors, purchase steel for further processing as opposed to producing molten steel on site.

As shown in Table 4-1, the share of U.S. steel shipments for the six largest integrated producers fell from 78 in 1960 to 56 percent in 1986. Partial and complete shutdowns of plants were major contributors to this reduction, which was principally due to market shrinkage and import penetration. From 1977 to 1987, the number of integrated steel companies in the U.S. fell from 20 with 47 plants to 14 with 23 plants. The market shrinkage resulted not only from reduced demand by consuming industries, but also from increased competition from the minimills in traditional integrated mill products.

At their inception, minimills tended to specialize in products like bars and rods. Of late, however, minimills have begun to produce hot- and cold-rolled sheet and large structurals, which formerly were only produced by integrated producers. Minimills have moved into other product lines because they can satisfy demand for traditional minimill products and have available capacity.

4.1.3 Geographically Distinct Markets

Since transportation costs account for a significant portion of the delivered price of steel products, the steel

industry is characterized by geographically distinct markets

TABLE 4-1. SHARE OF THE SIX LARGEST INTEGRATED PRODUCERS IN THE U.S. STEEL SHIPMENTS--1950 TO 1986[45]

Year	Armco	Bethlehem	Inland	LTV	National	USS	Total
1950	4.1	14.9	4.5	18.0	5.5	30.8	77.8
1960	6.7	15.3	6.8	16.6	7.1	25.0	77.5
1970	5.1	13.1	4.5	14.4	6.9	19.9	63.9
1982	6.1	13.2	6.7	8.3	5.6	16.2	56.1
1983	5.7	12.9	7.1	8.6	6.0	16.3	56.6
1984	5.6	12.1	6.8	11.2	6.1	16.0	57.8
1985	5.4	12.0	6.4	14.6	6.0	17.1	61.7
1986	5.4	12.1	7.0	13.1	6.4	12.1	56.0

Note: USS was shut down after a labor disruption from August 1986 to February 1987.

for its products. These costs generally account for 3 to 10 percent of the total delivered cost of carbon steel products. The International Trade Commission (ITC) reported that U.S. inland transportation costs for carbon steel products are a significant factor in customers' purchase decisions and can affect a producers' or importers' price competitiveness, depending on the particular product and the location of the customer.[46] The substantial cost of inland transport makes imported steel products more competitive in coastal regions of the U.S. near their ports of entry than in inland markets where most of the domestic mills are located. Exceptions occur at locations like the Great Lakes region and parts of the inland Southeast where transporting imported products by barge on the St. Lawrence Seaway and the Mississippi River is relatively inexpensive.

Recent investigations by the ITC of unfair trade practices by foreign producers of steel indicate that freight advantages usually only occur on standard quality products.[47] Freight advantages are not as important a factor for the sales of specialty products--those produced by a small number of domestic or foreign plants. Therefore, these products are

shipped to all markets in the U.S. The ITC investigations also indicated that 85 to 95 percent of steel producers report selling their products to customers within 500 miles of the plant.[48] Table 4-2 provides estimated inland transportation costs (in dollars per ton) of domestic producers and importers of steel products by distance shipped from the plant or port of entry.

TABLE 4-2. INLAND TRANSPORTATION COSTS OF STEEL PRODUCTS BY SHIPPING DISTANCE: 1992[49]

Distance Shipped	Estimated Freight ($/ton)
Less than 100 miles	10 to 20
100 to 500 miles	15 to 45
Greater than 500 miles	35 to 60

The ITC report also lists the cost and availability of freight for shipments to steel customers as the most important factor in defining the geographic bounds of the market.[50] In fact, Mueller suggests that the delivered price of steel products is more important than production costs in determining which supplier is competitive in a particular market.[51] Mueller reports that despite shipping distances, consumers of steel along the West Coast or in the Gulf region find purchasing steel from foreign producers more economical than purchasing it from domestic producers in the steel belt. Other "market-defining" factors listed by the ITC include the degree to which the product is specialized, competition from neighboring suppliers, product quality, and existing relationships with certain customers.[52] In general, geographical markets are delineated where only neighboring plants complete directly. However, exceptions occur in markets where domestic or foreign producers have access to inexpensive transportation such as waterways.

Table 4-3 provides free-on-board (f.o.b.) prices obtained from American Metal Market for various steel mill products for 1990 to 1992. The f.o.b. prices vary by product --the more finished products (i.e., cold-rolled and galvanized steel) command a higher price. Comparing the inland transportation costs given in Table 4-2 to these product prices provides cost-to-value ratios in the range of 1 to 17 percent. This high ratio supports the notion that steel mill product markets are defined regionally across the U.S. This statement should be especially true in the case of low-valued semi-finished products.

TABLE 4-3. PRICES PER TON OF VARIOUS STEEL MILL PRODUCTS: 1990-1992[53]

	F.O.B. Price		
Steel Mill Product	1990	1991	1992
Hot-rolled carbon steel bar[a]	$408.60	$412.00	$349.60
Hot-rolled strip[a]	$442.00	$463.00	$470.00
Hot-rolled sheet[a]	$445.00	$457.60	$382.60
Carbon steel plates[a]	$475.00	$490.00	$490.00
Cold-finished carbon steel bar[a]	$507.4O	$515.00	$480.60
Cold-rolled sheet[b]	$612.80	$643.60	$555.80
Cold-rolled strip[a]	$744.80	$777.20	$788.00
Galvanized sheet[a]	$671.00	$707.00	$617.60

[a] Estimate reflects annual average F.O.B. (free on board) price reported at Pittsburgh mills.
[b] Estimate reflects price reported at most Midwest mills.

4.1.4 Market Behavior

Once the market structure is defined, we characterize the behavior of consumers and, most importantly, producers of steel. The discussion on behavior generally focuses on monopoly, oligopolistic, or competitive pricing. Making inferences about the behavior of producers often relies on developing a measure of the concentration of an industry or

market. A concentration measure should reflect the ability of firms to raise prices above the competitive level. Less concentrated markets are predicted to be more competitive and should result in a low concentration measure value, while a higher value should indicate a higher price-cost margin or a higher likelihood of noncompetitive behavior on the part of producers. A widely used measure is the concentration ratio. The n-firm concentration ratio reflects the share of total industry sales accounted for by the n largest firms. Unfortunately, concentration ratios only describe one point on the entire size distribution of sellers or producers.

Table 4-4 provides concentration ratios for the top 4, 8, and 20 U.S. steel companies by SIC code from 1972 through 1987. For all years, SIC codes 3312 (blast furnaces and steel mills) and 3315 (cold finishing of steel shapes) had a higher concentration of the value of shipments across the top 4, 8, and 20 U.S. steel companies than SIC codes 3315 (steel wire and related products) and 3317 (steel pipes and tubes). The industry concentration ratios may not be so high as to infer noncompetitive behavior, but that may because no one steel company serves the entire U.S. market. The concentration within a geographically defined product market would be more indicative of market behavior. Unfortunately, information of this type at the regional level by specific products is not available at this time.

4.2 MANUFACTURING PLANTS

Table 4-5 presents the 103 steel pickling plants that were in operation in 1991 by pickling process--continuous, push-pull, or batch. According to the information collection

TABLE 4-4. CONCENTRATION RATIOS FOR TOP 4, 8, and 20 U.S. STEEL COMPANIES BY SIC: 1972, 1977, 1982, and 1987[54]

SIC/Description/ Year		Value of Shipments				
				Percent accounted for by		
		No. of Companies	Total (10^6)	4 largest companies	8 largest companies	20 largest companies
3312	Blast Furnaces and Steel Mills					
	1987	271	15,804.7	44	63	81
	1982	211	11,763.3	42	64	82
	1977	395	15,331.9	45	65	84
	1972	241	10,304.7	45	65	84
3315	Steel wire and Related products					
	1987	274	3,330.3	21	34	54
	1982	252	2,420.9	22	32	54
	1977	262	2,258.6	21	32	52
	1972	234	1,227.7	18	30	52
3316	Cold finishing of steel shapes					
	1987	156	5,216.3	45	62	82
	1982	146	3,005.1	42	58	77
	1977	118	2,713.2	37	54	80
	1972	85	1,635.7	40	56	82
3317	Steel pipe and tubes					
	1987	155	3,856.3	23	34	58
	1982	170	3,762.2	24	39	64
	1977	130	2,681.4	24	39	68
	1972	115	1,292.1	23	40	70

TABLE 4-5. STEEL PICKLING FACILITIES BY PROCESS TYPE: 1991[55]

ID	Corporate Name	City	State	Process Type
105	Acme Steel Company	Riverdale	IL	Batch
9	Allied Tube & Conduit Corporation	Harvey	IL	Push-pull
103	Allied Tube & Conduit Corporation	Philadelphia	PA	Push-pull
42	Amac Enterprises, Inc.	Parma	OH	Push-pull
110	Amber Plating Works, Inc.	Chicago	IL	Continuous
14	American Spring Wire Corporation	Kankakee	IL	Push-pull
52	American Spring Wire Corporation	Bedford Heights	OH	Continuous
20	Armco Steel Company, L.P.	Butler	PA	Continuous
31	Armco Steel Company, L.P.	Ashland	KY	Continuous
49	Armco Steel Company, L.P.	Dover	OH	Push-pull
57	Armco Steel Company, L.P.	Middletown	OH	Continuous
32	Bethlehem Steel Corporation	Lackawanna	NY	Batch
45	Bethlehem Steel Corporation	Burns Harbor	IN	Continuous
46	Bethlehem Steel Corporation	Johnstown	PA	Continuous
109	Bethlehem Steel Corporation	Lackawanna	NY	Continuous
27	Bethlehem Steel Corporation	Sparrows Point	MD	Batch
29	Cargill Steel & Wire, Inc.	Nashville	TN	Continuous
37	Carpenter Technology Corporation	Orangeburg	SC	Continuous
38	Carpenter Technology Corporation	Reading	PA	Continuous
16	CF&I Steel Corporation	Pueblo	CO	Continuous
102	CSC Industries, Inc.	Warren	OH	Continuous
30	Dana Corporation	Antwerp	OH	Batch
56	Esab Welding Products, Inc.	Ashtabula	OH	Continuous
113	General Cable Corporation	Muncie	IN	Continuous
51	Granite City Pickling and Warehouse, Inc.	Granite City	IL	Batch
124	Greer Industries	Dover	OH	Continuous
59	Gulf Coast Galvanizing, Inc.	Citronelle	AL	Continuous/ Batch
	(continued)6Heidtman Steel Products, Inc.ErieMIContinuous			
28	Heidtman Steel Products, Inc.	Granite City	IL	Batch
107	Heidtman Steel Products, Inc.	Baltimore	MD	Push-pull

TABLE 4-5. STEEL PICKLING FACILITIES BY PROCESS TYPE: 1991 (continued)

ID	Corporate Name	City	State	Process Type
132	I/N Tek	New Carlisle	IN	Continuous
39	Indiana Pickling & Processing Co.	Portage	IN	Continuous
40	Inland Steel Company	East Chicago	IN	Continuous/ Batch
54	Insteel Industries, Inc.	Gallatin	TN	Batch
80	Ivaco, Inc.	Jacksonville	FL	Batch
2	Kasle Steel Corporation	Dearborn	MI	Continuous
50	Keystone Consolidated Industries, Inc.	Sherman	TX	Batch
55	Keystone Consolidated Industries, Inc.	Sherman	TX	Batch
84	Keystone Consolidated Industries, Inc.	Peoria	IL	Push-pull
58	Keystone Consolidated Industries, Inc.	Caldwell	TX	Continuous
12	LTV Steel Company, Inc.	Cleveland	OH	Batch
15	LTV Steel Company, Inc.	East Chicago	IN	Continuous/ Batch
83	LTV Steel Company, Inc.	Hennepin	IL	Continuous
131	Magnetics International, Inc.	Burns Harbor	IN	Continuous
100	Maneely-Illinois, Inc.	Chicago	IL	Continuous
118	MCM Enterprises, Inc.	Chicago	IL	Continuous
125	Midway Wire, Inc.	Chicago	IL	Continuous
33	Mt. Joy Wire Corporation	Mt. Joy	PA	Continuous
4	National Galvanizing, Inc.	Monroe	MI	Continuous
81	National Processing	East Chicago	IN	Batch
26	National Standard Company	Niles	MI	Batch
119	National Standard Company	Stillwater	OK	Push-pull
41	National Standard Company	Columbiana	AL	Batch
(continued)36	National Steel Corporation	Detroit	MI	Continuous
43	National Steel Corporation	Ecorse	MI	Batch
48	National Steel Corporation	Portage	IN	Batch
123	National Steel Corporation	Granite City	IL	Batch
23	National Wire Products Industries, Inc.	Baltimore	MD	Continuous
18	Northwestern Steel & Wire Company	Sterling	IL	Batch

TABLE 4-5. STEEL PICKLING FACILITIES BY PROCESS TYPE: 1991 (continued)

ID	Corporate Name	City	State	Process Type
85	Nucor Corporation	Crawfordsville	IN	Push-pull
19	Page Aluminized Steel Corporation	Monessen	PA	Batch
108	Paulo Products Company	Murfreesboro	TN	Push-pull
120	Paulo Products Company	Memphis	TN	Continuous
122	Rio Doce America, Inc.	Fontana	CA	Continuous
134	Riverdale Plating & Heat Treating, Inc.	Riverdale	IL	Batch
13	Rogers Galvanizing Company	Tulsa	OK	Push-pull
111	Rouge Steel Company	Dearborn	MI	Continuous
133	Rouge Steel Company	Dearborn	MI	Continuous
60	Samuel Steel Pickling Company	Cleveland	OH	Push-pull
3	Samuel-Whittar, Inc.	Detroit	MI	Batch
104	Seiz Corporation	Pottstown	PA	Continuous
21	Seneca Wire & Manufacturing Co.	Hanover	PA	Push-pull
86	Sharon Steel Corporation	Farrell	PA	Continuous
25	Smith Industries, Inc.	Houston	TX	Batch
112	Steel Warehouse Co. Inc.	South Bend	IN	Push-pull
53	Teledyne Industries Inc.	South Boston	VA	Continuous
106	Teledyne Industries Inc.	Monaca	PA	Batch
44	The Brenlin Group	Gadsden	AL	Batch
8	The Goodyear Tire & Rubber Co.	Randleman	NC	Continuous
117	Thomas Processing Company	Warren	OH	Push-pull
(continued)	136Tokyo Rope Mfg. Co., Ltd.	Danville	KY	Continuous
116	Toledo Pickling & Steel Sales, Inc.	Toledo	OH	Continuous
34	Trimas Corporation	Detroit	MI	Push-pull
22	Trinity Industries, Inc.	Lima	OH	Continuous
35	U.S. Department of Energy	Oak Ridge	TN	Push-pull
114	United States Steel & Pohang Iron & Steel	Pittsburg	CA	Continuous
127	USX Corporation, U.S. Steel Group	Dravosburg	PA	Continuous
128	USX Corporation, U.S. Steel Group	Fairfield	AL	Batch

TABLE 4-5. STEEL PICKLING FACILITIES BY PROCESS TYPE: 1991 (continued)

ID	Corporate Name	City	State	Process Type
129	USX Corporation, U.S. Steel Group	Gary	IN	Continuous
130	USX Corporation, U.S. Steel Group	Fairless Hills	PA	Continuous
11	Valley City Steel Company	Valley City	OH	Push-pull
24	Voss Steel dba as PGP Corporation	Taylor	MI	Push-pull
17	WCI steel, Inc.	Warren	OH	Batch
47	Weirton Steel Corporation	Weirton	WV	Continuous
7	Western Tube & Conduit Corporation	Little Rock	AR	Continuous
126	Western Tube & Conduit Corporation	Long Beach	CA	Continuous
5	Wheeling Pittsburgh Corporation	Steubenville	OH	Continuous
10	Wheeling Pittsburgh Corporation	Martins Ferry	OH	
82	Wheeling Pittsburgh Corporation	Yorkville	OH	Continuous
121	Wheeling Pittsburgh Corporation	Allenport	PA	Continuous
1	Wiremil, Inc.	Sanderson	FL	Continuous
101	Worthington Industries, Inc.	Porter	IN	Batch
115	Worthington Industries, Inc.	Monroe	OH	Continuous

request (ICR) data collected by EPA under the authority of Section 114 of the Clean Air Act, the number of plants employing the continuous pickling process totaled 56 in 1991. This information also indicated that 19 plants employed the push-pull process, and the batch process was used at 26 plants in 1991.

4.2.1 Location

Figure 4-1 identifies the number of U.S. steel pickling facilities operating in 1991 by state. According to the ICR information provided by the industry, one federal agency and 69 companies operated 103 steel pickling facilities in 20 states across the U.S in 1991. Table 4-6 provides steel pickling capacity by state. Indiana, Ohio, Pennsylvania, Michigan, and Illinois are the top five states in order of capacity, together accounting for 84.1 percent of U.S. steel pickling capacity.[56]

4.2.2 Product Lines, Processes, and Capacity

According to the ICR data, in 1991 204 pickling lines operated at 103 plants. Continuous pickling lines represented 63.2 percent of the total pickling lines operating in the U.S. during 1991. On the basis of number of facilities, 54.4 percent used the continuous pickling process, 25.2 percent used the batch pickling process, and 18.4 percent used the push-pull pickling process. Table 4-7 lists the capacity of each U.S. steel pickling plant operating during 1991 by pickling process.

4.2.2.1 Continuous Pickling. The U.S. has 36 known facilities with a total of 65 continuous coil pickling lines. The annual production capacities in 1991 ranged from 35,000 to 1,900,000 tons for a single pickling line and from 70,000 to 3,500,000 tons for a single facility. Further, 20 facilities with 64 continuous tube/rod/wire pickling lines operated in

Figure 4-1. U.S. steel pickling facilities operating in 1991 by state.[57]

the U.S. during 1991. The annual production capacities ranged from 4,300 to 156,000 tons for a single pickling line and from 4,700 to 421,000 tons for a single facility. In 1991, overall capacity for all continuous pickling lines was 46.1 million tons per year, while actual production was 37.4 million tons. Most of the larger facilities or pickling lines are associated with integrated steel mills. Some facilities have multiple continuous pickling lines.

4.2.2.2 Push-Pull Pickling. The U.S. had 19 facilities with 22 push-pull pickling lines in 1991. The annual

TABLE 4-6. STEEL PICKLING: CAPACITY BY STATE: 1991[58]

Rank	State	Total Capacity (tons)
1	Indiana	19,186,200
2	Ohio	11,469,500
3	Pennsylvania	6,673,436
4	Michigan	6,312,140
5	Illinois	4,475,021
6	West Virginia	2,200,000
7	California	2,079,620
8	Alabama	1,782,500
9	New York	1,250,000
10	Kentucky	549,770
11	Maryland	448,000
12	Tennessee	318,663
13	Florida	156,000
14	Oklahoma	102,506
15	Texas	79,509
16	North Carolina	55,016
17	Arkansas	40,000
18	South Carolina	25,000
19	Colorado	24,300
20	Virginia	1,700
	Total	57,228,881

TABLE 4-7. STEEL PICKLING FACILITY CAPACITIES BY PROCESS TYPE: 1991[59]

ID	Corporate Name	City	State	Capacity		
				Batch	Push-pull	Continuous
1	Wiremil, Inc.	Sanderson	FL	100,000		
2	Kasle Steel Corporation	Dearborn	MI		458,000	
3	Samuel-Whittar, Inc.	Detroit	MI		245,000	
4	National Galvanizing, Inc.	Monroe	MI		350,000	
5	Wheeling Pittsburgh Corporation	Yorkville	OH			1,270,200
6	Heidtman Steel Products, Inc.	Baltimore	MD		360,000	
7	Western Tube& Conduit Corporation	Little Rock	AR			40,000
8	The Goodyear Tire & Rubber Co.	Randleman	NC			55,016
9	Allied Tube & Conduit Corporation	Harvey	IL			421,000
10	Wheeling Pittsburgh Corporation	Allenport	PA			748,000
11	Valley City Steel Company	Valley City	OH		380,000	
12	LTV Steel Company, Inc.	East Chicago	IN			3,086,000
13	Rogers Galvanizing Company	Tulsa	OK			
14	American Spring Wire Corporation	Kankakee	IL	37,800		
15	LTV Steel Company, Inc.	Cleveland	OH			2,900,000
16	CF & I Steel Corporation	Pueblo	CO			24,300
17	WCI Steel, Inc.	Warren	OH			1,000,000
18	Northwestern Steel & Wire Company	Sterling	IL			116,500
19	Page Aluminized Steel Corporation	Monessen	PA			12,000
					(continued)20Armco Steel Company, L.P.AshlandKY548,637	
21	Seneca Wire & Manufacturing Co.	Hanover	PA			10,000
22	Trinity Industries, Inc.	Lima	OH	88,000		
23	National Wire Products Industries, Inc.	Baltimore	MD			36,000
24	Voss Steel dba as PGP Corporation	Taylor	MI			480,000
25	Smith Industries, Inc.	Houston	TX	50,000		

TABLE 4-7. STEEL PICKLING FACILITY CAPACITIES BY PROCESS TYPE: 1991 (continued)

ID	Corporate Name	City	State	Capacity		
				Batch	Push-pull	Continuous
26	National Standard Company	Stillwater	OK			102,506
27	Bethlehem Steel Corporation	Johnstown	PA			273,600
28	Heidtman Steel Products, Inc.	Erie	MI		280,000	
29	Cargill Steel & Wire, Inc.	Nashville	TN			200,000
30	Dana Corporation	Antwerp	OH	17,160		
31	Armco Steel Company, L.P.	Butler	PA			614,000
32	Bethlehem Steel Corporation	Sparrows Point	MD			52,000
33	Mt.Joy Wire Corporation	Mt. Joy	PA			18,842
34	Trimas Corporation	Detroit	MI	30,000		
35	U.S.Department of Energy	Oak Ridge	TN	7		
36	National Steel Corporation	Portage	IN			1,400,000
37	Carpenter Technology Corporation	Orangeburg	SC	25,000		
38	Carpenter Technology Corporation	Reading	PA	170,000		
39	Indiana Pickling & Processing Co.	Portage	IN		600,000	
						(continued)
40	Inland Steel Company	East Chicago	IN			3,200,000
41	National Standard Company	Niles	MI			9,140
42	Amac Enterprises, Inc.	Parma	OH	18,000		
43	National Steel Corporation	Granite City	IL			888,000
44	The Brenlin Group	Gadsden	AL			560,000
45	Bethlehem Steel Corporation	Lackawanna	NY			750,000
46	Bethlehem Steel Corporation	Lackawanna	NY			500,000
47	Weirton Steel Corporation	Weirton	WV			2,200,000
48	National Steel Corporation	Ecorse	MI			1,090,000

TABLE 4-7. STEEL PICKLING FACILITY CAPACITIES BY PROCESS TYPE: 1991 (continued)

ID	Corporate Name	City	State	Capacity		
				Batch	Push-pull	Continuous
49	Armco Steel Company, L.P.	Middletown	OH			2,657,200
50	Keystone Consolidated Industries, Inc.	Sherman	TX	8,100		
51	Granite City Pickling and Warehouse, Inc.	Granite City	IL		250,000	
52	American Spring Wire Corporation	Bedford Heights	OH	75,000		
53	Teledyne Industries Inc.	Monaca	PA	11,500		
54	Insteel Industries, Inc.	Gallatin	TN	80,966		
55	Keystone Consolidated Industries, Inc.	Sherman	TX	8,909		
56	Esab Welding Products, Inc.	Ashtabula	OH	53,232		
57	Armco Steel Company, L.P.	Dover	OH			267,000
58	Keystone Consolidated Industries, Inc.	Peoria	IL			211,650
59	Gulf Coast Galvanizing, Inc.	Citronelle	AL	30,000		
60	Samuel Steel Pickling Company	Cleveland	OH		350,000	
					(continued)	80Ivaco, Inc.JacksonvilleFL56,000
81	National Processing	East Chicago	IN		306,600	
82	Wheeling Pittsburgh Corporation	Martins Ferry	OH			746,335
83	LTV Steel Company, Inc.	Hennepin	IL			1,310,400
84	Keystone Consolidated Industries, Inc.	Caldwell	TX	12,500		
85	Nucor Corporation	Crawfordsville	IN		1,300,000	
86	Sharon Steel Corporation	Farrell	PA			802,000
100	Maneely-Illinois, Inc.	Chicago	IL			70,000
101	Worthington Industries, Inc.	Porter	IN		500,000	
102	CSC Industries, Inc.	Warren	OH	70		
103	Allied Tube & Conduit Corporation	Philadelphia	PA			136,494
104	Seiz Corporation	Pottstown	PA		300,000	
105	Acme Steel Company	Riverdale	IL			650,000

TABLE 4-7. STEEL PICKLING FACILITY CAPACITIES BY PROCESS TYPE: 1991 (continued)

ID	Corporate Name	City	State	Capacity		
				Batch	Push-pull	Continuous
106	Teledyne Industries Inc.	South Boston	VA	1,700		
107	Heidtman Steel Products, Inc.	Granite City	IL		325,000	
108	Paulo Products Company	Murfreesboro	TN	14,690		
109	Bethlehem Steel Corporation	Burns Harbor	IN			3,400,000
110	Amber Plating Works, Inc.	Chicago	IL	34,560		
111	Rouge Steel Company	Dearborn	MI			710,000
112	Steel Warehouse Co. Inc.	South Bend	IN		555,400	
113	General Cable Corporation	Muncie	IN			42,200
114	United States Steel & Pohang Iron & Steel	Pittsburg	CA			1,440,000
					(continued)	115Worthington Industries, Inc.MonroeOH550,000
116	Toledo Pickling & Steel Sales, Inc.	Toledo	OH			237,000
117	Thomas Processing Company	Warren	OH		300,000	
118	MCM Enterprises, Inc.	Chicago	IL			4,711
119	National Standard Company	Columbiana	AL			77,500
120	Paulo Products Company	Memphis	TN	23,000		
121	Wheeling Pittsburgh Corporation	Steubenville	OH			449,953
122	Rio Doce America, Inc.	Fontana	CA			569,620
123	National Steel Corporation	Detroit	MI		760,000	
124	Greer Industries	Dover	OH		110,350	
125	Midway Wire, Inc.	Chicago	IL	137,300		
126	Western Tube & Conduit Corporation	Long Beach	CA			70,000
127	USX Corporation, U.S. Steel Group	Dravosburg	PA			1,737,000
128	USX Corporation, U.S. Steel Group	Fairfield	AL			1,115,000
129	USX Corporation, U.S. Steel Group	Fairless Hills	PA			1,840,000
130	USX Corporation, U.S.Steel Group	Gary	IN			3,496,000

ID	Corporate Name	City	State	Capacity		
				Batch	Push-pull	Continuous
131	Magnetics International, Inc.	Burns Harbor	IN			
132	I/N Tek	New Carlisle	IN			1,300,000
133	Rouge Steel Company	Dearborn	MI			1,900,000
134	Riverdale Plating & Heat Treating, Inc.	Riverdale	IL	18,100		
135	Tokyo Rope Mfg. Co., Ltd.	Danville	KY			1,133

production capacities ranged from 110,000 to 1,300,000 tons for a single line or a single facility. The majority of the push-pull pickling lines are associated with minimills or the steel service industry, which cleans, splits, and cuts coils to specific customer requirements. Only two facilities have multiple lines: one with two lines and the other with three lines. The remaining 17 facilities each have one push-pull line. In 1991, overall capacity for all push-pull pickling lines was 8.28 million tons per year, while actual production was 4.47 million tons.

4.2.2.3 Batch Pickling. The U.S. had 26 facilities with 53 batch pickling processes in 1991. Eleven facilities used HCl batch pickling as a metal surface cleaning or etching process for various metal shapes prior to applying surface coatings such as galvanizing. The other 15 facilities, with 26 process units, perform rod or wire batch pickling to remove oxide or scale from the material. The annual production capacities in 1991 ranged from 1,700 to 100,000 tons for a single batch pickling process and from 1,700 to 170,000 tons for a single facility. In 1991, overall capacity for all batch pickling operations was 1.1 million tons per year. Virtually all facilities employing batch pickling processes have multiple process units.

4.2.3 Employment

Data from EPA's ICR indicate that employment at U.S. steel pickling plants ranged from 1 to 250 people in 1991. The average level of employment was 45.4 people across the 103 U.S. steel pickling plants operating during 1991.

4.2.4 Current Events

Allegheny Ludlum Corporation is currently constructing a new annealing and pickling line for its stainless steel finishing plant in Vandergrift, Pennsylvania. The new line is part of Allegheny Ludlum’s recently announced $56 million

capital investment plan for the facility. The annealing and pickling line will include Mannesmann Demag's electrolytic and turbulent pickling technology handling strip thicknesses from 0.012 to 0.125 inch in widths from 25 to 52 inches and will process at a speed of 200 feet per minute. Installation of the new line is scheduled for mid-1994.[60]

Washington Steel Corporation, a subsidiary of Lukens Incorporated, is currently upgrading an existing line at its Massillon, Ohio, facility. Modifications include adding an electrolytic neutral salt and mixed acid pickling line to an existing 56-inch annealing line, converting it to a 50-inch annealing and pickling line. This modified line, scheduled to start up in December 1993, will replace the cold-rolled stainless mill's four existing annealing and pickling lines and will increase Washington Steel's finishing capabilities. The project is part of a $10.2 million modernization program at the Ohio plant.[61]

4.3 FIRM CHARACTERISTICS

A regulatory action to reduce pollutant discharges from steel pickling facilities and acid regeneration plants will potentially affect the business entities that own the regulated facilities. Facilities comprise a site of land with plant and equipment that combine inputs (raw materials, fuel, energy, and labor) to produce outputs (steel). Companies that own these facilities are legal business entities that have the capacity to conduct business transactions and make business decisions that affect the facility. The terms facility, establishment, plant, and mill are synonymous in this analysis and refer to the physical location where products are manufactured. Likewise, the terms company and firm are synonymous and refer to the legal business entity that owns one or more facilities. As seen in Figure 4-2, the chain of ownership may be as simple as one facility owned by one company or as complex as multiple facilities owned by

subsidiary companies.

Figure 4-2. Chain of ownership.

Potentially affected firms include entities that own steel pickling plants as well as acid regeneration plants. According to the ICR data, one federal agency and 69 companies operated 103 steel pickling plants in 1991. In addition, two companies operated separate acid regeneration plants, while eight companies operated acid regeneration process lines at existing steel pickling plants. Tables 4-8 to 4-10 list U.S. steel companies and their steel pickling capacity for 1991 by continuous, push-pull, and batch pickling processes, respectively.

TABLE 4-8. U.S. STEEL COMPANY PICKLING CAPACITIES: CONTINUOUS PROCESS

Rank	Percent of Industry	Quantity (10^3 tons)	Corporate Name
1	17.1%	8,188,000	USX Corporation, U.S. Steel Group
2	15.2%	7,296,400	LTV Steel Company, Inc.
3	10.4%	4,975,600	Bethlehem Steel Corporation
4	8.5%	4,086,837	Armco Steel Company, L.P.
5	7.1%	3,378,000	National Steel Corporation
6	6.7%	3,214,488	Wheeling Pittsburgh Corporation
7	6.7%	3,200,000	Inland Steel Company
8	5.5%	2,610,000	Rouge Steel Company
9	4.6%	2,200,000	Weirton Steel Corporation
10	3.0%	1,440,000	United States Steel & Pohang Iron & Steel
11	2.7%	1,300,000	I/N Tek
12	2.1%	1,000,000	WCI Steel, Inc.
13	1.7%	802,000	Sharon Steel Corporation
14	1.4%	650,000	Acme Steel Company
15	1.2%	569,620	California Steel Ind. Inc.,
16	1.2%	560,000	The Brenlin Group
17	1.2%	557,494	Allied Tube & Conduit Corporation
18	1.0%	480,000	Voss Steel dba of PGP Corporation
19	0.5%	237,000	Toledo Pickling & Steel Sales, Inc.
20	0.4%	211,650	Keystone Consolidated Industries, Inc.
21	0.4%	200,000	Cargill Steel & Wire, Inc.
22	0.4%	189,146	National Standard Company
23	0.2%	116,500	Northwestern Steel & Wire Company
24	0.2%	110,000	Western Tube & Conduit Corporation
25	0.1%	70,000	John Maneely Co.
26	0.1%	55,016	The Goodyear Tire & Rubber Co.
27	0.1%	42,200	General Cable Corporation
28	0.1%	36,000	National Wire Products Industries, Inc.
29	0.1%	24,300	CF&I Steel Corporation
30	0.0%	18,842	Mount Joy Wire Corporation

(continued)31 0.0%12,000Page
Aluminized Steel Corporation

TABLE 4-8. U.S. STEEL COMPANY PICKLING CAPACITIES: CONTINUOUS PROCESS (Continued)

Rank	Percent of Industry	Quantity (10^3 tons)	Corporate Name
32	0.0%	10,000	Seneca Wire & Manufacturing Co.
33	0.0%	4,711	MCM Enterprises, Inc.
34	0.0%	1,133	ATR Wire & Cable Co., Inc.
TOTAL	100%	47,846,937	

4.3.1 Ownership

The legal form of ownership affects the cost of capital, availability of capital, and effective tax rate faced by the firm. Business entities that own steel pickling facilities or acid regeneration plants will generally be one of three types of entities:

- sole proprietorships
- partnerships, and
- corporations.

Each type has its own legal and financial characteristics that may influence how firms are affected by the regulatory alternatives. Table 4-11 provides information about the legal form of ownership of firms for the relevant SIC codes.[62] Figure 4-3 compares the legal form of ownership of all firms in the U.S. and the steel industry.[63, 64]

4.3.1.1 Sole Proprietorship. A sole proprietorship consists of one individual in business for him/herself who contributes all of the equity capital, takes all of the risks, makes the decisions, takes the profits, or absorbs the losses. Behrens reports that sole proprietorships are the most common form of business.[65] The popularity of the sole proprietorship is in large part due to the simplicity of establishing this legal form of organization. For 1987, Internal Revenue Service (IRS) data indicate that nonfarm sole proprietorships

TABLE 4-9. U.S. STEEL COMPANY PICKLING CAPACITIES: PUSH-PULL PROCESS

Rank	Percent of Industry	Capacity (10^3 tons)	Corporate Name
1	15.7%	1,300,000	Nucor Corporation
2	12.7%	1,050,000	Worthington Industries, Inc.
3	11.7%	965,000	Heidtman Steel Products, Inc.
4	9.2%	760,000	National Steel Corporation
5	7.2%	600,000	Indiana Pickling & Processing Co.
6	6.7%	555,400	Steel Warehouse Co. Inc.
7	5.5%	458,000	Kasle Steel Corporation
8	4.6%	380,000	Valley City Steel Company
9	4.2%	350,000	National Galvanizing, Inc.
10	4.2%	350,000	Samuel Steel Pickling Company
11	3.7%	306,600	National Processing
12	3.6%	300,000	Seiz Corporation
13	3.6%	300,000	Thomas Processing Company
14	3.0%	250,000	Granite City Pickling and Warehouse, Inc.
15	3.0%	245,000	Samuel-Whittar, Inc.
16	1.3%	110,350	Greer Industries
TOTAL	100.0%	8,280,350	

TABLE 4-10. U.S. STEEL COMPANY PICKLING CAPACITIES: BATCH PROCESS[66]

Rank	Percent of Industry	Quantity (10^3 tons)	Corporate Name
1	17.7%	195,000	Carpenter Technology Corporation
2	12.5%	137,300	Midway Wire, Inc.
3	10.2%	112,800	American Spring Wire Corporation
4	9.1%	100,000	Wiremil, Inc.
5	8.0%	88,000	Trinity Industries, Inc.
6	7.3%	80,966	Insteel Industries, Inc.
7	5.1%	56,000	Florida Wire and Cable Co.
8	4.8%	53,232	Esab Welding Products, Inc.
9	4.5%	50,000	Smith Industries, Inc.
10	3.4%	37,690	Paulo Products Company
11	3.1%	34,560	Amber Plating Works, Inc.
12	2.7%	30,000	Gulf Coast Galvanizing, Inc.
13	2.7%	30,000	Trimas Corporation
14	2.7%	29,509	Keystone Consolidated Industries, Inc.
15	1.6%	18,100	Riverdale Plating & Heat Treating, Inc.
16	1.6%	18,000	Amac Enterprises, Inc.
17	1.6%	17,160	Dana Corporation
18	1.2%	13,200	Teledyne Industries Inc.
19	0.0%	70	CSC Industries, Inc.
20	0.0%	7	U.S. Department of Energy
TOTAL	100.0%	1,101,594	

TABLE 4-11. LEGAL FORM OF FIRM ORGANIZATION IN THE PRIMARY METALS[a] INDUSTRY: 1987[67]

Item	Corporation	Sole Proprietor-ship	Partner-ships	Other	Total
Single-facility firms	3,610	N.A.	N.A.	N.A.	4,215
Multifacility firms	1,168	N.A.	N.A.	N.A.	1,185
ALL FIRMS	4,777	210	113	300	5,400

[a] Primary metals is defined by SIC 33.

represented almost 72 percent of U.S. businesses but accounted for only 6 percent of business receipts.[68] The 1987 Census of Manufactures reports, however, that very few firms in the U.S. primary metals industry are sole proprietorship--only 210 of the 5,400 firms under SIC 33. This type of business organization accounts for a minimal proportion of the industry at less than 4 percent.

Legally, the individual and the proprietorship are the same entity. From a legal standpoint, personal and business debt are not distinguishable. From an accounting standpoint, however, the firm may have its own financial statements that reflect only the assets, liabilities, revenues, costs, and taxes of the firm, aside from those of the individual.

When a lender lends money to a proprietorship, the proprietor's signature obligates him or her personally of all of his/her assets. A lender's assessment of the likelihood of repayment based on the firm and the personal financial status of the borrower is considered legal and sound lending practice because they are legally one-and-the-same. Table 4-12 highlights the advantages and disadvantages of this ownership type.[69]

4.3.1.2 Partnerships. For 1987, IRS data on business tax returns indicate that partnerships represented only 9 percent of U.S. businesses and accounted for an even smaller

Figure 4-3. Comparison of the legal form of ownership for firms in the U.S. and primary metals industry: 1987.[70,71]

TABLE 4-12. ADVANTAGES AND DISADVANTAGES OF THE SOLE PROPRIETORSHIPS[72]

Advantages	Disadvantages
Simplicity of organization	Owner's possible lack of ability and experience
Owner's freedom to make all decisions	Limited opportunity for employees
Owner's enjoyment of all profits	Difficulty in raising capital
Minimum legal restrictions	Limited life of the firm
Ease of discontinuance	Unlimited liability of proprietor
Tax advantages	

Note: A brief evaluation of these advantages and disadvantages is available in Steinhoff and Burgess (1989).

percentage of business receipts--4 percent.[73] For 1987, the Census of Manufactures reports that only 113 of the 5,400 companies listed under SIC code 33 are partnerships--accounting for just over 2 percent of all firms in the industry.

A partnership is an association of two or more persons to operate a business. In the absence of a specific agreement, partnerships mean that each partner has an equal voice in management and an equal right to profits, regardless of the amount of capital each contributes. A partnership pays no federal income tax; all tax liabilities are passed through to the individuals and are reflected on individual tax returns. Each partner is fully liable for all debts and obligations of the partnership. Thus, many of the qualifications and complications present in analyses of proprietorships (e.g., capital availability) are present--in some sense magnified--in analyses of partnerships. Table 4-13 lists the advantages and disadvantages of this ownership type.

TABLE 4-13. ADVANTAGES AND DISADVANTAGES OF THE PARTNERSHIP[74]

Advantages	Disadvantages
Ease of organization	Unlimited liability
Combined talents, judgement, and skills	Limited life
Larger capital available to the firm	Divided authority
Definite legal status of the firm	Danger of disagreement
Tax advantages	

Note: A brief evaluation of these advantages and disadvantages is available in Steinhoff and Burgess (1989).

4.3.1.3 Corporations. According to IRS business tax returns for 1987, corporations represented only 19.7 percent of U.S. businesses but accounted for 90 percent of all business receipts.[75] For 1987, the Census of Manufactures reports that 4,777 of 5,400 firms listed under SIC code 33 for the primary metals industry are corporations. Therefore, corporations represent the vast majority (88.5 percent) of the business entities involved in manufacturing steel.

Unlike proprietorships and partnerships, a corporation is a legal entity separate and apart from its owners or founders. Financial gains from profits and financial losses are borne by owners in proportion to their investment in the corporation. Analysis of credit availability to a corporation must recognize at least two features of corporations. First, they have the legal ability to raise needed funds by issuing new stock. Second, institutional lenders (banks) to corporations assess credit worthiness solely on the basis of the financial health of the corporation--not the financial health of its owners. A qualification of note is that lenders can require (as a loan condition) owners to agree to separate contracts obligating them personally to repay loans. Table 4-14 highlights the advantages and disadvantages of this ownership type.

TABLE 4-14. ADVANTAGES AND DISADVANTAGES OF THE CORPORATION[76]

Advantages	Disadvantages
Limited liability to stockholders	Government regulation
Perpetual life of the firm	Expense of organization
Ease of transferring ownership	Capital stock tax
Ease of expansion	
Applicability for both large and small firms	

Note: A brief evaluation of these advantages and disadvantages is available in Steinhoff and Burgess (1989).

4.3.2 Size Distribution

Firm size is likely to be a factor in the distribution of the regulatory action's financial impacts. Grouping the firms by size facilitates the analysis of small business impacts, as required by the Regulatory Flexibility Act (RFA) of 1982.

Firms are grouped into small and large categories using Small Business Association (SBA) general size standard definitions for SIC codes. These size standards are presented either by number of employees or by annual receipt levels, depending on the SIC code. As presented in Table 4-15, the firms owning steel pickling facilities or acid regeneration plants are covered by various SIC codes within the two-digit code 33 for the primary metals industry. Thus, according to SBA size standards, these firms are categorized as small if the total number of employees at the firm is less than 1,000; otherwise the firm is classified as large.

TABLE 4-15. SBA SIZE STANDARDS BY SIC CODE FOR THE PRIMARY METALS INDUSTRY

SIC Code	Description	SBA Size Standard in Number of Employees
3312	Blast furnaces and steel mills	1,000
3315	Steel wire and related products	1,000
3316	Cold finishing of steel shapes	1,000
3317	Steel pipe and tubes	1,000
3357	Nonferrous wire drawing and insulating	1,000
3398	Metal heat treating	750

As shown in Table 4-16, potentially affected firms range in size from 40 to 93,139 employees.[77,78] Figure 4-4 shows the size distribution of potentially affected firms by total employment. A total of 36 firms, or 51.4 percent, are categorized as small, while the remaining 34 firms, or 48.6 percent, are in the large category.

Firms may differ in size for one or both of the following reasons:

- Steel pickling facilities vary by size. All else being equal, firms with large plants are larger than firms with small plants.
- Firms vary in the number of plants they own. All else being equal, firms with more plants are larger than those with fewer plants.

TABLE 4-16. U.S. STEEL COMPANY EMPLOYMENT BY LEGAL FORM OF ORGANIZATION: 1992[79,80]

Company ID	Company Name	Type	Employees	
1	Acme Steel Company	Public Corporation	2,774	
2	Allied Tube & Conduit Corporation	N.A.	1,250	m
3	Amac Enterprises, Inc.	Private Corporation	90	
4	Amber Plating Works, Inc.	Private Corporation	100	
5	American Spring Wire Corporation	Private Corporation	400	
7	Armco Steel Company	Limited Partnership	7,500	
8	Bethlehem Steel Corporation	Public Corporation	24,900	
9	Cargill Inc.	Private Corporation	38,482	
10	Carpenter Technology Corporation	Public Corporation	3,534	
11	CF&I Steel Corporation	Public Corporation	1,850	
12	CSC Industries, Inc.	Public Corporation	1,501	
13	Dana Corporation	Public Corporation	35,000	
14	Esab Welding Products, Inc.	Subsidiary	1,100	
15	General Cable Corporation	Public Corporation	5,500	
16	Granite City Pickling and Warehouse, Inc.	N.A.	50	m
17	Greer Industries	Division	625	m
18	Gulf Coast Galvanizing, Inc.	Non-corporate	50	m
19	Heidtman Steel Products, Inc.	Private Corporation	500	
20	I/N Tek	Non-corporate	N.A.	
21	Indiana Pickling & Processing Co.	N.A.	1,500	o
22	Inland Steel Industries	Public Corporation	17,180	
			(continued)	
23	Insteel Industries, Inc.	Public Corporation	1,050	
24	Florida Wire and Cable Co.	Private Corporation	433	
25	Kasle Steel Corporation	Private Corporation	350	

TABLE 4-16. U.S. STEEL COMPANY EMPLOYMENT BY LEGAL FORM OF ORGANIZATION: 1992 (continued)

Company ID	Company Name	Type	Employees	
26	Keystone Consolidated Industries, Inc.	Public Corporation	2,000	
27	LTV Steel Company, Inc.	Public Corporation	17,900	
28	Magnetics International, Inc.	N.A.	40	
29	John Maneely Co.	Private Corporation	1,000	
30	MCM Enterprises, Inc.	Private Corporation	450	
31	Midway Wire, Inc.	N.A.	50	m
32	Mount Joy Wire Corporation	Private Corporation	120	
33	National Galvanizing, Inc.	Subsidiary of Tang Industries Inc.	100	
34	National Processing		1,500	o
35	National Standard Company	N.A.	1,250	m
36	National Steel Corporation	Public Corporation	10,299	
37	National Wire Products Industries, Inc.	Division	100	
38	Northwestern Steel & Wire Company	Public Corporation	2,550	
39	Nucor Corporation	Public Corporation	5,800	
40	Page Aluminized Steel Corporation	Private Corporation	75	
41	Paulo Products Company	Private Corporation	300	
42	California Steel Ind., Inc..	N.A.	875	m
			(continued)	
43	Riverdale Plating & Heat Treating, Inc.	Private Corporation	75	
44	Rogers Galvanizing Company	Private Corporation	150	
45	Rouge Steel Company	Private Corporation	3,000	
46	Samuel Steel Pickling Company	N.A.	50	m
47	Samuel-Whittar, Inc.	N.A.	375	m
48	Seiz Corporation	Private Corporation	160	

TABLE 4-16. U.S. STEEL COMPANY EMPLOYMENT BY LEGAL FORM OF ORGANIZATION: 1992 (continued)

Company ID	Company Name	Type	Employees	
49	Seneca Wire & Manufacturing Co.	Private Corporation	525	
50	Sharon Steel Corporation	N.A.	1,500	o
51	Smith Industries, Inc.	Private Corporation	543	
52	Steel Warehouse Co. Inc.	Private Corporation	275	
53	Teledyne Industries Inc.	Subsidiary of Teledyne Inc.	1,500	o
54	The Brenlin Group	Private Corporation	3,400	
55	The Goodyear Tire & Rubber Co.	Public Corporation	93,139	
56	Thomas Processing Company	N.A.	625	m
57	ATR Wire & Cable Co., Inc.	N.A.	N.A.	
58	Toledo Pickling & Steel Sales, Inc.	Private Corporation	100	
59	Trimas Corporation	Public Corporation	2,800	
60	Trinity Industries, Inc.	Public Corporation	12,500	
61	U.S. Department of Energy	Federal Agency	375	m
62	United States Steel & Pohang Iron & Steel		1,250	m
			(continued)	63
			USX Corporation, U.S. Steel group	Public Corporation	44,872	
64	Valley City Steel Company	N.A.	50	m
65	Voss Steel dba as PGP Corporation	N.A.	175	m
66	WCI Steel, Inc.	Subsidiary of Renco Group Inc.	3,000	
67	Weirton Steel Corporation	Public Corporation	6,800	
68	Western Tube & Conduit Corporation	Subsidiary	200	
69	Wheeling Pittsburgh Corporation	Public Corporation	5,684	
70	Wiremil, Inc.	N.A.	50	m
71	Worthington Industries, Inc.	Public Corporation	7,000	

m Employee estimate represents the midpoint of the range provided by the ICR data since information not available from Ward's Directory.

o Employee estimate represents the low end of the open range (>1500) provided by ICR data (>1500).

Control economies are typically plant-related rather than firm-related. For example, a firm with six uncontrolled plants with average annual receipts of $1 million per plant may face approximately six times the control capital requirements of a firm with one uncontrolled plant whose receipts total $6 million per year. Alternatively two firms with the same number of plants facing approximately the same control capital costs may be financially affected very differently if the plants of one are larger than those of another.

Figure 4-4. 1991 size distribution of firms owning steel pickling facilities.[81]

Table 4-17 shows the average size of the plants (based on 1991 total employment level) represented in each company size category. As expected, larger firms own larger facilities on average. Table 4-18 shows the distribution of firms by the number of plants owned. A slight correlation seems to exist between the number of steel pickling plants owned and the size of the firm. The average number of steel pickling plants owned by small firms is 1.14 (41 facilities ÷ 36 firms) as compared to an average of 1.82 steel pickling plants (62 facilities ÷ 34 firms) owned by large firms. Of course, nonsteel pickling plants are not reflected in this distribution.

TABLE 4-17. AVERAGE SIZE OF FACILITY BY FIRM SIZE CATEGORY: 1991[a,82]

Firm size based on employment (1991)	Average Size of Facility
Small (< 1,000)	17.8
Large (>1,000)	62.9
Total, all firms	45.4

[a]Facility size is measured as total employment in 1991.

TABLE 4-18. DISTRIBUTION OF FIRMS BY NUMBER OF FACILITIES OWNED: 1991[83]

	Number of facilities owned per firm			
Firm-level size based on employment	1	2 to 3	Over 3	Total
Small (< 1,000)	32	4	0	36
Large (>1,000)	21	7	6	34
Total, all firms	53	11	6	70

4.3.3 Issues of Vertical and Horizontal Integration

Vertical integration is a potentially important dimension in analyzing firm-level impacts because the regulation could affect a vertically integrated firm on more than one level. For example, the regulation may affect companies for whom pickling is only one of several processes in which the firm is involved. For example, a company owning steel pickling facilities may also manufacture beverage containers, heavy machinery, or automobile parts, for example. This firm would be considered vertically integrated because it is involved in more than one level of production requiring steel manufacture and finished products made from steel. A regulation that increases the cost of pickling steel will affect the cost of producing products like beverage containers made from steel products that are pickled during the production process.

Horizontal integration is also a potentially important dimension in firm-level impact analyses for either or both of two reasons:

- A diversified firm may own facilities in unaffected industries. This type of diversification would help mitigate the financial impacts of the regulation.
- A diversified firm could be indirectly as well as directly affected by the regulation. For example, if a firm is diversified in manufacturing pollution control equipment (an unlikely scenario), the regulation could indirectly and favorably affect it.

The range of SIC codes represented by firms owning steel pickling facilities is presented in Table 4-19. Seventeen companies report conducting business within SIC 3312 (blast furnaces and steel mills), eight list SIC 3315 (steel wire and related products) and SIC 3316 (cold-finishing of steel shapes), and four list SIC 3317 (steel pipe and tubes). Lines of business reported by companies that are outside the primary metals industry include SIC 3452 (bolts, nuts, screws, rivets, and washers), SIC 3465 (automotive stampings), and SIC 7538 (general automotive repair shops).

4.3.4 Financial Condition

Table 4-20 illustrates the financial experience of U.S. steel producers, processors, and converters for 1991 and 1992.[84] Integrated producers, as a whole, incurred rather large operating losses for both 1991 and 1992. Alternatively, the nonintegrated mills (minimills, specialty mills, and processing mills) were slightly profitable over these years, except for minimills in 1992.

4.3.5 Current Events

American Metal Market reported a number of developments that changed the U.S. steel industry during 1992.[85] Bethlehem Steel shut down its Bar, Rod, and Wire division based in

TABLE 4-19. SIC LISTINGS FOR U.S. STEEL COMPANIES OWNING STEEL PICKLING FACILITIES[86]

SIC	Description	Number of Companies
1311	Crude petroleum and natural gas	1
2911	Petroleum refining	1
3011	Tires and inner tubes	1
3052	Rubber and plastics hose and belting	1
3069	Fabricated rubber products, n.e.c.	1
3299	Nonmetallic mineral products, n.e.c.	1
3312	Blast furnaces and steel mills	17
3315	Steel wire and related products, mfpm	8
3316	Cold finishing of steel shapes	8
3317	Steel pipe and tubes-mfpm	4
3325	Steel foundries, n.e.c.	1
3356	Rolling, drawing and extruding of nonferrous metals, except copper and aluminum	1
3357	Nonferrous wire drawing and insulating	2
3398	Metal heat treating	2
3423	Hand and edge tools, n.e.c.	1
3441	Fabricated structural metal	2
3443	Fabricated plate work	1
3449	Miscellaneous metal work	1
3452	Bolts, nuts, screws, rivets and washers	1
3462	Iron and steel forgings	1
3465	Automotive stampings	1
3471	Metal plating and polishing	3
3479	Metal coating and allied services	4
3496	Miscellaneous fabricated wire products	5
3499	Fabricated metal products, n.e.c.	3
	(Continued) 3531 Construction machinery	1
3532	Mining machinery and equipment	1

TABLE 4-19. SIC LISTINGS FOR U.S. STEEL COMPANIES OWNING STEEL PICKLING FACILITIES (continued)

SIC	Description	Number of Companies
3533	Oilfield and gasfield machinery and equipment	1
3545	Machine tool accessories	1
3548	Gas and electric welding and soldering equipment	1
3568	Power transmission equipment, n.e.c.	1
3592	Carburetors, pistons, piston rings and valves	1
3624	Carbon and graphite products	1
3625	Relays and industrial controls	1
3644	Noncurrent-carrying wiring devices	1
3714	Motor vehicle parts and accessories	1
3731	Ship building and repairing	2
3743	Railroad equipment	1
3799	Transportation equipment, not elsewhere classified	1
5051	Metal service centers and offices-wholesale	4
6719	Offices of holding companies, n.e.c.	3
7538	General automotive repair shops	1

TABLE 4-20. FINANCIAL EXPERIENCE OF U.S. STEEL PRODUCERS AND CONVERTERS: 1991-1992[87]

	Integrated		Minimills		Specialty		Processors	
Item	1991	1992	1991	1992	1991	1992	1991	1992
Total net sales	22,961	23,382	10,013	9,891	4,319	4,318	5,865	6,007
Raw Materials	4,841	4,904	2,768	2,601	1,671	1,591	3,514	3,518
Direct Labor	4,071	4,003	916	926	531	560	455	495
Other	8,493	8,426	3,066	3,031	1,484	1,551	1,040	1,048
Total cost of goods sold	22,938	23,067	9,015	8,893	3,733	3,752	5,215	5,280
Operating income or (loss)	23	316	999	999	586	567	650	727
General, selling, and administrative expenses	1,087	1,222	579	570	289	295	456	470
Net operating income or (loss)	-1,063	-906	419	428	297	272	194	257
Net interest income or (expense)	-409	-412	-195	-187	-82	-73	-118	-103
All other income or (expense)	-638	-128	-62	-322	-28	-51	-55	-26
Net income or (loss) before taxes	-2,112	-1,446	90	-137	187	149	21	120
Depreciation and amortization	1,041	1,132	383	407	120	125	200	202

Johnstown, Pennsylvania, and sold the wire mill to TMB Industries of Chicago and the remaining mills to the Ispat Group of Indonesia. Oregon Steel made a bid to purchase CF&I Steel out of Chapter 11 creditor protection, while Sharon Steel Corporation halted all steelmaking and rolling operations in November before re-entering bankruptcy court protection. Armco Incorporated purchased Cyclops Industries, Inc., making the combined company the nation's second largest specialty steel producer behind Allegheny Ludlum Corporation. Late in the year, Lukens, Inc., purchased Washington Steel Corporation and Washington Specialty Metals, Incorporated. Other U.S. producers facing financial difficulties during the year were Northwestern Steel and Wire Corporation, McLouth Steel Corporation, Thomas Steel Corporation, and Edgewater Steel Corporation.

Figure 4-1. U.S. steel pickling facilities operating in 1991 by state.[57]

the U.S. during 1991. The annual production capacities ranged from 4,300 to 156,000 tons for a single pickling line and from 4,700 to 421,000 tons for a single facility. In 1991, overall capacity for all continuous pickling lines was 46.1 million tons per year, while actual production was 37.4 million tons. Most of the larger facilities or pickling lines are associated with integrated steel mills. Some facilities have multiple continuous pickling lines.

4.2.2.2 Push-Pull Pickling. The U.S. had 19 facilities with 22 push-pull pickling lines in 1991. The annual

45. Lima, Jose Guilerme de Heraclito. Restructuring the U.S. Steel Industry: Semi-finished Steel Imports, International and U.S. Adaptation. Boulder, CO. Westview Press. 1991. Table 4.5, p. 67.

Certain Flat-Rolled Carbon Steel Products from Argentina, Australia, Austria, Belgium, Brazil, Canada, Finland, France, Germany, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Poland, Romania, Spain, Sweden, and the United Kingdom: Volume II: Information Obtained in the Investigation. (Publication 2664). U.S. International Trade Commission. August 1993. p. I-167.

Certain Flat-Rolled Carbon Steel Products from Argentina, Australia, Austria, Belgium, Brazil, Canada, Finland, France, Germany, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Poland, Romania, Spain, Sweden, and the United Kingdom: Volume II: Information Obtained in the Investigation. (Publication 2664). U.S. International Trade Commission. August 1993. p. I-167.

Certain Flat-Rolled Carbon Steel Products from Argentina, Australia, Austria, Belgium, Brazil, Canada, Finland, France, Germany, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Poland, Romania, Spain, Sweden, and the United Kingdom: Volume II: Information Obtained in the Investigation. (Publication 2664). U.S. International Trade Commission. August 1993. p. I-168.

U.S. International Trade Commission. August 1993 (Volume II). p. I-168.

Certain Flat-Rolled Carbon Steel Products from Argentina, Australia, Austria, Belgium, Brazil, Canada, Finland, France, Germany, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Poland, Romania, Spain, Sweden, and the United Kingdom: Volume II: Information Obtained in the Investigation. (Publication 2664). U.S. International Trade Commission. August 1993. p. I-168.

Mueller, Hans. 1984. Protection and Competition in the U.S. Steel Market: A Study of Managerial Decision Making in Transition (Monograph No. 30). Murfreesboro, TN: Business and Economics Research Center, Middle Tennessee State University.

Certain Flat-Rolled Carbon Steel Products from Argentina, Australia, Austria, Belgium, Brazil, Canada, Finland, France, Germany, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Poland, Romania, Spain, Sweden, and the United Kingdom: Volume II: Information Obtained in the Investigation. (Publication 2664). U.S. International Trade Commission. August 1993. p. I-168.

53. American Metal Market. 1993. Metal Statistics: 1993. New York. Chilton Publications.

54. U.S. Department of Commerce. Census of Manufactures. Industry Series: Concentration Ratios in Manufacturing. Washington, D.C., Government Printing Office. 1991

55. U.S. Environmental Protection Agency. Information Collection Request.

U.S. Environmental Protection Agency. 1993. Information Collection Request (ICR) database.

EPA ICR

58. U.S. Environmental Protection Agency. Information Collection Request.

59. U.S. Environmental Protection Agency. Information Collection Request.

American Metal Market. May 14, 1993. "Alleghany Ludlum awards anneal line pact to Mannesmann." p. 3.

American Metal Market. March 19, 1993. "PM to modernize line at Washington Steel." p. 5.

U.S. Department of Commerce. 1987 Census of Manufactures Industry Series: Type of Organization. Washington, DC, Government Printing Office. 1990.

U.S. Department of Commerce. Statistical Abstract of the U.S. Washington, DC, Government Printing Office. 1992.

U.S. Department of Commerce. Census of Manufactures Industry Series: Type of Organization. Washington, DC, Government Printing Office. February 1991.

Behrens, Robert H. Commercial Loan Officer's Handbook. Boston, Banker's Publishing Company. 1985.

66. U.S. Environmental Protection Agency. Information Collection Request (source is the same for attached sheets).

67. U.S. Department of Commerce. 1987 Census of Manufactures Industry Series. Washington, D.C., Government Printing Office. Type of Organization.

U.S. Department of Commerce. 1992 Statistical Abstract of the United States. Washington, DC, Table no. 826. 1992.

Steinhoff, D., and J.F. Burgess. Small Business Management Fundamentals. 5th ed. New York, McGraw-Hill Book Company. 1989.

70. U.S. Department of Commerce. Census of Manufactures, Industry Series: Type of Organization. Washington, D.C., Government Printing Office. February 1991.

71. U.S. Department of Commerce. Statistical Abstract of the U.S. Washington, D.C., Government Printing Office.

72. Steinhoff, D., and J.F. Burgess. Small Business Management Fundamentals. 5th ed. New York, McGraw-Hill Book Company. 1989.

U.S. Department of Commerce. 1992 Statistical Abstract of the United States. Washington, DC, Table no. 826. 1992.

74. Ref. 72.

U.S. Department of Commerce. 1992 Statistical Abstract of the United States. Washington, DC, Table no. 826. 1992.

76. Ref. 72.

Ward's Business Directory of U.S. Private and Public Companies. 1994. Washington, D.C.: Gale Research Inc.

U.S. Environmental Protection Agency. 1993. Information Collection Request (ICR) database.

79. Ward's Business Directory of U.S. Private and Public Companies 1994.

80. U.S. Environmental Protection Agency (EPA). Information Collection Report (ICR). Data obtained by EPA under the authority of Section 194 of the Clean Air Act.

81. EPA ICR.

U.S. Environmental Protection Agency. Information Collection Request. Database. 1993.

U.S. Environmental Protection Agency. Information Collection Request. Database. 1993.

Steel: Semiannual Monitoring Report (Publication 2655). U.S. International Trade Commission. June 1993. Table 22.

American Metal Market. 1993. Metal Statistics, 1993. New York: Chilton Publications.

86. Ward's Business Directory of U.S. Private and Public Companies. 1994.

87. American Iron and Steel Institute Annual Statistical Report 1992.

EPA ICR

SECTION 5
MARKETS

Steel products are produced and consumed domestically as well as traded internationally. Therefore, domestic producers export some of these products to other countries, and foreign producers supply their steel products to U.S. markets. This section includes tables on quantity trends over the past decade for steel mill products. Although the fraction of each steel mill product actually pickled is not known at present, the information provided here is useful because these products represent all the finished products that are subject to steel pickling processes.

5.1 PRODUCTION

5.1.1 Domestic Production

U.S. shipments for steel mill products from 1983 to 1992 are shown in Table 5-1.[88] As shown, net shipments increased by 21.6 percent over this period from 67.6 million tons in 1983 to 82.2 million tons in 1992. Sheets and strip consistently account for the largest percentage of annual U.S. shipments followed by semi-finished products, shapes and plates, and bars. In 1992, these four product groups accounted for 88.3 percent of total U.S. shipments of steel mill products. Rails, tool steel, and wire products together account for less than 2 percent of total shipments in 1992.

5.1.2 Foreign Production (Imports)

Table 5-2 shows the imports of steel mill products to the U.S. between 1983 and 1992.[89] Imports increased from 17.1 million tons in 1983 to 26.2 million tons in 1984, an increase

of 53.3 percent. From 1984 to 1991, the quantity of imported

TABLE 5-1. SHIPMENTS OF STEEL MILL PRODUCTS: 1983-1992[90]

Steel Mill Products	1983 Tons (10^3)	1983 Percentage	1984 Tons (10^3)	1984 Percentage	1985 Tons (10^3)	1985 Percentage	1986 Tons (10^3)	1986 Percentage	1987 Total (10^3)	1987 Percentage
Semi-Finished	3,860	5.7%	4,407	6%	4,345	5.9%	4,955	7.1%	5,455	7.1%
Shapes and Plates	7,438	11.0%	8,495	12%	9,026	12.4%	8,093	11.5%	9,167	12.0%
Rails	884	1.3%	1,239	2%	926	1.3%	640	0.9%	515	0.7%
Bars	11,653	17.2%	13,170	18%	12,608	17.3%	12,115	17.2%	13,517	17.6%
Tool Steel	46	0.1%	61	0%	60	0.1%	56	0.1%	58	0.1%
Pipe & Tubing	3,244	4.8%	4,275	6%	4,096	5.6%	2,836	4.0%	3,569	4.7%
Wire	1,359	2.0%	1,223	2%	1,136	1.6%	1,080	1.5%	1,105	1.4%
Tin Mill	4,308	6.4%	4,062	6%	3,773	5.2%	3,801	5.4%	3,988	5.2%
Sheets & Strip	34,791	51.5%	36,807	50%	37,070	50.8%	36,687	52.2%	39,278	51.2%
Total Steel Mill Products	67,583	100.0%	73,739	100.0%	73,040	100.0%	70,263	100.0%	76,652	100.0%

Steel Mill Products	1988 Tons (10^3)	1988 Percentage	1989 Tons (10^3)	1989 Percentage	1990 Tons (10^3)	1990 Percentage	1991 Tons (10^3)	1991 Percentage	1992 Tons (10^3)	1992 Percentage
Semi-Finished	5,975	7.1%	6,236	7.4%	6,313	7.4%	6,915	8.8%	6,981	8.5%
Shapes and Plates	12,537	15.0%	12,739	15.1%	14,038	16.5%	12,617	16.0%	12,637	15.4%
Rails	615	0.7%	562	0.7%	518	0.6%	487	0.6%	562	0.7%
Bars	14,423	17.2%	14,104	16.8%	14,668	17.3%	12,788	16.2%	13,164	16.0%
Tool Steel	64	0.1%	67	0.1%	58	0.1%	51	0.1%	64	0.1%
Pipe & Tubing	4,443	5.3%	4,011	4.8%	4,652	5.5%	4,488	5.7%	4,198	5.1%
Wire	1,073	1.3%	1,002	1.2%	918	1.1%	865	1.1%	900	1.1%
Tin Mill	4,069	4.9%	4,126	4.9%	4,031	4.7%	4,041	5.1%	3,927	4.8%
Sheets & Strip	40,639	48.5%	41,262	49.1%	39,784	46.8%	36,594	46.4%	39,808	48.4%

Total Steel Mill Products	83,838	100.0%	84,109	100.0%	84,980	100.0%	78,846	100.0%	82,241	100.0%

TABLE 5-2. IMPORTS OF STEEL MILL PRODUCTS (Net tons): 1983-1992[91]

Steel Mill Products	1983	1984	1985	1986	1987
Ingots, blooms, billets, slabs, etc.	822,483	1,515,837	2,440,368	2,084,096	2,282,654
Wire rods	1,185,291	1,589,788	1,479,176	1,357,875	1,467,030
Structural shapes and pilings	1,558,275	2,155,625	2,118,518	1,855,617	1,888,019
Plates	1,103,199	1,538,495	1,377,921	1,106,904	1,096,424
Rails and accessories	159,353	373,890	382,045	275,710	245,989
Bars and tool steel	975,713	1,719,450	1,549,406	1,473,129	1,356,422
Pipe and tubing	2,862,061	5,421,713	4,463,668	2,936,811	2,770,183
Wire and wire products	872,187	1,178,715	1,055,821	1,022,026	1,040,687
Tin mill products	523,125	737,781	785,545	676,164	619,454
Sheets and strip	7,008,209	9,931,923	8,603,181	7,903,983	7,647,635
Total Steel Mill Products	17,069,896	26,163,217	24,255,649	20,692,315	20,414,497

	1988	1989	1990	1991	1992
Ingots, blooms, billets, slabs, etc.	2,844,979	2,197,833	2,362,843	2,257,813	2,394,252
Wire rods	1,493,833	1,107,506	959,975	826,268	1,117,640
Structural shapes and pilings	1,959,354	1,485,716	916,027	523,158	506,694
Plates	1,733,205	1,437,123	1,572,691	1,291,077	1,608,229
Rails and accessories	268,493	157,411	132,614	155,435	162,346
Bars and tool steel	1,442,340	1,398,874	1,138,656	1,062,366	1,181,592
Pipe and tubing	3,282,669	2,473,323	2,596,015	2,735,399	1,543,504
Wire and wire products	552,780	494,308	432,340	391,808	430,985
Tin mill products	546,241	596,879	573,679	555,084	606,409
Sheets and strip	6,767,000	5,972,004	6,483,779	6,047,056	7,522,851

steel mill products dropped by 39.6 percent, falling to a low of 15.8 million tons in 1991. Imports rose again from 1991 to 1992, reaching a level of 17.1 million tons. As shown, in 1992, the largest categories of U.S. imported steel mill products were sheets and strip (44.1 percent); ingots, blooms, billets, slabs, etc. (14 percent); plates (9.4 percent); and pipe and tubing (9 percent).

Table 5-3 shows imports of steel mill products by country of origin from 1988 to 1992.[92] Throughout this period the U.S. imported the largest share of steel mill products from Europe, Asia, and Africa--primarily due to imports from the European Economic Community (EEC) and Japan. However, U.S. dependence on imports from Canadian sources is increasing. Imports from Canada increased by 33.4 percent since 1988 to 4.2 million tons in 1992. At the same time, Canada increased its share of total U.S. imports from 15.2 percent in 1988 to 24.8 percent in 1992.

Table 5-4 shows imports of steel mill products by U.S. customs district for 1992.[93] Importation of steel mill products through customs districts in the Great Lakes and along the Canadian border accounted for 38.3 percent of total U.S. imports in 1992. Customs districts within the Gulf Coast and along the Mexican border accounted for 22.8 percent of total U.S. steel mill product imports in 1992 followed by Pacific Coast custom districts (21.5 percent), Atlantic Coast custom districts (15.7 percent), and off-shore custom districts (1.7 percent).

5.2 CONSUMPTION

5.2.1 Domestic Consumption

Domestic consumption, or apparent U.S. consumption, is calculated as U.S. shipment minus exports, plus imports. Table 5-5 shows domestic consumption of steel mill products from 1983 to 1992. Domestic consumption of steel mill

products increased by 13.9 percent over this period from 83.5

TABLE 5-3. IMPORTS OF STEEL MILL PRODUCTS BY COUNTRIES OF ORIGIN: 1988-1992[94]

Country	1988		1989		1990		1991		1992	
	Tons	% of Total	Tons	% of Total	Tons	% of Total	Tons	% of Total	Tons	% of Total
Canada	3,172,825	15.2%	2,974,940	17.2%	2,873,467	16.7%	2,928,973	18.5%	4,233,390	24.8%
Latin America	2,602,348	12.5%	2,252,333	13.0%	2,589,299	15.1%	2,382,782	15.0%	2,296,745	13.5%
Europe	8,024,561	38.4%	6,647,965	38.4%	6,455,444	37.6%	5,644,498	35.6%	5,400,899	31.6%
Asia & Africa	6,728,563	32.2%	5,105,875	29.5%	4,839,955	28.2%	4,451,322	28.1%	4,681,580	27.4%
Oceania	362,597	1.7%	339,865	2.0%	410,455	2.4%	437,887	2.8%	461,887	2.7%
Total Imports	20,890,894	100.0%	17,320,978	100.0%	17,168,620	100.0%	15,845,462	100.0%	17,074,501	100.0%

TABLE 5-4. IMPORTS OF STEEL MILL PRODUCTS BY CUSTOMS DISTRICT (Net tons): 1992[95]

Steel Mill Products	U.S. Total	Customs Districts Within[a]				
		Atlantic Coast	Gulf Coast-Mexican Border	Pacific Coast	Great Lakes/ Canadian Border	Off-Shore
Semi-Finished	3,511,892	419,754	885,184	1,149,542	1,047,338	10,073
Shapes and Plates	2,114,923	281,031	711,867	166,398	942,222	13,407
Rails	162,346	17,187	71,121	61,362	12,140	536
Bars	1,114,705	117,080	110,756	54,836	733,790	98,242
Tool Steel	66,887	47,842	4,217	2,463	12,364	-
Pipe & Tubing	1,543,504	228,102	520,560	242,720	487,723	64,398
Wire	430,985	69,579	50,626	62,486	237,627	10,667
Tin Mill	606,409	120,338	103,359	130,004	221,566	31,140
Sheets & Strip	7,522,851	1,374,753	1,443,484	1,803,148	2,845,061	56,403
Total	17,074,502	2,675,666	3,901,174	3,672,959	6,539,831	284,866

[a] The following ports make up the custom districts as follows: Atlantic Coast-Boston, Providence, New York City, Philadelphia, Baltimore, Washington, DC Norfolk, Charlotte, Charleston, Savannah, Tampa, Miami Gulf Coast-Mobile, New Orleans, Port Arthur, Houston, Dallas, Laredo, El Paso Nogales Pacific Coast-San Diego, Los Angeles, San Francisco, Columbia Snake, Seattle, Off Shore-Virgin Islands, Anchorage, Honolulu, San Juan.

TABLE 5-5. DOMESTIC CONSUMPTION OF STEEL MILL PRODUCTS: 1983-1992[a]

Steel Mill Products	1983 Tons	1983 % Imp.	1984 Tons	1984 % Imp.	1985 Tons	1985 % Imp.	1986 Tons	1986 % Imp.	1987 Total	1987 % Imp.
Semi-Finished	5,758,883	34.9%	7,430,443	41.8%	8,170,096	48.0%	8,332,210	41.3%	9,122,924	41.1%
Shapes and Plates	9,948,376	26.8%	12,068,533	30.6%	12,397,190	28.2%	10,948,530	27.1%	12,000,521	24.9%
Rails	1,023,282	15.6%	1,593,812	23.5%	1,294,615	29.5%	902,578	30.5%	745,234	33.0%
Bars and Tool Steel	12,504,661	7.8%	14,816,855	11.6%	14,118,310	11.0%	13,562,904	10.9%	14,809,554	9.2%
Pipe & Tubing	5,848,109	48.9%	9,489,287	57.1%	8,360,349	53.4%	5,651,761	52.0%	6,187,027	44.8%
Wire	2,203,928	39.6%	2,373,747	49.7%	2,166,784	48.7%	2,067,447	49.4%	2,109,941	49.3%
Tin Mill	4,581,569	11.4%	4,637,761	15.9%	4,394,641	17.9%	4,197,691	16.1%	4,370,826	14.2%
Sheets & Strip	41,585,511	16.9%	46,511,366	21.4%	45,461,690	18.9%	44,363,037	17.8%	46,591,951	16.4%
Total	83,454,319	20.5%	98,921,804	26.4%	96,363,675	25.2%	90,026,158	23.0%	95,937,978	21.3%

	1988 Tons	1988 % Imp.	1989 Tons	1989 % Imp.	1990 Tons	1990 % Imp.	1991 Tons	1991 % Imp.	1992 Tons	1992 % Imp.
	10,242,221	42.4%	9,114,429	36.3%	9,006,859	36.9%	9,133,537	33.8%	9,999,130	35.1%
	16,048,244	23.0%	14,861,466	19.7%	15,753,558	15.8%	13,284,562	13.7%	14,037,993	15.1%
	869,846	30.9%	702,376	22.4%	582,820	22.8%	601,219	25.9%	697,369	23.3%

15,787,880	9.1%	15,318,717	9.1%	15,419,607	7.4%	13,320,995	8.0%	13,842,497	8.5%
7,475,279	43.9%	6,041,327	40.9%	6,777,232	38.3%	6,470,282	42.3%	5,105,036	30.2%
1,589,616	34.8%	1,464,964	33.7%	1,280,288	33.8%	1,167,392	33.6%	1,240,846	34.7%
4,184,542	13.1%	4,505,057	13.2%	4,428,986	13.0%	4,402,474	12.6%	4,189,744	14.5%
46,462,643	14.6%	44,843,698	13.3%	44,596,689	14.5%	39,965,120	15.1%	45,915,302	16.4%
102,660,271	20.3%	96,852,034	17.9%	97,846,039	17.5%	88,345,581	17.9%	95,027,917	18.0%

[a] Domestic consumption, or apparent U.S. consumption, is defined as U.S. shipments minus exports plus imports.

million tons in 1983 to 95 million tons in 1992. Sheets and strip consistently accounted for the largest percentage of annual U.S. consumption followed by bars and tool steel, shapes and plates, and semi-finished products. In 1992, these four product groups accounted for 88.2 percent of total U.S. consumption of steel mill products. Rails and wire products together accounted for roughly 2 percent of total consumption in 1992.

Table 5-5 also shows the import share of U.S. total consumption during the period 1983 through 1992. The share of imports in domestic consumption declined slightly from 20.5 percent in 1983 to 18 percent in 1992. Import penetration, as reflected by this share, reached a high of 26.5 percent in 1984. In other words, foreign sources accounted for over one-quarter of U.S. consumption of steel mill products in that year. The share of imports in domestic consumption slowly fell from 1984 to its 1992 level of 18 percent.

5.2.2 Foreign Consumption (Exports)

Table 5-6 provides U.S. exports of steel mill products for 1983 through 1992.[96] From 1983 to 1990, U.S. exports of steel mill products rose by 284 percent--from 1.2 million tons to 4.3 million tons. Exports rose again to 6.3 million tons in 1991 but fell back to 4.3 million tons in 1992. As Table 5-6 shows, in 1992, sheets and strip (33 percent), pipe and tubing (14.8 percent), and bars and tool steel (13.2 percent) were the largest categories of U.S. steel mill product exports.

Table 5-7 presents U.S. exports of steel mill products by country of destination for 1992.[97] Latin America (41.8 percent), Canada (32.9 percent), and Asia (16.7 percent) are the largest importers of U.S. exported steel mill products.

TABLE 5-6. EXPORTS OF STEEL MILL PRODUCTS (Net Tons): 1983-1992[98]

Steel Mill Products:	1983	1984	1985	1986	1987
Ingots, blooms, billets, slabs, etc.	102,754	73,536	89,708	58,885	73,543
Wire rods	6,137	8,646	4,740	5,876	8,217
Structural shapes and pilings	49,116	32,403	42,261	37,426	65,711
Plates	101,982	88,184	82,988	69,565	85,211
Rails and accessories	20,071	19,078	13,430	13,132	15,755
Bars and tool steel	170,052	133,595	99,096	81,225	121,868
Pipe and tubing	257,952	207,426	199,319	121,050	152,156
Wire and wire products	27,259	27,968	25,037	34,579	35,746
Tin mill products	249,556	162,020	163,904	279,473	236,628
Sheets and strip	213,698	227,557	211,491	227,946	333,684
TOTAL	1,198,577	980,414	931,976	929,156	1,128,519

	1988	1989	1990	1991	1992
Ingots, blooms, billets, slabs, etc.	61,430	390,816	522,326	699,087	422,915
Wire rods	10,161	36,094	106,633	166,457	70,847
Structural shapes and pilings	61,922	169,678	314,825	415,232	304,517
Plates	119,393	630,695	458,335	731,441	409,413
Rails and accessories	13,647	17,035	67,794	41,216	26,977
Bars and tool steel	141,460	251,157	445,049	580,371	567,095
Pipe and tubing	250,390	442,996	470,783	753,117	636,468
Wire and wire products	36,164	31,344	70,052	89,416	90,139
Tin mill products	430,699	217,822	175,693	193,610	343,665
Sheets and strip	943,357	2,390,306	1,671,090	2,675,936	1,415,549
Total	2,068,623	4,577,944	4,302,581	6,345,883	4,287,582

TABLE 5-7. EXPORTS OF STEEL MILL PRODUCTS (Net Tons) BY DESTINATION: 1992[99]

Steel Mill Products	Canada	Latin America	Europe	Asia	Oceania	Africa
Semi-Finished	55,316	320,504	28,276	85,575	3,526	563
Shapes and Plates	216,372	364,290	33,226	96,636	1,009	2,395
Rails	16,052	10,063	727	126	4	5
Bars	197,984	219,256	11,762	84,205	920	4,171
Tool Steel	2,360	2,431	790	297	4	91
Pipe & Tubing	250,756	142,059	95,007	140,597	3,781	47,089
Wire	41,023	31,194	3,827	13,536	235	325
Tin Mill	42,251	145,195	32,833	79,835	23	43,527
Sheets & Strip	589,228	558,810	46,256	216,373	1,903	2,980
Total	1,411,342	1,793,802	252,704	717,180	11,405	101,146

American Iron and Steel Institute (AISI). Annual Statistical Report, 1992. Table 11.

American Iron and Steel Institute (AISI). Annual Statistical Report, 1992. Table 19.

90. American Iron and Steel Institute. Annual Statistical Report, 1992.

91. American Iron and Steel Institute. Annual Statistical Report, 1992. Table 19.

American Iron and Steel Institute (AISI). Annual Statistical Report, 1992. Table 21.

American Iron and Steel Institute (AISI). Annual Statistical Report, 1992. Table 23.

94. American Iron and Steel Institute. Annual Statistical Report, 1992. Table 21.

95. American Iron and Steel Institute. Annual Statistical Report, 1992. Table 23.

American Iron and Steel Institute (AISI). Annual Statistical Report, 1992. Table 15.

American Iron and Steel Institute (AISI). Annual Statistical Report, 1992. Table 17.

98. American Iron and Steel Institute. Annual Statistical Report, 1992. Table 15.

99. American Iron and Steel Institute. Annual Statistical Report, 1992. Table 17.

REFERENCE LIST

1. U.S. Environmental Protection Agency (EPA). Information Collection Report (ICR). Data obtained by EPA under the authority of Section 194 of the Clean Air Act.

2. Ref. 1.

3. Ref. 1.

4. American Iron and Steel Institute (AISI). Annual Statistical Report. 1992.

5. Russell, Clifford S. and Vaughan, William J. 1976. Steel Production: Processes, Products, and Residuals. Baltimore MD: Johns Hopkins University Press. p. 24.

6. Ref. 5., pp. 25-26.

7. Ref. 5., pp. 104-105.

8. Ref. 5., pp. 104-105.

9. The Making, Shaping and Treating of Steel, 10th edition. Association of Iron and Steel Engineers. Pittsburgh, PA. 1985.

10. Ref. 9., p. 1085.

11. Ref. 5., Table 7.3.

12. Ref. 9., p. 1084.

13. Background Information Document (BID): 1993. Steel Pickling NESHAP. Chapter 3 as provided by the RTI Engineers.

14. Iron Age. March, 1993. "Getting out of a picklish situation." 9(3):18-21.

15. Standard & Poor's Industry Surveys. 1992. Steel and Heavy Machinery: Basic Analysis. p. S-25.

16. Ref. 15.

17. Ref. 15.

18. Hogan, William T. 1987. Minimills and Integrated Mills: A Comparison of Steelmaking in the United States. Lexington, MA: D.C. Heath and Company.

19. American Metal Market. June 27, 1989. "Heidtman Steel breaks ground for its fourth pickling facility." 97(124):3.

20. Certain Flat-Rolled Carbon Steel Products from Argentina, Australia, Austria, Belgium, Brazil, Canada, Finland, France, Germany, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Poland, Romania, Spain, Sweden, and the United Kingdom: Volume II: Information Obtained in the Investigation. (Publication 2664). U.S. International Trade Commission. August 1993. p. 20.

21. Ref. 20., Tables 17 and 18.

22. Ref. 20., Table 29.

23. Ref, 20., Table 29.

24. Ref. 4.

25. The Competitive Status of the U.S. Steel Industry: A Study of the Influences of Technology in Determining International Industrial Competitive Advantage. National Research Council. Washington DC, National Academy Press. 1985.

26. U.S. Department of Labor, Bureau of Labor Statistics, SIC 33. January 1990-1993.

27. Chemical Week. June 16, 1993. HCL as Complex as Ever: Tightness Can't Last." 152(23):67-68.

28. Ref. 27.

29. Lancaster, Kelvin J. A New Approach to Consumer Theory. Journal of Political Economy. 74:132-157. 1966.

30. Ref. 4., Table 12.

31. Ref. 4., Table 12.

32. Ref. 20., I-48 to I-49

33. Ref. 4., Table 12.

34. Ref. 25.

35. Ref. 34.

36. Standard & Poor's Industry Surveys. 1992. Steel and Heavy Machinery: Basic Analysis. p. S-18.

37. Ref. 36.

38. Ref. 36.

39. Ref. 36.

40 Ref. 4., P. S-19.

41. Ref. 4., P. S-19.

42. Ref. 4., P. S-19.

43. Ref. 4., P. S-19.

44. Ref. 4., P. S-19.

45. Lima, Jose Guilerme de Heraclito. Restructuring the U.S. Steel Industry: Semi-finished Steel Imports, International and U.S. Adaptation. Boulder, CO. Westview Press. 1991. Table 4.5, p. 67.

46. Ref. 20., P. I-168.

47. Ref. 20., P. I-167.

48. Ref. 20., P. I-168.

49. Ref. 20., P. I-168.

50. Ref. 20., P. I-168.

51. Mueller, Hans. 1984. Protection and Competition in the U.S. Steel Market: A Study of Managerial Decision Making in Transition (Monograph No. 30). Murfreesboro, TN: Business and Economics Research Center, Middle Tennessee State University.

52. Ref. 20., P. I-168.

53. American Metal Market. 1993. Metal Statistics: 1993. New York. Chilton Publications.

54. U.S. Department of Commerce. Census of Manufactures. Industry Series: Concentration Ratios in Manufacturing. Washington, D.C., Government Printing Office. 1991.

55. Ref. 1.

56. Ref. 1.

57. Ref. 1.

58. Ref. 1.

59. Ref. 1.

60. American Metal Market. May 14, 1993. "Alleghany Ludlum awards anneal line pact to Mannesmann." p. 3.

61. American Metal Market. March 19, 1993. "PM to modernize line at Washington Steel." p. 5.

62. U.S. Department of Commerce. 1987 Census of Manufactures Industry Series. Type of Organization. Washington, D.C., Government Printing Office. February 1991.

63. U.S. Department of Commerce. Statistical Abstract of the U.S. Washington, D.C., Government Printing Office. 1992. Table. No. 826.

64. Ref. 62.

65. Behrens, Robert H. Commercial Loan Officer's Handbook. Boston, Banker's Publishing company. 1985.

66. Ref. 1.

67. Ref. 63., Table No. 826.

68. Ref. 62.

69. Steinhoff, D., and J.F. Burgess. Small Business Management Fundamentals. 5th Ed. New York, McGraw-Hill Book Company. 1989.

70. Ref. 62.

71. Ref. 63.

72. U.S. Department of Commerce. 1992 Statistical Abstract of the United States. Washington, D.C., Table No. 826. 1992.

73. Ref. 69.

74. Ref. 69.

75. Ref. 72.

76. Ref. 69.

77. Ward's Business Directory of U.S. Private and Public Companies. 1994. Washington, D.C.: Gale Research, Inc.

78. Ref. 1.

79. Ref. 77.

80. Ref. 1.

81. Ref. 1.

82. Ref. 1.

83. Ref. 1.

84. Steel: Semi-annual Monitoring Report (Publication 2655). U.S. International Trade Commission. June 1993. Table 22.

85. American Metal Market. 1993. Metal Statistics, 1993. New York: Chilton Publications.

86. Ref. 78.

87. Ref. 84.

88. Ref. 4., Table 11.

89. Ref. 4., Table 19.

90. Ref. 4., Table 11.

91. Ref. 4., Table 19.

92. Ref. 4., Table 21.

93. Ref. 4., Table 23.

94. Ref. 4., Table 21.

95. Ref. 4., Table 23.

96. Ref. 4., Table 15.

97. Ref. 4., Table 17.

98. Ref. 4., Table 15.

99. Ref. 4., Table 17.

100. Standard Industrial Classification Manual.

101. U.S. Department of Labor. Bureau of Labor Statistics Producer Price Indexes Data for November 1991.

102. Ref. 101.

103. Ref. 101.

104. Ref. 101.

105. Ref. 101.

APPENDIX A

This appendix contains full descriptions of the relevant 4-digit SIC codes in the Primary Metals industry (SIC 33). Appendix Tables A-1 rough -A5 contain a detailed listing of steel producers included in each SIC code discussed below. Information in this appendix was taken from Standard Industrial Classification Manual.[100]

SIC 3312: Steel Works, Blast Furnaces (Including Coke Ovens), and Rolling Mills. Establishments primarily engaged in manufacturing hot metal, pig iron, and silvery pig iron from iron ore and iron steel scrap; converting pig iron, scrap iron, and scrap steel into steel; and hot-rolling iron and steel into basic shapes, such as plates, sheets, strips, rods, bars, and tubing.

SIC 3315: Steel Wiredrawing and Steel Nails and Spikes. Establishments primarily engaged in drawing wire from purchased iron or steel rods, bars, or wire and may be engaged in the further manufacture of products made from wire; establishments primarily engaged in manufacturing steel nails and spikes from purchased materials are also included in this industry.

SIC 3316: Cold-Rolled Steel Sheet, Strip, and Bars. Establishments primarily engaged in: cold-rolling steel sheets and strips from purchased hot-rolled sheets, cold-drawing steel bars and steel shapes from purchased hot-rolled steel bars, and producing other cold finished steel.

SIC 3317: Steel Pipe and Tubes. Establishments primarily engaged in producing welded or seamless steel pipes and tubes

and heavy riveted steel pipe from purchased materials.

SIC 3357: Drawing and Insulating of Nonferrous Wire. Establishments primarily engaged in drawing, drawing and insulating, and insulating wire and cable of nonferrous metals from purchased wire bars, rods, or wire. Also included are establishments primarily engaged in manufacturing insulated fiber optic cable.

SIC 3398: Metal Heat Treating. Establishments primarily engaged in heat treating or metal for the trade.

TABLE A-1. PRIMARY PRODUCTS AND PRODUCT CODES FOR SIC 3312: BLAST FURNACES AND STEEL MILLS

Primary Product Description	Product Code
Steel ingots and semifinished shapes and forms	3312-2
Semifinished products (excluding wire rods), carbon	3312-213
Wire rods, carbon	3312-219
Semifinished products (excluding wire rods), alloy	3312-236
Semifinished products (excluding wire rods), stainless	3312-256
Tin mill products, h.r. sheets and strip	3312-3
Sheets, h.r. carbon	3312-311
Sheets and strip, hot dipped galvanized, carbon	3312-313
Sheets and strip, electrolytic galvanized, carbon	3312-315
Other metallic coated sheets and strip, carbon	3312-317
Strip, h.r. carbon	3312-319
Tinplate	3312-326
Tin free steel	3312-328
Strip, h.r. stainless	3312-359
Hot rolled bars, plates and structural shapes	3312-4
Plates, carbon	3312-412
Heavy structural shapes, piling and piles, carbon	3312-415
Bars, h.r., carbon	3312-422
Bars, light structurals, carbon	3312-424
Concrete reinforcing bars, carbon	3312-425
Plates, alloy	3312-431

TABLE A-1. PRIMARY PRODUCTS AND PRODUCT CODES FOR SIC 3312: BLAST FURNACES AND STEEL MILLS (continued)

Primary Product Description	Product Code
(Continued)Bars, h.r., (including light structurals), alloy	3312-441
Tool steel, other than high speed alloy	3312-449
Plates and structural shapes, stainless	3312-45
Bars, h.r., stainless	3312-461
Steel wire	3312-5
Carbon wire	3312-5A
Steel pipe and tubes	3312-6
Pipe and oil country tubular goods, carbon	3312-6A
Pipe and tubing, alloy	3312-6E
Cold rolled sheets and strip (excl. metallic coated and electrical)	3312-7
Sheets and strip, c.r., carbon	3312-71
Sheets and strip, c.r., stainless	3312-75
Cold finished bars	3312-8
Bars, c.f., stainless	3312-851

TABLE A-2. PRIMARY PRODUCT AND PRODUCT CODES FOR SIC 3315: STEEL WIRE AND RELATED PRODUCTS-MFPM[101]

Primary Product Description	Product Code
Noninsulated ferrous wire, rope, cable and strand	3315-1
Wire rope and cable	3315-111
Wire strand and forms	3315-151
Steel nails and spikes	3315-2
Steel wire nails	3315-2A
Wire staples and tacks, cut nails and spikes	3315-2B
Steel wire	3315-5
Carbon wire	3315-5A
Steel fencing and fence gates	3315-6
Ferrous wire cloth and other woven wire products	3315-7
Other fabricated ferrous wire products	3315-9
Welded steel wire fabric	3315-96
Other wire products	3315-98

TABLE A-3. PRIMARY PRODUCT AND PRODUCT CODES FOR SIC 3316: COLD FINISHING OF STEEL SHAPES-MFPM[102]

Primary Product Description	Product Code
Sheets and strip, metallic coated and electrical, c.r.	3316-3
Cold rolled sheets and strip	3316-7
Sheets and strip, c.r., carbon	3316-71
Sheets and strip, c.r., alloy	3316-73
Sheets and strip, c.r., stainless	3316-75
Cold finished bars	3316-8
Bars, c.f., carbon	3316-811
Bars, c.f., alloy	3316-831

TABLE A-4. PRIMARY PRODUCT AND PRODUCT CODES FOR SIC 3317: STEEL PIPE AND TUBES-MFPM[103]

Primary Product Description	Product Code
Steel pipe and tubes	3317-6
Pipe and oil country tubular goods, carbon	3317-6A
Pressure tubing, carbon	3317-6B
Mechanical tubing, carbon	3317-6C
Pipe and tubing, alloy	3317-6E
Pressure tubing, stainless	3317-6F
Mechanical tubing, stainless	3317-6G

TABLE A-5. PRIMARY PRODUCT AND PRODUCT CODES FOR SIC 3357: NONFERROUS WIRE DRAWING AND INSULATING[104].

Primary Product Description	Product Code
Aluminum and aluminum-base alloy bare wire and cable	3357-A
Copper & copper-base alloy wire & cable for electrical transmission, including bare & tinned	3357-B
Other bare nonferrous metal wire	3357-C
Fiber optic cable	3357-E
Electronic wire & cable	3357-1
Telephone & telegraph wire and cable	3357-2
Control and signal wire and cable	3357-3
Buildig wire and cable with underwriters, labels	3357-4
Apparatus wire and cordage	3357-6
Magnet & wire	3357-7
Power wire and cable	3357-8
Other insulated wire and cable	3357-9

100.

101. U.S. Department of Labor. Bureau of Labor Statistics Producer Price Indexes Data for November 1991.

102. U.S. Department of Labor. Bureau of Labor Statistics Producer Price Indexes Data for November 1991.

103. U.S. Department of Labor. Bureau of Labor Statistics Producer Price Indexes Data for November 1991.

104. U.S. Department of Labor. Bureau of Labor Statistics Producer Price Indexes Data for November 1991.