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Preliminary Study of the Iron and Steel Category

40 CFR Part 420
Effluent Limitations Guidelines and Standards

PRELIMINARY STUDY OF THE IRON & STEEL CATEGORY

40 CFR PART 420
EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS

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EXECUTIVE SUMMARY

Purpose of This Review

EPA is required by Section 304 of the Clean Water Act to review effluent limitations guidelines and standards periodically to determine whether the current regulations remain appropriate in light of changes in the industrial category caused by advances in manufacturing technologies, in-process pollution prevention, or end-of-pipe wastewater treatment. EPA is also required by the terms of a consent decree with the Natural Resources Defense Council (NRDC) to initiate preliminary reviews of a number of categorical effluent limitations guidelines and standards on a set schedule.[4] This review is being conducted pursuant to those legislative and judicial requirements.

The approach taken includes:

- A preliminary assessment of the status of the industry with respect to the regulation promulgated in 1982 and as amended in 1984;
- Identification of better performing mills that use conventional and innovative in-process pollution prevention and end-of-pipe technologies;
- Estimation of possible effluent reduction benefits if the industry was upgraded to the level of better performing mills;
- Identification of regulatory and implementation issues with the current regulation; and
- Identification of possible solutions to those issues.

Industry Profile

There are 84 steel-producing companies located in the United States with more than 300 separate manufacturing sites. The U.S. domestic demand for finished and semi-finished steel products was approximately 104 million tons in 1993. U.S. producers manufactured about 98 million tons of raw steel and shipped about 89 million tons to domestic and export markets. Imports of semi-finished and finished steel accounted for about 19 million tons, or about 19% of U.S. demand. Exports from the U.S. totaled about 4.0 million tons. The industry operated at about 89% of capacity in 1993.[6]

During the past fifteen years, the U.S. steelmaking industry consolidated and modernized to become competitive in the U.S. and on world markets. Annual raw steelmaking capacity declined from over 150 million tons in 1978 to approximately 110 million tons in 1993. Direct steel industry employment declined from 450,000 people in 1978 to approximately 127,000 people in 1993. Approximately 61% of the raw steel produced is currently manufactured in basic oxygen furnaces and 39% in electric arc furnaces; steel is no longer manufactured in open hearth furnaces in the U.S. During 1993, approximately 86% of the raw steel was continuously cast as opposed to approximately 15% in 1978. After a series of annual losses from steelmaking operations (losses for eight of the eleven years during the period 1982 through 1992), the industry returned to profitability during 1993, and is operating profitably during the economic expansion continuing in 1994. U.S. steel producers are now among the lowest cost steel producers in the world.[6]

Capital spending for new plants and equipment, including environmental controls, has ranged from less than one to more than three billion dollars on an annual basis over the past 15 years. Capital spending devoted to environmental controls ranged from less than 5 to nearly 21 percent. Total investment in environmental controls for the period 1951 through 1992 was more than 7 billion dollars (water - $2.6 billion; air - $4.5 billion; solid waste - $0.1 billion). The industry is at or returning to the point where capital investments at the high end of its investment cycle may be made.[29]

For 1992, the industry reported the following Toxics Release Inventory (TRI) data for direct and indirect wastewater discharges under Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA):

Pollutants	Direct Discharge (lbs/yr)	Discharge to POTWs (lbs/yr)
Ammonia-N	1,830,000	679,000
Cyanide Compounds	65,500	14,400
Phenol	65,000	618,000
Toxic Metal Compounds*	447,000	55,400
Other SARA Organic Compounds	671,000	63,100

*As defined in the Toxics Release Inventory.

Forty iron and steel mills were included on state 304(l) short lists which identifies facilities discharging to impaired waterbodies (see Appendix C). Receiving water sediment contamination by polynuclear aromatic hydrocarbons has been documented at several iron and steel mills where blast furnace coke has been manufactured as an intermediate product. Three companies have been required to conduct sediment characterization and remediation as a result of consent decrees resulting from recent federal Clean Water Act enforcement actions.

40 CFR Part 420: Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category

Part 420 was promulgated in May 1982 (47 FR 23258) and was last amended in May 1984 (49 FR 21024) as part of a Settlement Agreement among EPA, the iron and steel industry, and the NRDC. The regulation was the first promulgated under the 1977

Amendments to the Clean Water Act. There are a number of regulatory issues identified by this study that pertain to Part 420, as described below.

Effluent Limitations Guidelines and Standards

- Comparisons of long-term average effluent quality performance for a number of better performing mills (data represent time periods ranging from six months to more than one year) with the long-term average bases for Part 420 reveal that, in all subcategories, mills are performing substantially better than is required by Part 420. In a limited number of cases, zero discharge of pollutants is being approached. This performance reflects increased high-rate process water recycle, advances in application of treatment technologies, and advances in treatment system operations.

- A number of mills continue to discharge in excess of the effluent limitations required by Part 420.

- Several mills are not achieving the zero discharge limitations applicable to semi-wet steelmaking operations.

- In at least 10 of the 12 current subcategories, toxic and nonconventional pollutants not currently regulated by Part 420 are discharged. The current effluent limitations guidelines and standards for toxic organic pollutants for the cold forming subcategory are no longer applicable.

- Scandinavian researchers have documented formation of chlorinated dibenzo-p-dioxins (CDDs) and chlorinated dibenzofurans (CDFs) in electric arc furnace steelmaking where steel is manufactured by remelting steel scraps.[53-55] There are no published studies for U.S. mills that characterize the formation of CDDs and CDFs in electric arc furnaces, other steelmaking furnaces, or other iron and steel operations. There are also no published data that characterize process wastewater discharges from U.S. iron and steel mills for CDDs and CDFs.

- At §420.03, the regulation provides for alternative effluent limitations (the water bubble) where dischargers can conduct intra-plant "trades" of like pollutants from one outfall to another to save costs or improve compliance prospects. Part 420 is the only effluent limitations guideline regulation that contains such a provision. Although not widely used, the present cost savings from §420.03 is more than $120 million, and there may be opportunities to increase its utilization.[38]

Potential Load Reductions

- Based on modelled estimates for the iron and steel industry to upgrade to the treatment level of better performing mills, a pollutant loading reduction of 1.9 million pounds of toxic equivalents per year can be achieved with a total capital investment of $339 million. Operating and maintenance costs are estimated at $32.2 million per year. Assuming an equipment life of 20 years and annual interest rates of 7% and 10%, the cost effectiveness for the industry as a whole for these pollutant removals is $34/lb-eq removed and $38/lb-eq removed, respectively.

- Other modelled estimates of pollutant removals not included in the toxic equivalent analysis are 29 million pounds per year of total suspended solids, 6.9 million pounds per year of oil and grease, and 710,000 pounds per year of ammonia-N.

Multimedia Pollutant Transfers

- Because most process wastewaters from basic steelmaking operations are generated as a result of air emission control and gas cleaning, there are substantial pollutant transfers from the air media to the water and solid waste media.

- The most significant transfer of pollutants from the water to the air media results from quenching of coke with untreated cokemaking and by-product recovery process wastewaters. This quenching practice is not widely used today; however, virtually none of the toxic pollutants found in cokemaking wastewaters are regulated by State Implementation Plans (SIPs) for coke quenching operations.

- Cross-media transfers from leaking coke quench sumps, leaking by-product recovery wastewater sumps, leaking blast furnace slag pits, a limited number of unlined wastewater collection and treatment ponds, and leaking above-ground and below-ground storage tanks for fuel and various chemicals (including chlorinated solvents), have resulted in groundwater contamination at many steel mills.

Opportunities for Pollution Prevention

- The greatest long-term opportunities for pollution prevention will result from new cokemaking methods that result in reduced emissions and discharges, and new iron and steelmaking methods that reduce or eliminate the need for coke. Several research projects are underway; however, the technologies have not been demonstrated to the point where they could serve as the basis for revised BAT or NSPS.

- A nonrecovery cokemaking technology (coke by-products such as coal tar, crude light oil, and ammonia are not recovered) has been fully demonstrated. The process results in virtually no process wastewater discharges and air emissions that can be readily controlled. This technology could serve as the basis for revised NSPS.

- There appear to be many pollution prevention opportunities in the areas of increased process water recycle and reuse, cascade of process wastewaters from one operation to another, residuals management, and nondischarge disposal methods.

Applicability and Subcategorization

- The regulation promulgated in 1982 provided a temporary exclusion (not to exceed one year) for 21 mills or parts of mills with central wastewater treatment facilities (§420.01(b)). The exclusion remains in the regulation and continues to present problems for state and EPA regional NPDES permit writers.

- The 1982 regulation does not specifically address small, stand-alone steel finishing operations. These facilities may not be characteristic of the larger facilities which were used to establish the effluent limitations guidelines and standards. These smaller facilities may be more similar to the type of facilities that will be regulated by the Metal Products and Machinery Category, currently under development.

- It may be appropriate to evaluate regulating continuous strip electroplating operations at steel mills under Part 420, instead of under Part 433 - Metal Finishing. Wastewater discharges from continuous strip electroplating operations and wastewaters from steel finishing operations are almost universally co-treated at steel finishing mills. Also, the database used by EPA to establish the Part 420 effluent limitations and standards included both electroplating and steel finishing wastewaters.

- The current industry subcategorization in Part 420 may need to be reevaluated with regard to regulating continuous strip steel finishing lines constructed during the past several years. These mills are configured with both steel finishing and metal finishing operations and are used to apply coatings of metals and metal combinations that were not commonly used in 1982.

- The current subcategorization does not adequately address nonintegrated steel producers (so-called "mini-mills") that are equipped with electric arc furnaces, continuous casters, and hot forming mills.

- In some instances, Part 420 is obsolete because some segments of the industry no longer exist in the U.S. (e.g., beehive cokemaking, ferromanganese blast furnace (ironmaking), open hearth steelmaking).

1.0 INTRODUCTION

40 CFR Part 420, Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category, was promulgated in May 1982 (47 FR 23258), and last amended in May 1984 (49 FR 21024) in response to challenges from the steel industry and the Natural Resources Defense Council (NRDC).[1,2,3] The regulation was the first promulgated by the U.S. Environmental Protection Agency (EPA) under the 1977 Amendments to the Clean Water Act, and thus was the first to distinguish between conventional, nonconventional, and toxic pollutants in the regulatory scheme established by the 1977 Amendments. The regulation has been implemented through the National Pollutant Discharge Elimination System (NPDES) permit program and through state and local pretreatment programs, and has resulted in effluent reduction and water quality benefits.

1.1 Purpose of This Review

EPA is required by Section 304 of the Clean Water Act to review effluent limitations guidelines and standards periodically to determine whether the current regulation remains appropriate in light of, among other things, changes in the industrial category caused by advances in manufacturing technologies, in-process pollution prevention, and end-of-pipe wastewater treatment. EPA is also required by the terms of a consent decree with the NRDC to initiate preliminary reviews of a number of categorical effluent limitations guidelines and standards on a set schedule.[4] This review is being conducted pursuant to those legislative and judicial requirements.

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This report was commissioned by the Agency to use as one of many sources of information to determine whether revisions to the Iron and Steel Manufacturing Effluent Limitations Guidelines and Standards at 40 CFR Part 420 are warranted. Consequently, recommendations are not made within the body of this report as to whether any specific revisions should be made.

1.2 Structure of the Regulation

40 CFR Part 420 contains the following twelve subparts for twelve distinct manufacturing operations conducted in the manufacture of steel and finished and semi-finished steel products:

A. Cokemaking
B. Sintering
C. Ironmaking
D. Steelmaking
E. Vacuum Degassing
F. Continuous Casting
G. Hot Forming
H. Salt Bath Descaling
I. Acid Pickling
J. Cold Forming
K. Alkaline Cleaning
L. Hot Coating

Electroplating operations conducted at steel mills are not regulated by 40 CFR Part 420, but are regulated by 40 CFR Part 433 - Metal Finishing.

Part 420 contains production-based effluent limitations guidelines and standards. Accordingly, steel mills with higher levels of production will receive higher permit discharge allowances. The regulation was structured in a building-block manner to facilitate co-treatment of compatible wastewaters from different operations as shown by the following groupings:[5]

Cokemaking	Hot Forming
Sintering Ironmaking	Salt Bath Descaling Combination Acid Pickling Cold Rolling
Steelmaking Vacuum Degassing Continuous Casting	Acid Pickling Cold Rolling Alkaline Cleaning Hot Coating

The regulation contains effluent limitations for the same pollutants for each group of manufacturing operations, such that discharge permits can reflect co-treatment of compatible wastewaters from these processes. At the time 40 CFR Part 420 was promulgated, EPA sought to discourage co-treatment of wastewaters across these groups to foster process-specific high-rate recycle of process water where possible, and to minimize less effective treatment of toxic metal and toxic organic pollutants caused by dilution of pollutant levels by waste streams not containing those pollutants.[5]

1.3 Pollutants Limited by 40 CFR Part 420

Conventional Pollutants

Total Suspended Solids
Oil & Grease
pH

Nonconventional Pollutants

Ammonia-N
Phenols (4AAP)

Priority or Toxic Pollutants

Total Cyanide	Total Zinc
Total Chromium	Benzene
Hexavalent Chromium	Benzo(a)pyrene
Total Lead	Naphthalene
Total Nickel	Tetrachloroethylene

2.0 INDUSTRY PROFILE

The American Iron and Steel Institute (AISI) reported the following statistics for the U.S. iron and steel industry for 1992 or 1993:[6]

- Number of steel producing companies in the U.S. in 1992: 84
- Leading steel producing states in 1993: Indiana, Ohio, and Pennsylvania
- 1993 Estimated direct employment: 127,000
- 1992 Average hourly employee cost: $29.57
- 1993 U.S. raw steel capacity: 109.9 million net tons
- 1993 U.S. raw steel production: 97.9 million net tons
- 1993 U.S. capacity utilization: 89.1 percent
- 1992 world steel production: 787.6 million net tons
- 1992 Steel productivity (man hours/ton):
  - -- United States 5.3
  - -- Germany 5.6
  - -- Japan 5.4
- 1993 Steel production methods: 61% basic oxygen furnaces
  39% electric arc furnaces
  0% open hearth furnaces
- 1993 Continuous casting: 86% of raw steel produced
- 1993 U.S. steel shipments of semi-finished and finished products (domestic and export): 89.0 million net tons
- 1993 U.S. steel imports: 19.5 million net tons
- 1993 U.S. steel exports: 4.0 million net tons

- 1993 U.S. domestic demand: 104.5 million net tons

- Environmental control investment: >$7 billion (1951-1992)

- Environmental control costs in 1992: $10 to $20 per ton of steel (typical costs to manufacture steel are in the range of $400 to $700 per ton)

- 1993 Selected product applications/markets (millions of net tons):

--	Service centers	23.7
--	Construction and contractors	13.4
--	Automotive industry	12.7
--	Container industry	4.3
--	Appliance industry	1.6

Detailed information about manufacturing processes and wastewater treatment; production trends and capacity utilization; imports, exports and financial performance; and capital spending and pollution control investments are presented in this section.

2.1 Manufacturing Processes and Wastewater Treatment

40 CFR Part 420 includes twelve subparts for regulating steel manufacturing and steel finishing operations that generate and discharge process wastewaters and wastewater pollutants; however, electroplating operations performed at steel mills are regulated by 40 CFR Part 433 - Metal Finishing. The major processes regulated by 40 CFR Part 420 and electroplating operations conducted at steel mill sites are described briefly below in terms of principal products and by-products, process water usage, wastewater pollutants, and typical treatment systems. More complete descriptions of these processes are found in ***The Making, Shaping and Treating of Steel, 10th Edition***.[7] Figure 2-1 is a simplified schematic diagram of the major ironmaking, steelmaking, and steel finishing processes. Table 2-1 presents a summary of the wastewater pollutants associated with each process.[8] Note that tables and figures are located at the end of each section of this report.

2.1.1 Cokemaking

Carbon in the form of metallurgical coke is used to reduce iron oxides to metallic iron in blast furnaces. Virtually all coke in the U.S. is produced in by-product coke plants. The coke is produced on a batch basis by distilling metallurgical coals (blends of high, medium, and low volatile coals designed to produce coke of sufficient strength for use in ironmaking blast furnaces) in slot type ovens at temperatures of 1,650 to 2,000°F in the absence of air. Coke batteries comprise numerous ovens constructed side-by-side equipped with ancillary coal charging, gas collecting mains, and coke pushing and coke quenching facilities. The coking process typically lasts 16 hours. Coal is charged into the tops of the ovens with larry cars or by pipeline. After the coking process is complete, the incandescent coke is pushed into a flat bed rail car and transported to a coke quench station where the coke is quenched with water to near ambient temperature.

The moisture and volatile components of the coal, typically 20 to 35% by weight, are collected and processed to recover by-products, including crude coal tars, crude light oil (aromatics, paraffins, cycloparaffins and naphthenes, sulfur compounds, nitrogen and oxygen compounds), anhydrous ammonia or ammonium sulfate, naphthalene, and sodium phenolate.

The typical volume of process wastewaters generated at a well-controlled by-product coke plant is approximately 100 gallons per ton (gpt) of coke produced.[9] About 25 to 35 gpt is generated from water contained in the coal charge in the form of waste ammonia liquor. The balance results from steam addition for distilling ammonia from the waste ammonia liquor, crude light oil recovery, and miscellaneous sources. Cokemaking wastewaters contain high levels of oil & grease (O&G), ammonia-N, cyanides, thiocyanates, phenolics, benzenes, toluene, xylene, other aromatic volatile components, and polynuclear aromatic compounds (see Table 2-1).[9]

The conventional wastewater treatment approach consists of physical/chemical treatments, including oil separation, dissolved gas flotation, and ammonia distillation followed by biological treatment with nitrification. An innovative biological treatment approach without ammonia distillation pretreatment has been installed at one plant.[10]

During the past ten years, the number of active coke plants in the United States has declined as a result of the consolidation of the industry, more stringent air pollution control regulations, and because coke requirements for blast furnace operations has decreased with the trend toward alternate carbon sources (e.g., direct injection of oil and pulverized coal).[11] Many blast furnace operators are using these techniques.

2.1.2 Sintering

Sinter plants are used to beneficiate (upgrade the iron content) iron ores and to recover iron values from wastewater treatment sludges and mill scale generated at integrated steel mills (see Section 2.3.2 for definition of "integrated"). Sinter plants consist of numerous raw material storage bins; a mixing drum for each sinter strand; sinter strands (travelling grate combustion devices); a windbox (device for drawing air through the travelling gate); a discharge end; a cooling bed for sintered product; and wet or dry air pollution control devices. Coke breeze (fine coke particles), iron ores, sludges, mill scales, and limestone are mixed in sinter machines and charged to a travelling grate at a depth of approximately one foot. The mixture is ignited and air is drawn through the bed as it travels toward the exit end. Clinkers (i.e., sinter of suitable size and weight) are formed for charging to the blast furnace.

Wastewaters are generated from wet air pollution control devices on the wind box and discharge ends of the sinter machines. Applied flows for wet air pollution control devices are typically 1,500 gpt of sinter, with discharge rates of 120 gpt for the better controlled plants.[12] Wastewater treatment comprises sedimentation for removal of heavy solids, recycle of clarifier or thickener overflows, and metals precipitation treatment for blowdowns. Some sinter plants are operated with once-through treatment. The principal pollutants include total suspended solids (TSS), O&G, ammonia-N, cyanide, phenolic compounds, and metals (principally lead and zinc).[12]

2.1.3 Ironmaking

Blast furnaces are used to produce molten iron which makes up about two-thirds of the charge to basic oxygen steelmaking furnaces, the balance being cold steel scrap. The raw materials charged to the top of the blast furnace include coke, limestone, beneficiated iron ores, and sinter. Hot blast (preheated air) is blown into the bottom of the furnace through a bustle pipe and tuyeres (orifices) located around the circumference of the furnace. The iron-bearing furnace burden (material charged to the furnace) is supported by coke and is reduced to molten iron and slag as it descends through the furnace. The molten iron, at approximately 2,800 to 3,000°F, is tapped at regular intervals into refractory-lined cars for transport to the steelmaking furnaces. Molten slag, which floats on top of the molten iron, is also tapped and processed for sale as a by-product. Blast furnace slag may be used as railroad ballast, as an aggregate in cement manufacturing, and for other construction uses.

A simplified summary of the chemical reactions that occur in the blast furnace is presented below:

$3Fe_2O_3 + H_2 \dashrightarrow 2Fe_3O_4 + H_2O$
$3Fe_2O_3 + CO \dashrightarrow 2Fe_3O_4 + CO_2$

$Fe_3O_4 + H_2 \dashrightarrow 3FeO + H_2O$
$Fe_3O_4 + CO \dashrightarrow 3FeO + CO_2$

$FeO + H_2 \dashrightarrow Fe + H_2O$
$FeO + CO \dashrightarrow Fe + CO_2$

$3Fe + CO + H_2 \dashrightarrow Fe_3C + H_2O$
$3Fe + 2CO \dashrightarrow Fe_3C + CO_2$

$CO_2 + C \dashrightarrow 2CO$
$H_2O + C \dashrightarrow CO + H_2$

$FeO + C \rightarrow Fe + CO$

$3Fe + C \rightarrow Fe_3C$

The hot blast exits the furnace top as blast furnace gas in enclosed piping and is cleaned and cooled in a combination of dry dust catchers and high-energy venturi scrubbers. The cleaned gas is combusted in stoves to preheat the incoming air and used as fuel elsewhere in integrated mills. Direct contact water used in the gas coolers and high-energy scrubbers comprises nearly all of the wastewater from blast furnace operations. About 6,000 gpt of iron is applied at the furnace.[13] The principal pollutants include TSS, ammonia-N, cyanides, phenolic compounds, and metals (copper, lead, and zinc). Standard treatment in the industry includes sedimentation in thickeners or clarifiers, cooling with mechanical draft cooling towers, and high-rate recycle. Low-volume blowdowns (<70 gpt of iron) are either consumed in slag cooling at furnaces with adjacent slag pits, or treated in conventional metals precipitation systems. A few mills practice alkaline chlorination to treat ammonia-N, cyanides, and phenolic compounds.

2.1.4 Steelmaking

All steelmaking in the U.S. is conducted in basic oxygen furnaces or electric arc furnaces; open hearth furnaces are no longer operated. Basic oxygen furnace (BOF) and electric arc furnace (EAF) processes are batch processes with tap-to-tap (batch cycle) times of about 45 minutes and two to three hours, respectively. Up to 360 tons per heat may be produced in a BOF, while capacities in EAFs range from less than 10 tons to more than 300 tons per heat.[14] BOFs are typically used for high tonnage production of carbon steels, while EAFs are used to produce carbon steels and low tonnage alloy and specialty steels.

The principal purpose of BOF steelmaking is to refine a metallic charge consisting of approximately two-thirds molten iron and one-third steel scrap by oxidizing silicon, carbon, manganese, phosphorus and a portion of the iron. Oxygen is injected into the molten bath either through the top of the furnace (top blown), bottom of the furnace (bottom blown), or both (combination blown). Residual sulfur is controlled by managing furnace slag processes. Off-gases from furnaces in the U.S. are controlled by one of three methods:

- **Semi-Wet**. Furnace off-gases are conditioned with moisture prior to processing in electrostatic precipitators or bag houses;
- **Wet - Open Combustion**. Excess air is admitted to the off-gas collection system allowing carbon monoxide to combust prior to high-energy wet scrubbing for air pollution control; and
- **Wet - Suppressed Combustion**. Excess air is not admitted to the off-gas collection system prior to high-energy wet scrubbing for air pollution control.

About 1,100 gpt and 1,000 gpt of steel are applied in the open combustion and suppressed combustion systems, respectively.[15] The principal pollutants are TSS and metals (lead, zinc). Standard treatment consists of sedimentation in clarifiers or thickeners and recycle of 90% or more of the applied water. Blowdown treatment consists of metals precipitation. It may be possible to operate semi-wet off-gas systems at zero discharge by balancing the applied water with evaporative losses, but none are operated in this fashion. One suppressed combustion BOF installation located in Germany has been operated with dry emission controls.

Most EAFs are operated with dry air cleaning systems with no process wastewater discharges. A small number of wet and semi-wet systems also exist. The water flows and pollutants of concern for those systems with wet and semi-wet air cleaning systems are similar to those for the wet basic oxygen furnaces, but the levels of metals are higher because of the 100% scrap charge. Wastewater treatment operations are similar to those for the wet basic oxygen furnaces.

2.1.5 Vacuum Degassing

In this batch process, molten steel is subjected to a vacuum for composition control, temperature control, deoxidation (O_2 removal), degassing (H_2 removal), decarburization, and to otherwise remove impurities from the steel. Oxygen and hydrogen are the principal gases removed from the steel. In most degassing systems, vacuum is provided by barometric condensers; thus, direct contact between the gasses and the barometric water occurs. The principal pollutants are low levels of TSS and metals (lead and zinc), which volatilize from the steel. Applied water rates are typically around 1,250 gpt of steel.[16] Discharge rates of 25 gpt are achieved through high-rate recycle. Standard treatment includes processing the total recirculating flow or a portion of the flow in clarifiers for TSS removal, cooling with mechanical draft cooling towers, and high-rate recycle. Blowdowns are usually co-treated with steelmaking and/or continuous casting wastewaters for metals removal. Vacuum degassing plants are often operated as part of ladle metallurgy stations where additional steel refining is conducted. These additional refining operations do not use process water.

2.1.6 Continuous Casting

Molten steel is tapped from the BOF or EAF into ladles of sufficient capacity to hold an entire heat. The ladles are then processed in ladle metallurgy stations and/or vacuum degassers prior to teeming (pouring) into ingot molds or direct casting into semi-finished shapes using continuous casters. Steel cast into ingot molds must undergo cooling, mold stripping, reheating, and hot rolling to produce the same semi-finished shape that can be produced with continuous casting. The casting machine includes a tundish (receiving vessel for molten steel), a water-cooled mold (or molds on multi-strand machines), secondary cooling water sprays, containment rolls, oxygen-acetylene torches for cutoff, and a runout table. Molten steel is transferred from the ladle to the tundish and then to the water-cooled mold at controlled rates. The steel solidifies as it passes through the mold and is cut to length on the runout table.

The four main types of continuous casters are billet, bloom, round, and slab. The names derive from the shape of the cast product. Casting machines are either single-strand or multi-strand. Modern slab casters used to manufacture flat-rolled products are universally of a curved-mold design, while those used to produce bar products may be of a straight vertical mold design with vertical cutoff or bending with horizontal cutoff.

Continuous casters usually include two separate closed-loop cooling water systems: one for the copper mold (mold cooling water system), and one for all other mechanical equipment (machine cooling water system). Direct contact water systems are used for spray cooling and for flume flushing to transport scale from the caster runout table. Applied water rates for the contact systems are typically about 3,600 gpt of cast product.[17] Discharge rates for the better controlled casters are less than 25 gpt. The principal pollutants are TSS, O&G, and low levels of particulate metals. Wastewater treatment includes scale pits for mill scale recovery and oil removal, mixed- or single-media filtration, and high-rate recycle.

2.1.7 Hot Forming

In hot forming operations, ingots, blooms, billets, slabs, or rounds are heated to rolling temperatures (about 1,800°F) in gas-fired or oil-fired reheat furnaces, and formed under mechanical pressure with work rolls to produce semi-finished shapes for further hot or cold rolling, or finished shapes for shipment. Water use and discharge rates from hot forming operations vary greatly depending upon the type of hot forming mill and the shapes produced.[18] Applied process water rates typically range from 1,500 gpt for specialty plate mills to more than 6,000 gpt for hot strip mills. Discharge rates range from the applied water rates for hot forming mills operated with once-through process water systems to near zero discharge for mills equipped with high-rate recycle systems. The principal pollutants are TSS and O&G. Low levels of metals are found in particulate form.

Process water is used for scale braking, flume flushing, and direct contact cooling. Wastewater treatment includes: processing in scale pits located adjacent to the hot forming mill to recover mill scale and remove gross amounts of tramp oils; recycle of a large portion of the scale pit effluent for flume flushing; sedimentation in clarifiers for TSS and O&G removal; filtration in mixed- or single-media filters; and discharge or recycle. High-rate recycle systems (e.g., >95%) have been installed at many hot forming mills.

2.1.8 Salt Bath Descaling

Salt bath descaling uses the aggressive physical and chemical properties of molten salt baths to remove heavy scale from selected specialty and high-alloy steels. Two processes, oxidizing and reducing, are commonly referred to by the names of the proprietary molten salt descaling baths, Kolene® and Hydride®, respectively. These processes may be batch or continuous and are conducted prior to combination acid pickling (hydrofluoric and nitric acids). Wastewaters originate from quenching and rinsing operations conducted after processing in the molten salt baths. Principal pollutants are TSS, cyanides, dissolved iron, hexavalent and trivalent chromium, and nickel. Wastewater flows normally range from 300 to 1,800 gpt, depending upon the product and process.[19] Descaling wastewaters are usually co-treated with wastewaters from other finishing operations (e.g., combination acid pickling, cold rolling).

2.1.9 Acid Pickling

The most common acid pickling processes are sulfuric, hydrochloric, and combination acid pickling operations used to remove oxide scale from the surfaces of semi-finished products prior to further processing by cold rolling, cold drawing, and subsequent cleaning and coating operations. Acid pickling operations may be either batch or continuous. For continuous pickling processes, flat rolled coils are welded end-to-end at the start of the line, and are cut by torch at the end of the line. Nearly all pickling operations in the steel industry involve immersion of the steel in acid and rinse tanks. Process wastewaters include spent pickling acids, rinse waters, and pickling line fume scrubbers. Process water and wastewater flows vary greatly depending upon product and process.[20] Waste pickle liquor flows typically range between 10 and 20 gpt of pickled product. Rinse water flows may range from less than 70 gpt for bar products to more than 1,000 gpt for certain flat-rolled products. The principal pollutants include TSS, dissolved iron, and metals. For carbon steel operations, the principal metals are lead and zinc, and for specialty and stainless steel, chromium and nickel.

In-process controls include: countercurrent rinsing; use of indirect heating versus direct steam sparging for acid solutions; and recycle and reuse of fume scrubber blowdowns. Spent acid solutions are rarely treated in conventional treatment systems on site; instead, they are generally sold as treatment aids for municipal and centralized wastewater treatment systems; injected into deep wells; or neutralized off site. Some steel mills are equipped with acid recovery or regeneration systems for spent sulfuric and hydrochloric acids, respectively. Rinse waters are usually co-treated with wastewaters from cold rolling, alkaline cleaning, hot coating, and electroplating operations.

2.1.10 Cold Forming

Cold forming involves cold rolling of hot rolled and pickled steels at ambient temperatures to impart desired mechanical and surface properties in the steel, and cold working of pipe and tube. In most cold rolling operations, the reduction in thickness is small compared to that resulting from hot forming. Cold rolling imparts hardness to the steel. Annealing (heat treating) and temper rolling are usually performed after the initial cold rolling to obtain desired mechanical properties.

Process wastewater results from using synthetic or animal-fat based rolling solutions, many of which are proprietary. The solutions may be treated and recycled at the mill, used on a once-through basis, or a combination of the two.[21] The principal pollutants are TSS, O&G (emulsified), and metals (lead and zinc for carbon steels and chromium and nickel for specialty and stainless steels;

chromium may also be a contaminant from cold rolling of carbon steels resulting from wear on chromium-plated work rolls). Toxic organic pollutants including naphthalene, other polynuclear aromatic compounds, and chlorinated solvents have been found in cold rolling wastewaters. Process wastewater discharge rates may range from less than 10 gpt for mills with recirculated rolling solutions to more than 400 gpt for mills with direct application of rolling solutions.

Conventional treatment of cold rolling wastewaters includes chemical emulsion breaking, dissolved gas flotation for gross oil removal, and co-treatment with other finishing wastewaters for removal of toxic metals.

2.1.11 Alkaline Cleaning

Batch or continuous alkaline cleaning occurs after cold forming and prior to hot coating or electroplating to provide a surface suitable to accept the coating. These finishing operations may be conducted in separate cleaning lines or as integral parts of coating or electroplating operations. The cleaning baths are solutions of carbonates, alkaline silicates, and phosphates in water. Electrolytic cleaning may be used for high-production operations. Because the baths are not aggressive chemical solutions, the principal pollutants generated are oils and greases removed from the steel, and low levels of toxic organic pollutants found in cold rolling solutions. Nearly all alkaline cleaning rinse operations in the steel industry involve immersion in rinse tanks. Alkaline cleaning wastewaters are usually co-treated with wastewaters from other steel finishing operations. Applied process water flow rates may range from 250 gpt to 350 gpt.

2.1.12 Hot Coating

Hot coating operations comprise immersing precleaned steel into molten baths of tin, zinc (hot dip galvanizing), combinations of lead and tin (terne coating), or combinations of aluminum and zinc (galvalume coating); any associated cleaning or fluxing steps prior to immersion; and any post-immersion steps (e.g., chromium passivation). Cadmium hot coating operations in the U.S. steel industry are limited to certain wire coating operations. The principal purposes of hot coating are to improve resistance to corrosion, and for some products, improve appearance.

Wastewaters result principally from product rinses and fume scrubbers. In-process controls include countercurrent rinses for lines with multiple rinses and recycle of fume scrubber water. The principal pollutants are usually those associated with the coating metal or metal combinations and hexavalent chromium for lines with chromium brightening or passivation operations. Wastewaters from hot coating lines located at integrated steel mills or at stand-alone steel finishing plants are almost universally co-treated with wastewaters from other steel finishing operations in metals precipitation systems. Applied process water rates may range from 600 gpt for flat rolled products to 2,400 gpt for wire products.

2.1.13 Electroplating

Electroplating operations conducted at steel mills are currently regulated by 40 CFR Part 433 - Metal Finishing, and not by 40 CFR Part 420. Historically, electroplating at steel mills was limited to tin and chromium electroplating for the food and beverage markets and relatively low tonnage production of zinc-electroplated (electro-galvanized) steel for the automotive markets. In recent years, electro-galvanized steel production has increased substantially in response to automobile manufacturers demand. New coatings consisting of combinations of iron, nickel, and other metals have been developed.

Wastewater flows at large continuous strip electroplating lines are typically about 500 gpt. The principal pollutants are TSS and O&G generated from the precleaning operations and the plated metals from electroplating, rinsing, and fume scrubbers. Conventional wastewater treatment includes metals precipitation. At some finishing mills, wastewaters from electroplating lines are pretreated or treated separately to minimize the volume of listed hazardous waste sludge generated due to heavy metal concentrations.

2.2 Industry Segments

The three principal types of steels produced in the United States are plain carbon steels, alloy steels, and stainless steels. These are defined as follows:[7]

> **Plain Carbon Steels**. Steels containing up to 1.65% manganese, 0.60% silicon, 0.60% copper, and smaller quantities of other alloying elements.
>
> **Alloy Steels**. Steels containing greater quantities of manganese, silicon, or copper than plain carbon steels, and/or steels containing specified minimum quantities of other alloying elements such as aluminum, chromium (less than 4%), cobalt, niobium (columbium), molybdenum, nickel, titanium, tungsten, vanadium, zirconium, or any other alloying element added to obtain a desired alloying effect.
>
> **Stainless Steels**. Steels containing at least 10% chromium in combination with other alloying elements.

Carbon steels represent the most important group of engineered materials. They are produced in much greater quantities than alloy and stainless steels (see Section 2.4) and have the most diverse applications of any engineered material.[7] Common uses include castings, forgings, tubular products, plates, sheet and strip, wire and wire products, structural shapes, bars, and railway items (rails, wheels and axles).

Alloy steels have enhanced properties due to the presence of the various elements listed above. They include construction alloy steels, high-strength low-alloy steels, alloy tool steels, heat-resistant steels, and electrical steels (high-silicon steels). Alloy steels are used where enhanced properties of strength, formability, hardness, weldability, corrosion resistance, or notch toughness are desired for specific applications.

Most stainless steels are produced as plates, sheets, strips, bars, tubes, and wires. These steels are specifically designed for corrosion-resistant applications or where surface staining is not desired.

Each type of steel may be produced in BOFs or EAFs; however, many alloy and stainless steels are produced in smaller EAFs to facilitate sequential production of low-tonnage steels with varying composition.

The three major segments of the U.S. iron and steel industry are: integrated producers that operate coke plants, blast furnaces, and BOFs for high-tonnage production of nearly all grades of carbon steels; nonintegrated producers that use EAF furnaces to produce carbon steel bar products and lower grades of flat rolled products (i.e., the "mini-mills"); and specialty steel producers that produce alloy and stainless steels, principally with EAFs. Manufacturing facilities within the U.S. industry vary in terms of operations performed, but can be classified into the five major groups described below.

2.3 Classification of Manufacturing Plants in the U.S. Iron and Steel Industry

For purpose of this review, manufacturing sites of the U.S. iron and steel industry currently regulated by 40 CFR Part 420 are classified as follows.

2.3.1 Stand-Alone By-Product Coke Plants

Stand-alone by-product coke plants are facilities that produce metallurgical coke and are not located at integrated steel mills. Typically, the coke produced is sold under long-term contracts to steel makers and on the spot market. These facilities may be owned by major steel producers (e.g., U.S. Steel - Clairton Works; LTV Steel - Aliquippa, Chicago, and Warren Plants), or may be smaller, independently owned and operated facilities (e.g., New Boston Coke, Tonawanda Coke). This group of facilities includes the largest U.S. coke plant (U.S. Steel - Clairton, 13,000 tons/day) and smaller facilities with typical production rates of 1,000 tons per day.

2.3.2 Integrated Steel Mills

Traditionally, integrated steel mills conducted all basic steelmaking operations (i.e., cokemaking, sintering, ironmaking, open hearth and/or BOF steelmaking, continuous casting); hot forming; and steel finishing operations (e.g., acid pickling, cold rolling, alkaline cleaning, hot coating, and electroplating) to produce finished steel products. Today, however, the term "integrated mill" generally refers to facilities where steel is manufactured in BOFs from molten iron produced in blast furnaces and scrap, as opposed to nonintegrated mills where steel is manufactured in EAFs by melting various grades of steel scrap. Due to consolidation of the industry, cokemaking and sintering operations have been permanently shut down at many integrated mills. For the most part, flat-rolled carbon steel products for the automotive, appliance, construction, and food and beverage markets are produced at integrated mills. Integrated mills may also have EAFs for producing steel from scrap steel.

2.3.3 Nonintegrated Steel Mills

As noted above, nonintegrated mills (also known as "mini-mills") are those where steel is manufactured from melting steel scrap in EAFs. Nonintegrated mills generally produce carbon, specialty, stainless, and high-alloy steels. These mills typically include a two- or three-furnace EAF shop, a continuous caster, and hot rolling mills. Specialty, stainless, and high-alloy steel mills include ladle metallurgy and vacuum degassing operations. Although nonintegrated steel producers are making inroads into carbon steel flat-rolled markets, most carbon steel produced at nonintegrated mills is currently in the form of bar, rod, or wire. Both flat-rolled and bar products are produced at specialty and high-alloy nonintegrated mills.

2.3.4 Stand-Alone Finishing Mills

Stand-alone finishing mills process semi-finished steel into finished steel products. Molten steel is not manufactured or processed at these sites. At most stand-alone finishing mills, hot rolled steel is processed by a combination of acid pickling, cold rolling, alkaline cleaning, hot coating, and electroplating operations.

2.3.5 Other Stand-Alone Operations

In addition to stand-alone coke plants and finishing mills, a limited number of other stand-alone operations in the U.S. industry also exist. These include a coke plant-sinter plant-blast furnace combination; stand-alone blast furnaces; stand-alone hot forming mills; and stand-alone cold forming and wire mills. Many of these facilities are located near integrated steel mills and finishing mills to allow for relatively inexpensive transportation of intermediate products, but typically have separate water and wastewater treatment systems and separate discharge permits.

2.4 Changes in the U.S. Steel Industry - 1982 through 1993

Table 2-2 presents a preliminary comparison of the number of facilities engaged in basic steelmaking operations in 1982 when the regulation was promulgated, and in 1993.[8,14,22,23] The estimates presented in Table 2-2 are preliminary because they were not derived from a comprehensive census of the industry. These results show the dramatic decrease in cokemaking, sintering, ironmaking, and steelmaking facilities at integrated mills, and increases in continuous casting.

2.5 Production Trends and Capacity Utilization

Figures 2-2 through 2-9 present data regarding production trends and capacity utilization for the U.S. iron and steel industry. These data were reported by AISI for the period 1973 through 1993.[24-29] AISI defines raw steel as steel in the first solid state after melting suitable for further processing or sale, including ingots, steel for foundry castings and strand or pressure cast blooms, billets, slabs or other product forms. Raw steel production capacity is defined as the tonnage capability to produce raw steel for a sustained back-log of steel orders. Steel production and steel shipments data reported by AISI are based upon reports by AISI member and non-member companies. Financial data do not represent data for all steel producing companies. Financial data for 1992 and 1993 represent data for companies producing about 66% of total raw steel produced.

The U.S. iron and steel industry has undergone the following major consolidation and changes during the period 1973 through 1993: mergers and bankruptcies among the major integrated steel producing companies; shutdown of smaller integrated companies and shutdown of all or parts of several integrated mills; modernization of basic steelmaking operations; and continued expansion of the nonintegrated segment of the industry. Figure 2-2 illustrates the results of some of these changes. Raw steelmaking capacity declined from a range of 150 to 160 million tons/year from 1973 to 1983, to a range of 110 to 117 million tons/year during the early 1990s. Actual production peaked at approximately 150 million tons during 1973, reached a low of approximately 75 million tons during the 1982 recession, and recovered to about 98 million tons during 1993.

The industry is highly capital-intensive, is cyclical with major economic trends, and historically has required high-capacity utilization to generate operating profits. Figure 2-3 shows that capacity utilization during the period 1975 through 1993 was highly variable, reaching the range of 85 to 88% during the 1977-1978 expansion, falling to less than 50% during 1982, recovering to nearly 90% during 1988, falling to approximately 75% during the 1990-1991 recession, and recovering to 89% during 1993. Because of relatively strong automotive, farm equipment, appliance, and construction industries, capacity utilization exceeded 91% for the first quarter of 1994.[30]

During the period 1973 through 1993, estimated world steel production fell to approximately 710 million tons in 1982 and rose to 865 million tons in 1989. Figure 2-4 shows that U.S. raw steel production declined from nearly 20% of world supply in 1973 to a relatively constant range of 10 to 12% during the late 1980s and early 1990s. There currently is overcapacity in world steel markets for many semi-finished and finished steel products.

Figures 2-5 through 2-9 illustrate important trends and changes in steel manufacturing methods and modernization of the industry. Prior to the advent of EAF steelmaking during the late 1930s, virtually all steel produced in the United States was manufactured from molten iron (hot metal) produced in blast furnaces. Open hearth furnaces were the principal steelmaking furnaces at integrated mills prior to the 1960s when BOF steelmaking became widespread commercially. Figure 2-5 illustrates the decline in blast furnace iron production from approximately 100 million tons/year in 1973 to a range of 48 to 56 million tons/year from 1987 through 1992, and about 40% in 1993. This dramatic decline is also reflected in Figure 2-6, in the ratio of pig iron produced to raw steel manufactured. These data highlight the increasing trend of EAF steel production shown in Figure 2-7. Raw steel produced in EAFs increased from approximately 10% in 1965 to a range of 35 to 38% during the period 1985 through 1992. Most of the new EAF capacity was installed at nonintegrated mills ("mini-mills") located to serve regional areas principally in the bar, rod, wire, and structural markets. More recently, nonintegrated mills have been constructed to produce flat-rolled steel products.

Figure 2-8 shows U.S. raw steel production by type of steelmaking furnace for the period 1973 through 1993. Open hearth furnace steelmaking declined from nearly 40 million tons in 1973 to zero in 1992, while EAF production increased from approximately 28 million tons to a maximum of 38 million tons in 1993. BOF steelmaking declined from approximately 83 million tons in 1973 to a range of 53 to 59 million tons/year during the 1988-1993 period. While the industry has been consolidating and shifting toward a higher proportion of raw steel produced at nonintegrated mills, most mills have been modernized extensively to produce higher quality products and to compete with imports to the U.S. market. This trend is illustrated in Figure 2-9 by the significant increase in the percentage of raw steel continuously cast as opposed to traditional ingot casting. These data show the percentage of steel continuously cast increased from approximately 15% in 1978 to nearly 86% in 1993. Installation of continuous casters accounted for a large portion of the industry's investment in new plant and equipment during this period.

2.6 Product Mix

Figure 2-10 presents steel shipments by type of steel (carbon, alloy, and stainless) for the period 1973 through 1993. Carbon steels currently account for more than 90% of steel mill shipments, alloy steels for less than 10%, and stainless steels for less than two percent. During the past six years, there has been a trend of decreasing alloy steel shipments with a corresponding increase in carbon steel shipments. Stainless steel shipments have remained fairly constant as a percentage of total steel shipments.

Historical steel shipments for the period 1973 through 1993 by major grades and markets are presented in Figures 2-11 and 2-12, respectively. The product data in Figure 2-11 show steady, slow declines in shipments of tin mill and wire and wire products, a significant decline in pipe and tubing shipments in the early 1980s that has not since recovered, and variable shipments of other products. Total shipments of all products were lower in the early 1990s than during the early 1970s. The results presented in Figure 2-11 are reflected in the data presented in Figure 2-12. A general trend of increasing shipments to steel service centers (processing plants that perform various sizing and shaping operations on steel prior to resale) has occurred in recent years, as end users have required more customized processing that can more economically be provided at service centers than at producing mills.

2.7 Imports and Exports, Employment, and Financial Performance

Figure 2-13 shows the import penetration to the U.S. steel markets of semi-finished and finished steel products for the period 1973 through 1993 in millions of tons/year and as a percentage of the apparent U.S. steel supply. These data do not include steel imported as manufactured goods (e.g., foreign-made automobiles). From the late 1970s through the late 1980s, import penetration to the U.S. market has been a major factor limiting the ability of U.S. manufacturers to raise prices and operate profitably. Import penetration peaked at approximately 26% of the U.S. supply during 1984 and declined to a range of 16 to 19% in recent years because of a combination of voluntary import agreements with major importing countries, anti-dumping actions against foreign countries and foreign steel-producing companies by U.S. manufacturers, and the consolidation and modernization of much of the U.S. industry.

Figure 2-14 presents plots of the value of steel imports and exports for the period 1973 through 1993. The difference represents the net balance of trade deficit in steel markets. The deficit was approximately $2 billion in 1973, peaked at approximately $9 billion in 1984, and fell to less than $6 billion in recent years. Factors contributing to the improvement in the balance of trade include improved productivity by U.S. steel producers, the value of the U.S. dollar compared to foreign currencies, and economic performance of selected foreign economies.

The consolidation and modernization of the U.S. steel industry has resulted in a major reduction in direct employment by U.S. producers from over 500,000 people in 1973 to approximately 127,000 in 1993, as shown annually in Figure 2-15. Part of the decline resulted from direct jobs that were lost because many companies now contract for services provided formerly by direct employees.

Figure 2-16 shows the financial performance of companies reporting financial results to AISI for the period 1973 through 1993. These results generally reflect the large integrated producers and do not represent performance across the entire industry. Collectively, the reporting companies showed operating profits during the period 1973 through 1981, and substantial operating losses for many of the subsequent years. Financial performance has improved considerably during 1993 and 1994 as a result of the economic recovery in this country, the weakness of the dollar compared to selected foreign currencies, and the improved position of the U.S. industry in terms of overall productivity and the trend toward production of higher grade products.

2.8 Capital Spending and Pollution Control Investments

Figure 2-17 shows capital investment for new plants and equipment for the period 1973 through 1993 and for environmental controls by reporting companies for the period 1973 through 1992 (the 1993 environmental control expenditures were not available at this writing). Also shown for each year is the percentage of the total capital invested for environmental controls. During this period, capital spending by reporting companies ranged from more than 3 billion dollars in 1976 to slightly more than one billion dollars in 1986. Environmental expenditures ranged from 15 to more than 20% of total-capital investments during the period 1976 through 1981 when compliance programs associated with the amendments to the Clean Air Act and Clean Water Act passed during the early and mid-1970s were implemented. The peak was in 1979 at 20.9 percent. From 1982 to 1992, environmental expenditures ranged from 4.4 to 12.9% of total capital investment.

Figure 2-18 presents capital investment for environmental controls by reporting companies for the period 1951 through 1992, broken out by investments in air and water pollution control facilities and solid waste disposal facilities. AISI reports that, through 1992, total capital investments for environmental controls exceeded $7.2 billion. Approximately $2.6 billion was invested in water pollution control facilities, $4.5 billion in air pollution control facilities, and about $100 million in solid waste disposal facilities.

Table 2-1

Iron and Steel Manufacturing Processes Identified Pollutants of Concern

Pollutants	Cokemaking	Sintering	Ironmaking	Steelmaking	Vacuum Degassing	Continuous	Hot Forming	Salt Bath Descaling	Acid Pickling	Cold Forming	Alkaline Cleaning	Hot Coating	Electroplating
Total Suspended Solids	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Oil & Grease	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ammonia-N	✓	✓	✓									✓	
Total Cyanide	✓	✓	✓					✓					
Thiocyanate	✓												
Phenols (4AAP)	✓	✓	✓										✓
Fluoride		✓	✓	✓					✓				
Sulfide	✓	✓	✓										
Metals:													
T. Antimony	✓			✓				✓	✓	✓	✓		
T. Arsenic	✓		✓	✓				✓	✓	✓		✓	
T. Cadmium		✓	✓	✓					✓	✓	✓	✓	✓
T. Chromium		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Chromium +6								✓				✓	✓
T. Copper		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Dissolved Iron								✓	✓			✓	✓
T. Lead		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
T. Nickel		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
T. Selenium	✓		✓	✓		✓		✓			✓		
T. Zinc	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Toxic Organics (partial list)													
BTX	✓												
PAHs	✓		✓										
Phenols	✓	✓	✓							✓	✓		✓

T = total
BTX = benzene, toluene, xylene
PAHs = polynuclear aromatic hydrocarbons

Table 2-2

Facilities Engaged in Basic Steelmaking Operations 1982 and 1993

Basic Steelmaking Operation	1982	1993
Cokemaking	67	27
Sintering	33	10
Ironmaking		
Number of Plants	54	22
Number of Blast Furnaces	127	45
Steelmaking		
Open Hearth	5	0
BOF	30	22
EAF	>110	100
Continuous Casting	54	>100

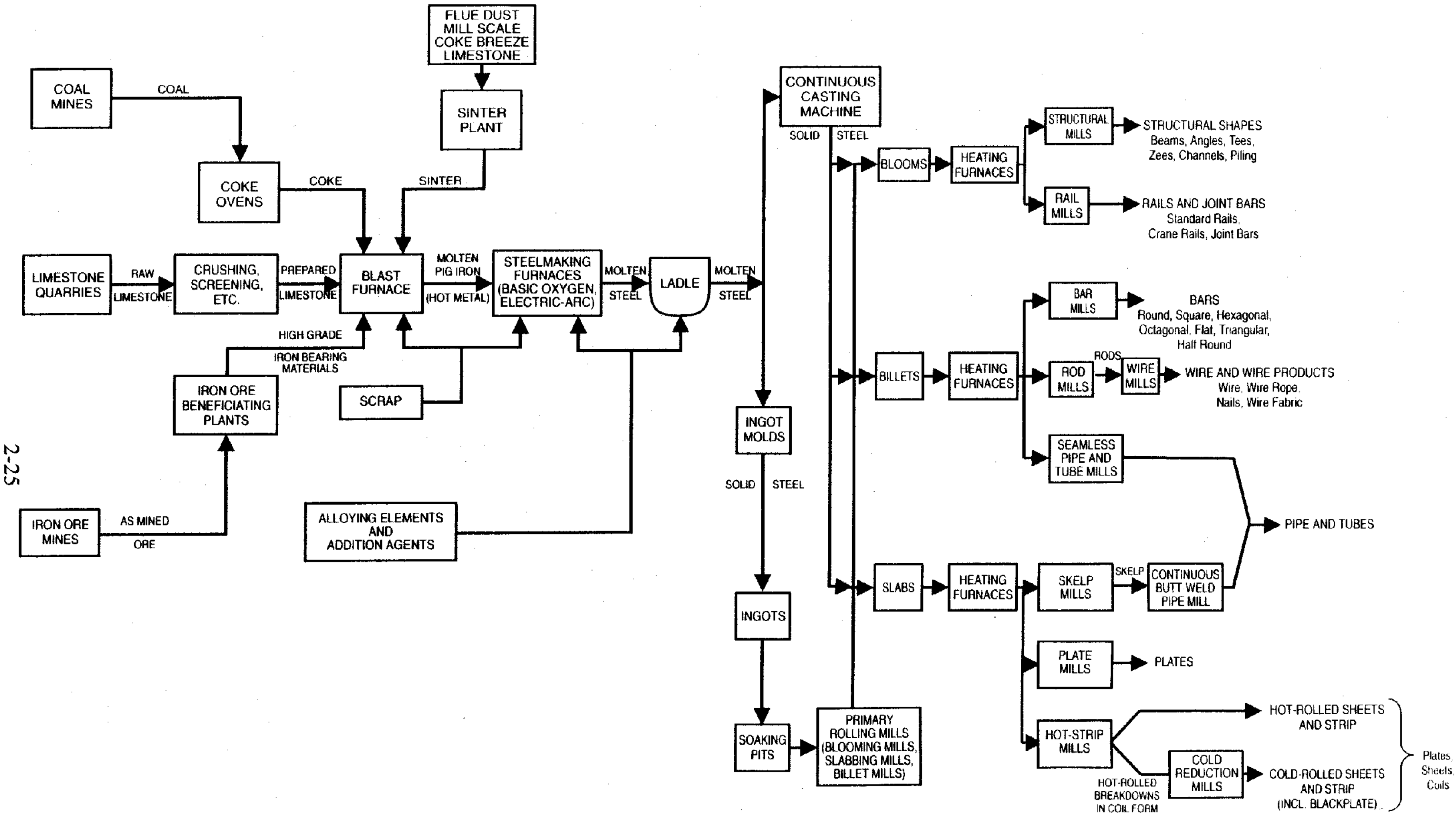
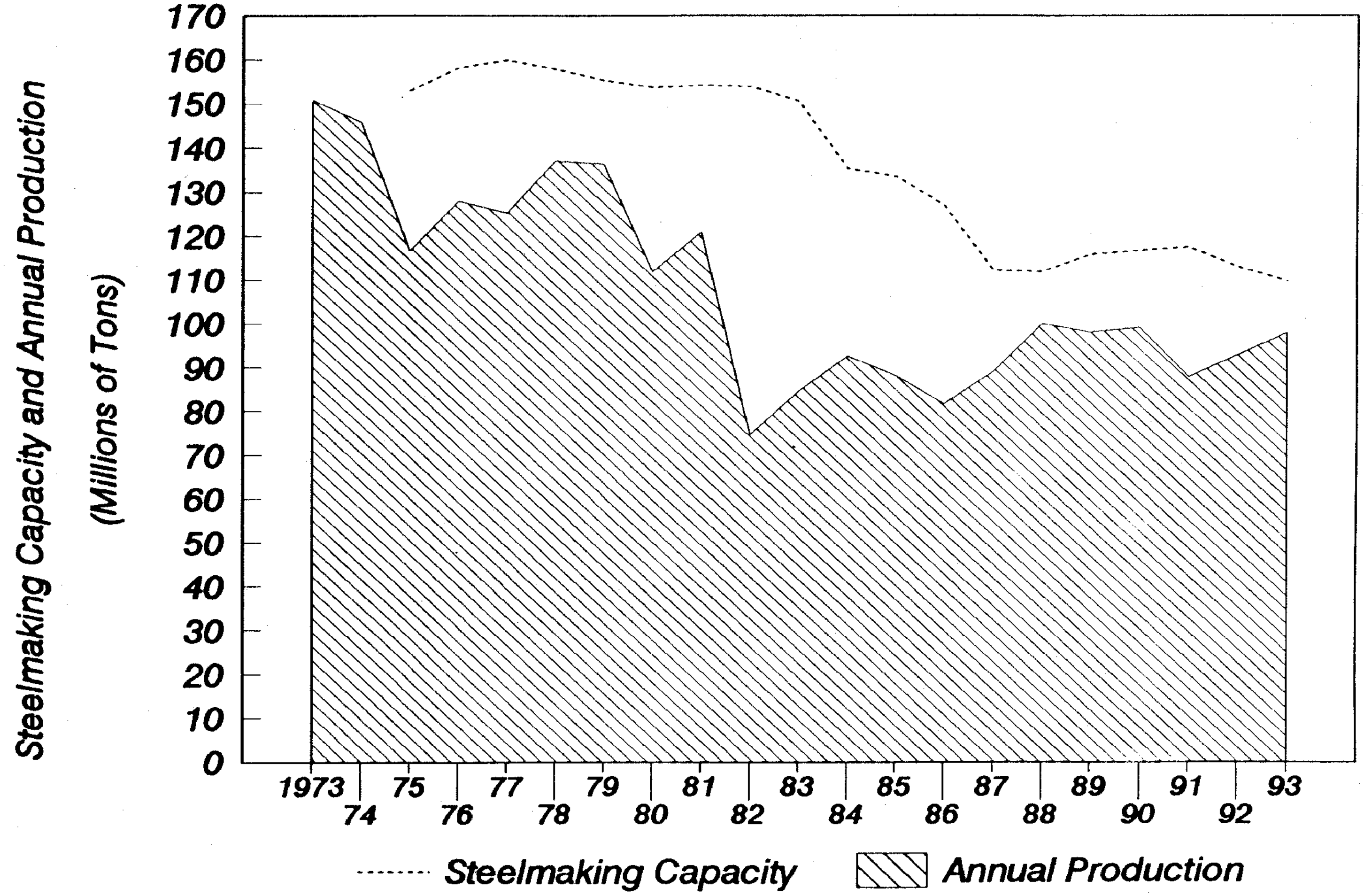


Figure 2-1. Steelmaking From Raw Materials to Finished Mill Products
(Coated Products Excluded)

Figure 2-2

U.S. Iron and Steel Industry

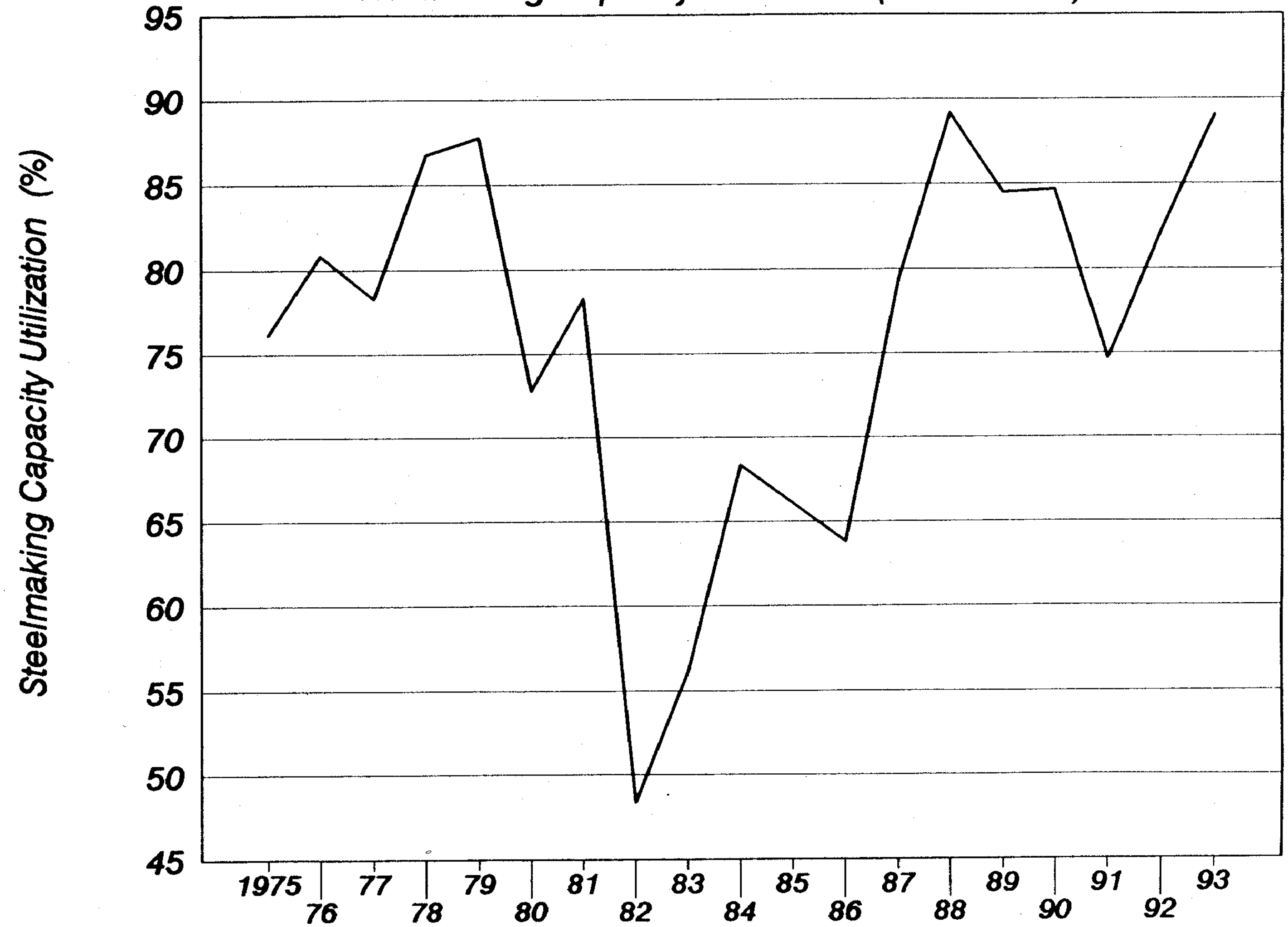
Steelmaking Capacity and Raw Steel Production (1973 - 1993)



Steelmaking capacity not available for 1973 and 1974

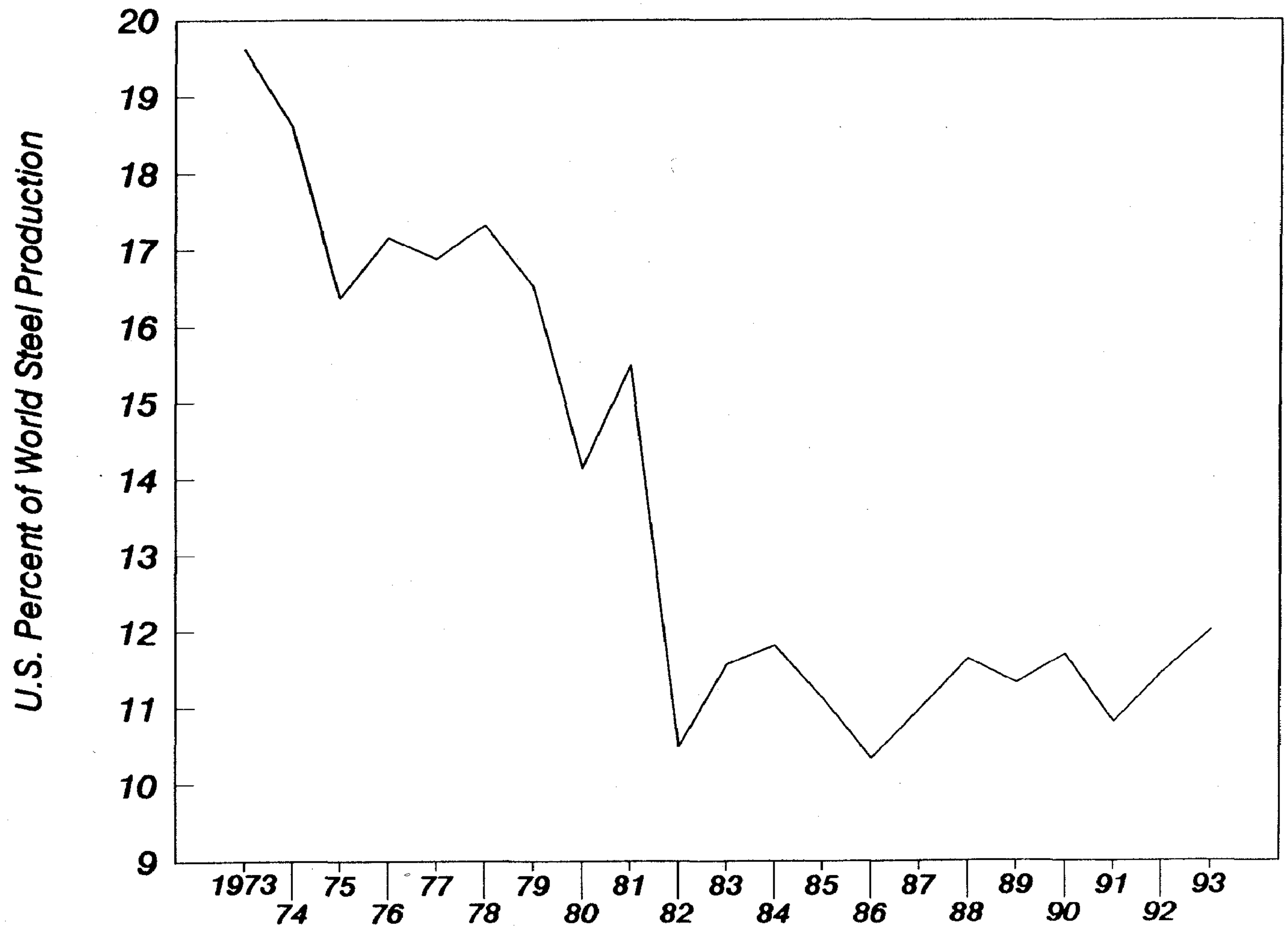
Source: American Iron & Steel Institute

Figure 2-3
US Iron and Steel Industry
Steelmaking Capacity Utilization (1975 - 1993)



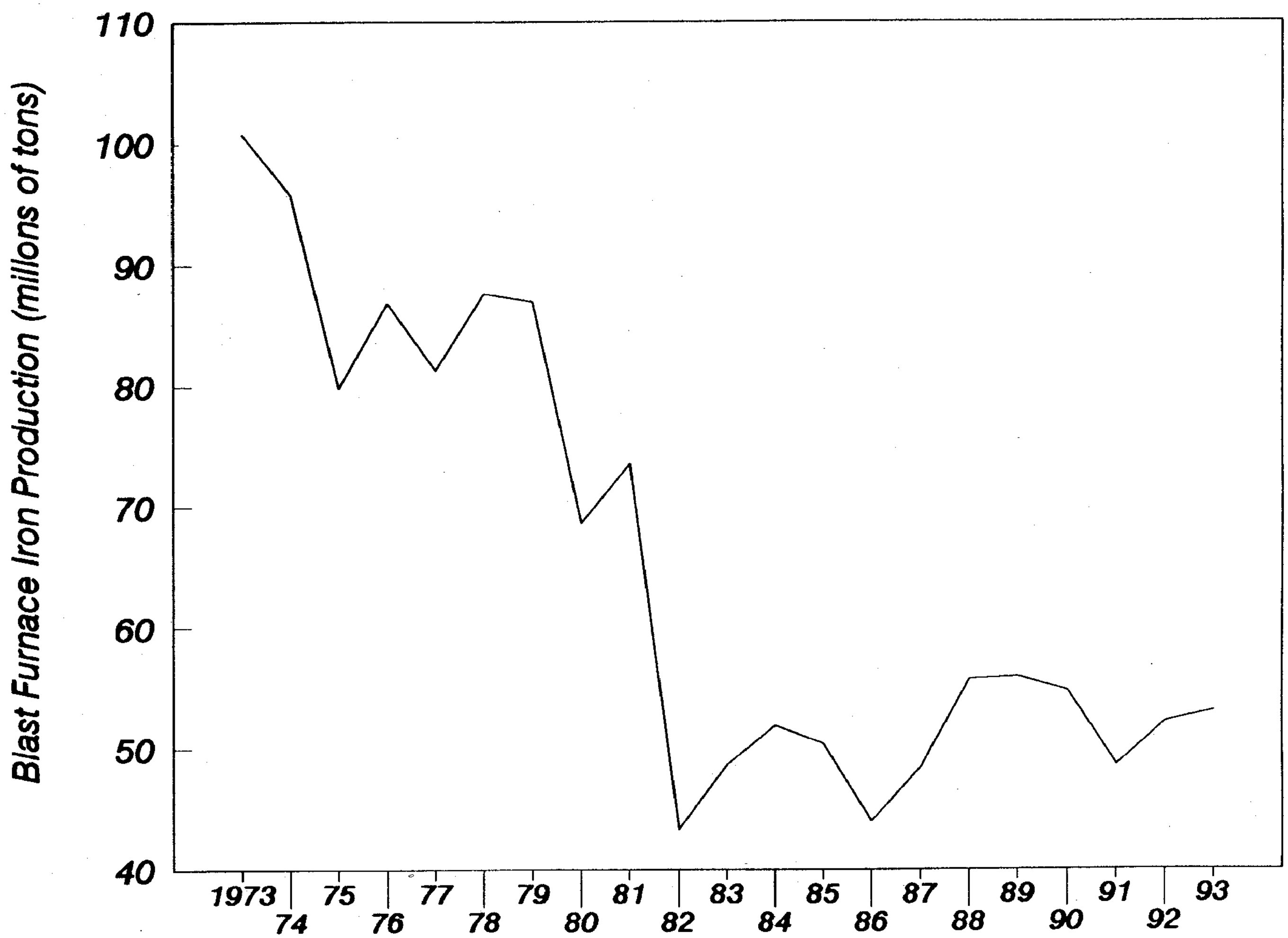
Source: American Iron & Steel Institute

Figure 2-4
U.S. Iron and Steel Industry
Production as Percent of World Production (1973 - 1993)



Source: American Iron & Steel Institute

Figure 2-5
U.S. Iron and Steel Industry
Blast Furnace Iron Production (1973 - 1993)

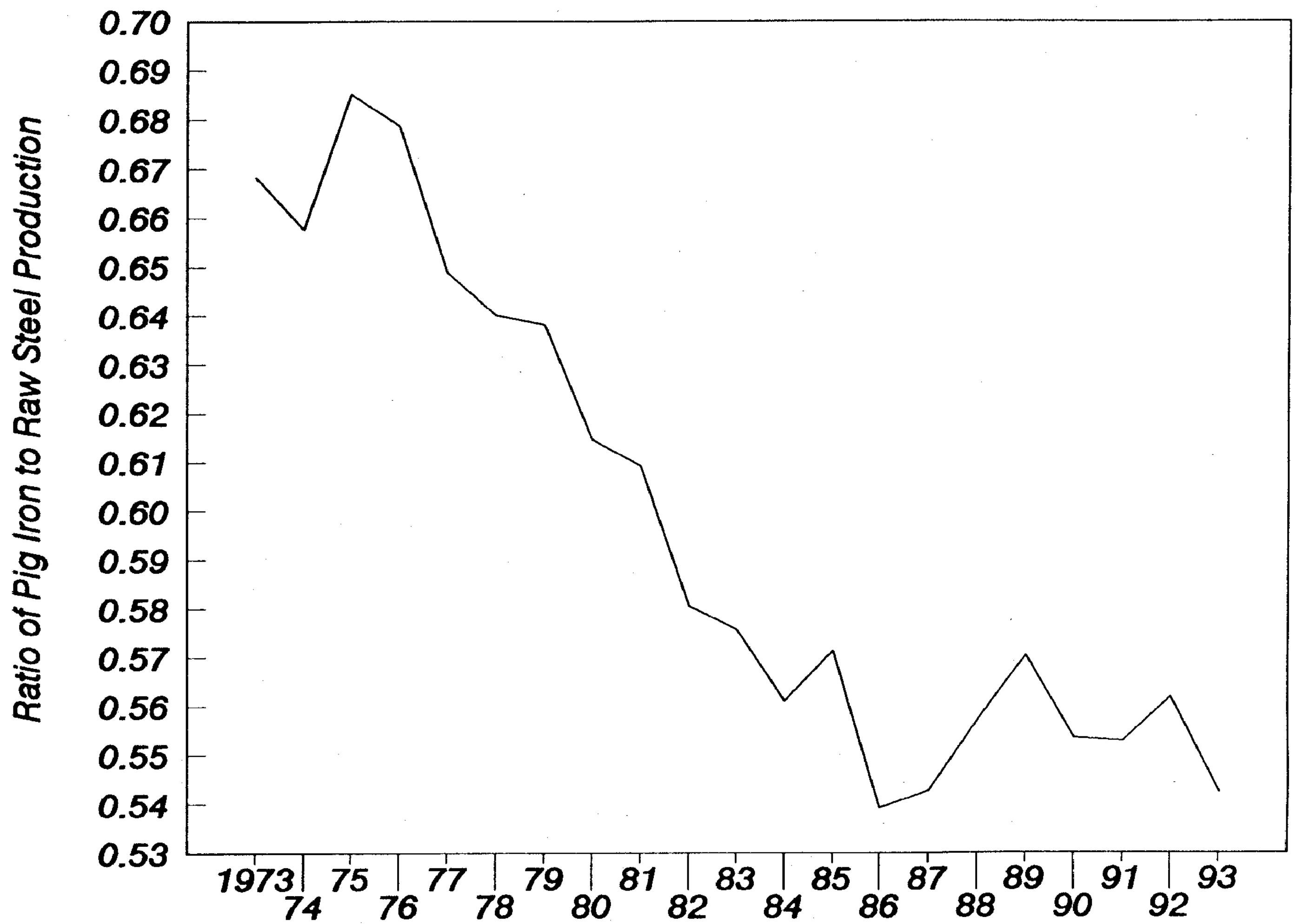


Source: American Iron & Steel Institute

Figure 2-6

U.S. Iron and Steel Industry

Ratio of Pig Iron to Raw Steel Production (1973 - 1993)

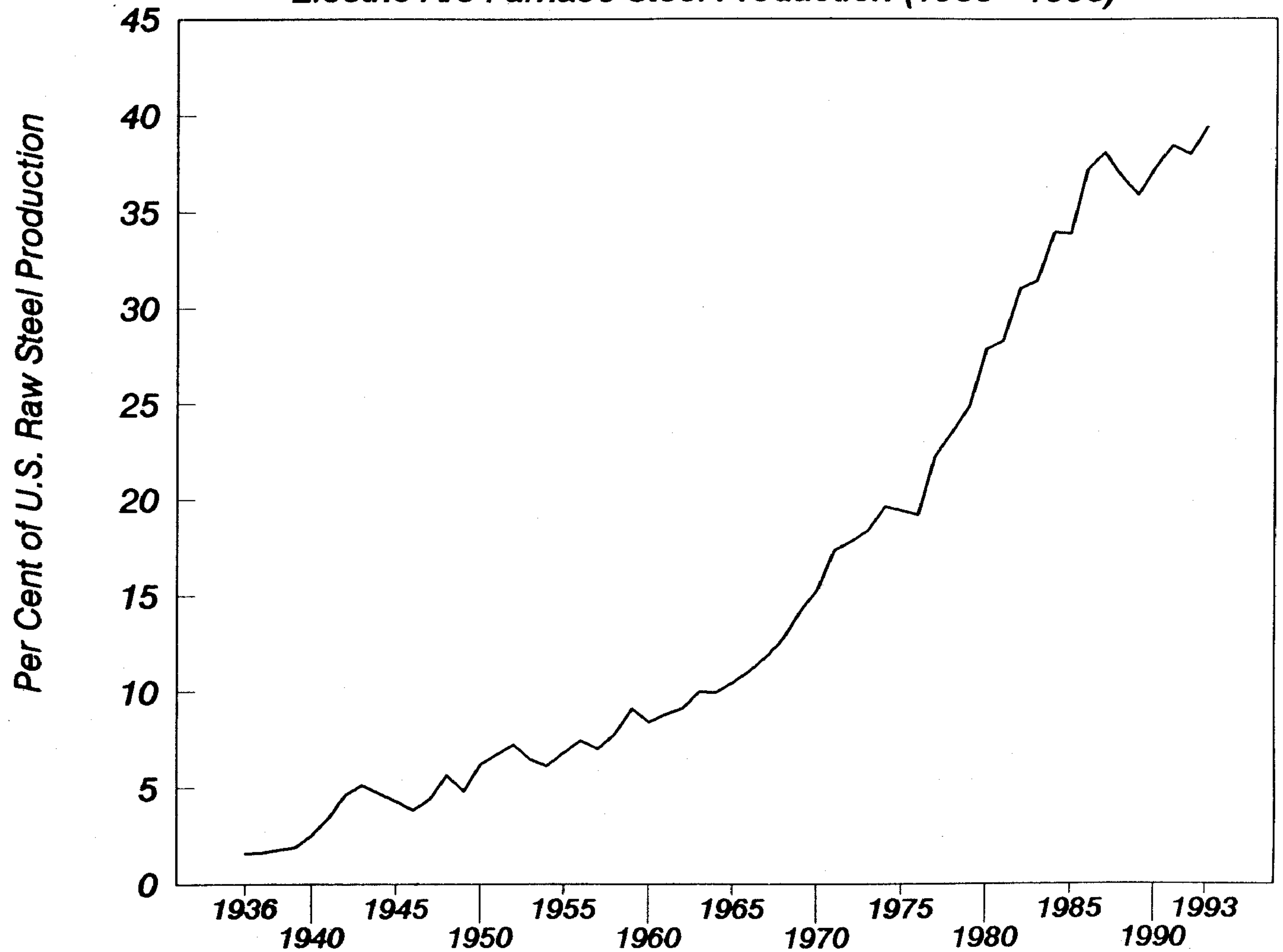


Source: American Iron & Steel Institute

Figure 2-7

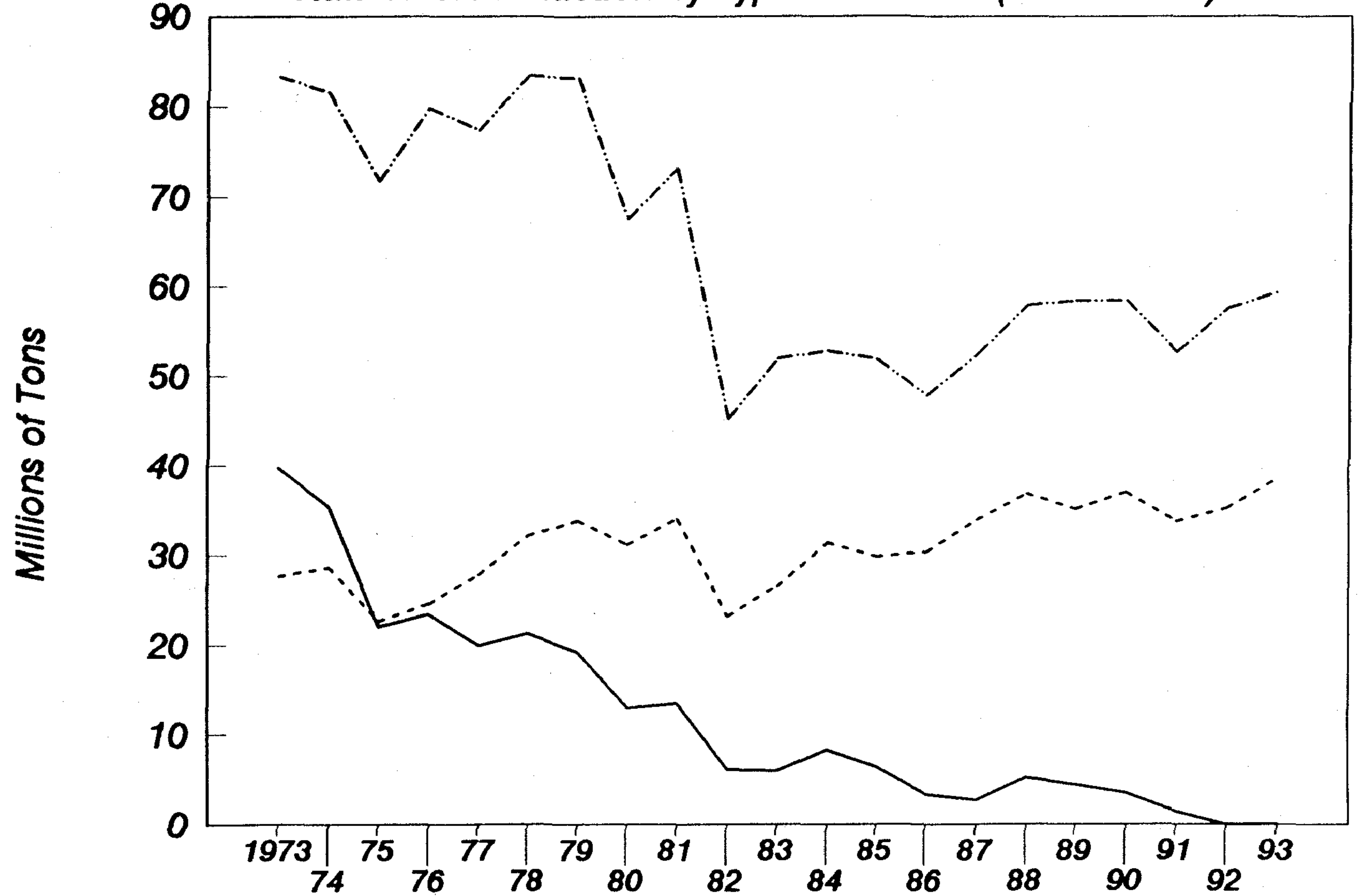
U.S. Iron and Steel Industry

Electric Arc Furnace Steel Production (1936 - 1993)



Source: American Iron & Steel Institute

Figure 2-8
U.S. Iron and Steel Industry
Raw Steel Production by Type of Furnace (1973 - 1993)



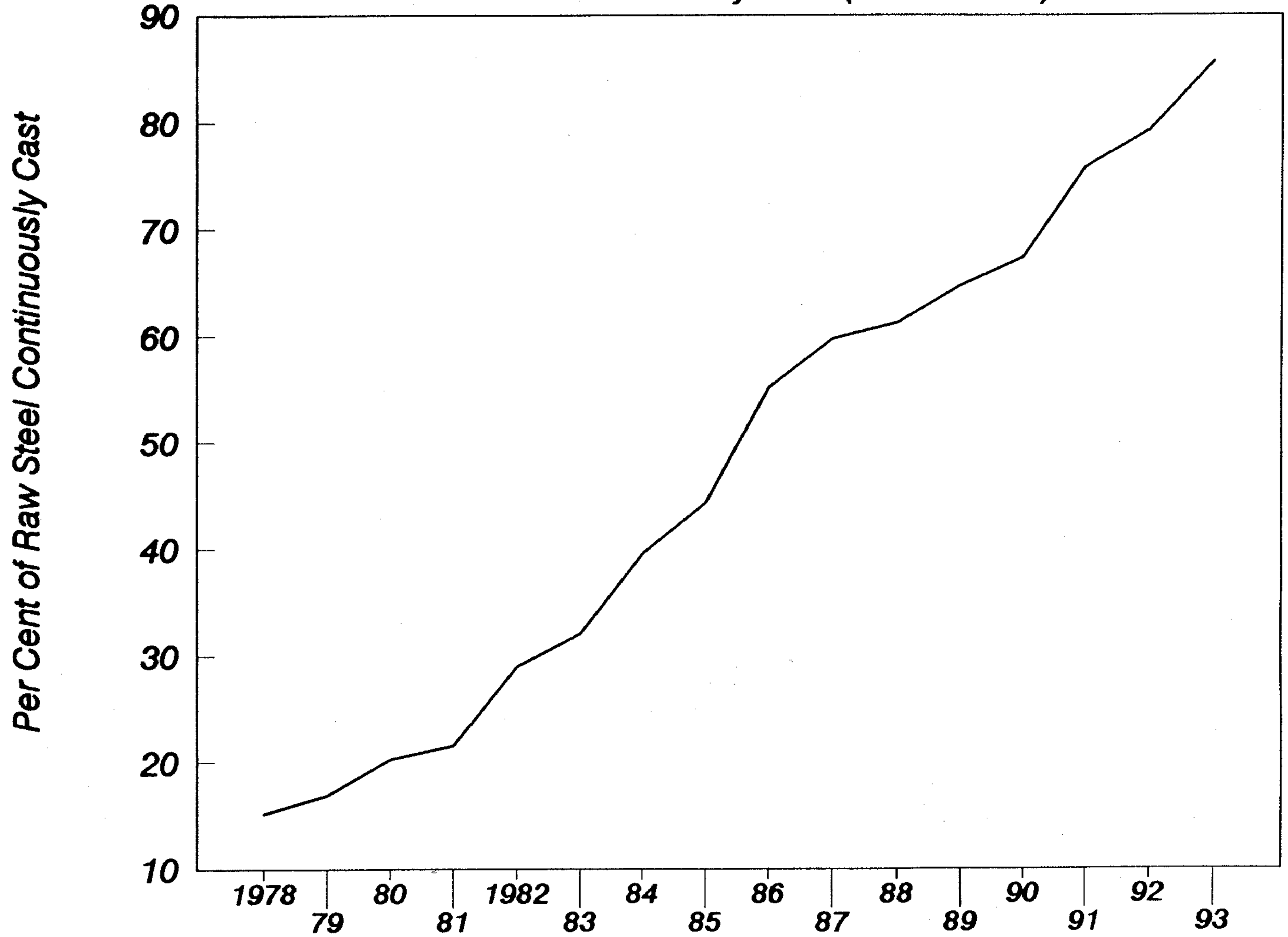
—·—·— Basic Oxygen - - - - Electric Arc ——— Open Hearth

Source: American Iron & Steel Institute

Figure 2-9

U.S. Iron and Steel Industry

Raw Steel Continuously Cast (1978 - 1993)

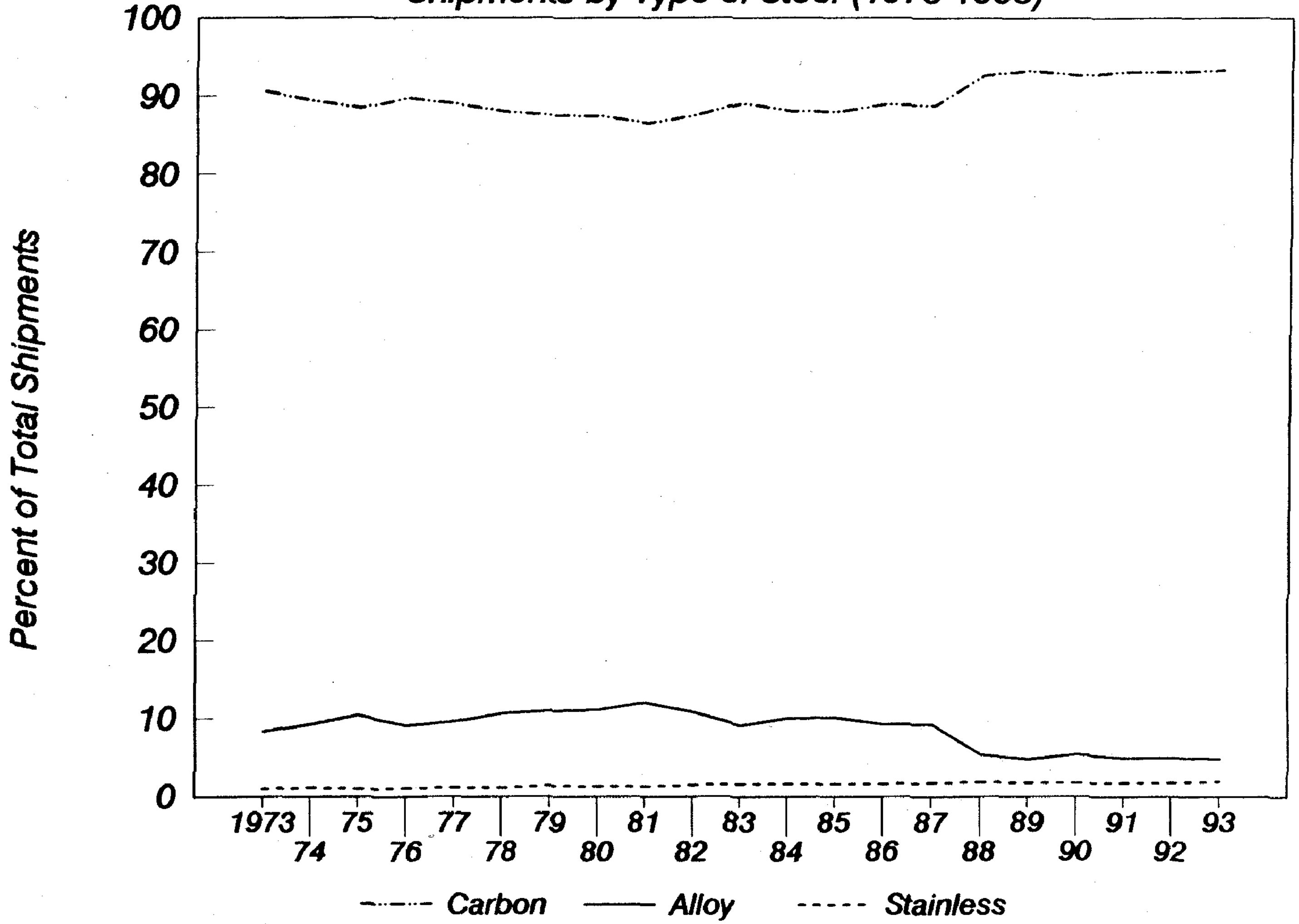


Source: American Iron & Steel Institute

Figure 2-10

U.S. Iron and Steel Industry

Shipments by Type of Steel (1973-1993)

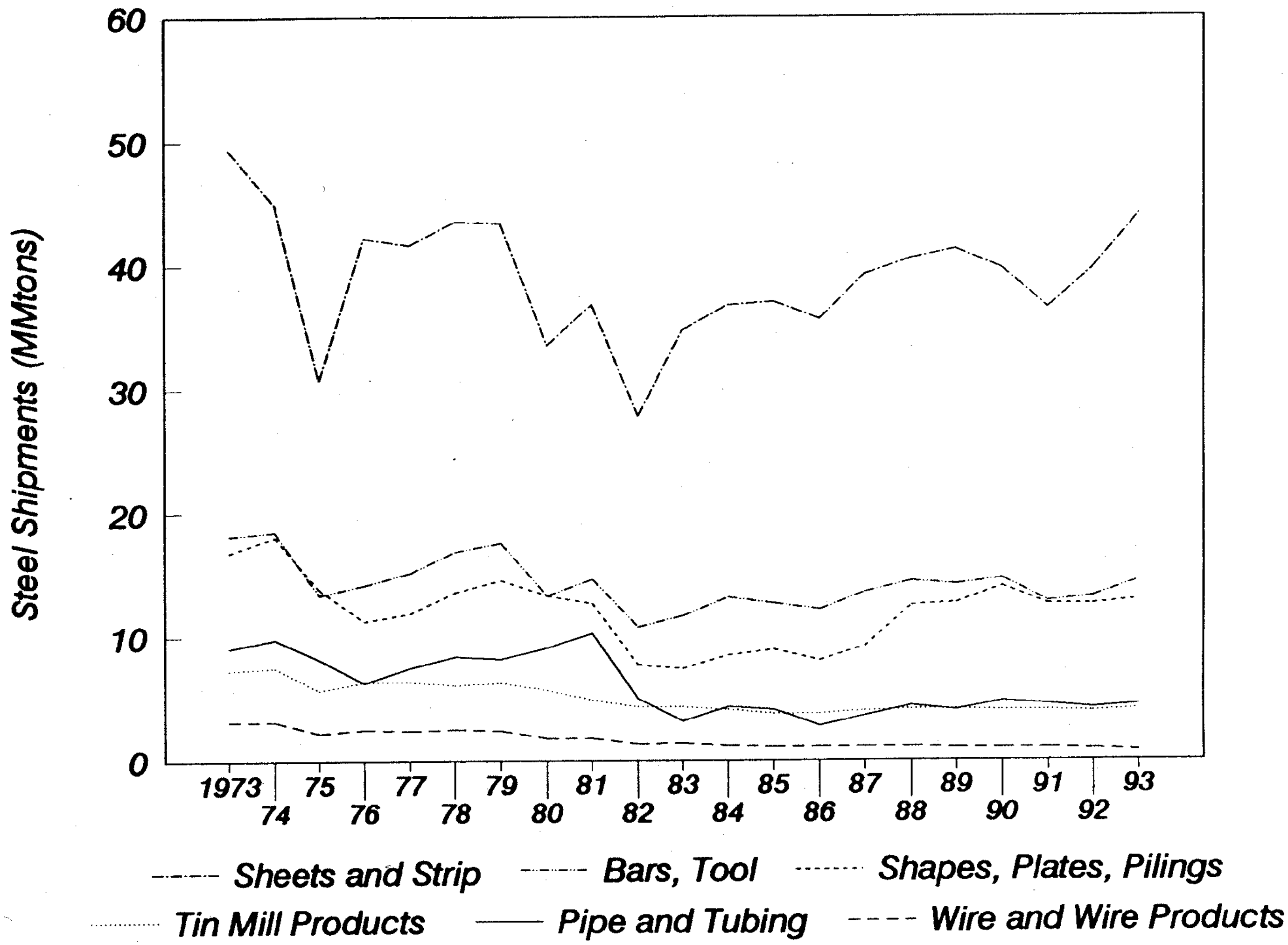


Source: American Iron & Steel Institute

Figure 2-11

U.S. Iron and Steel Industry

Steel Shipments, Major Products - All Grades

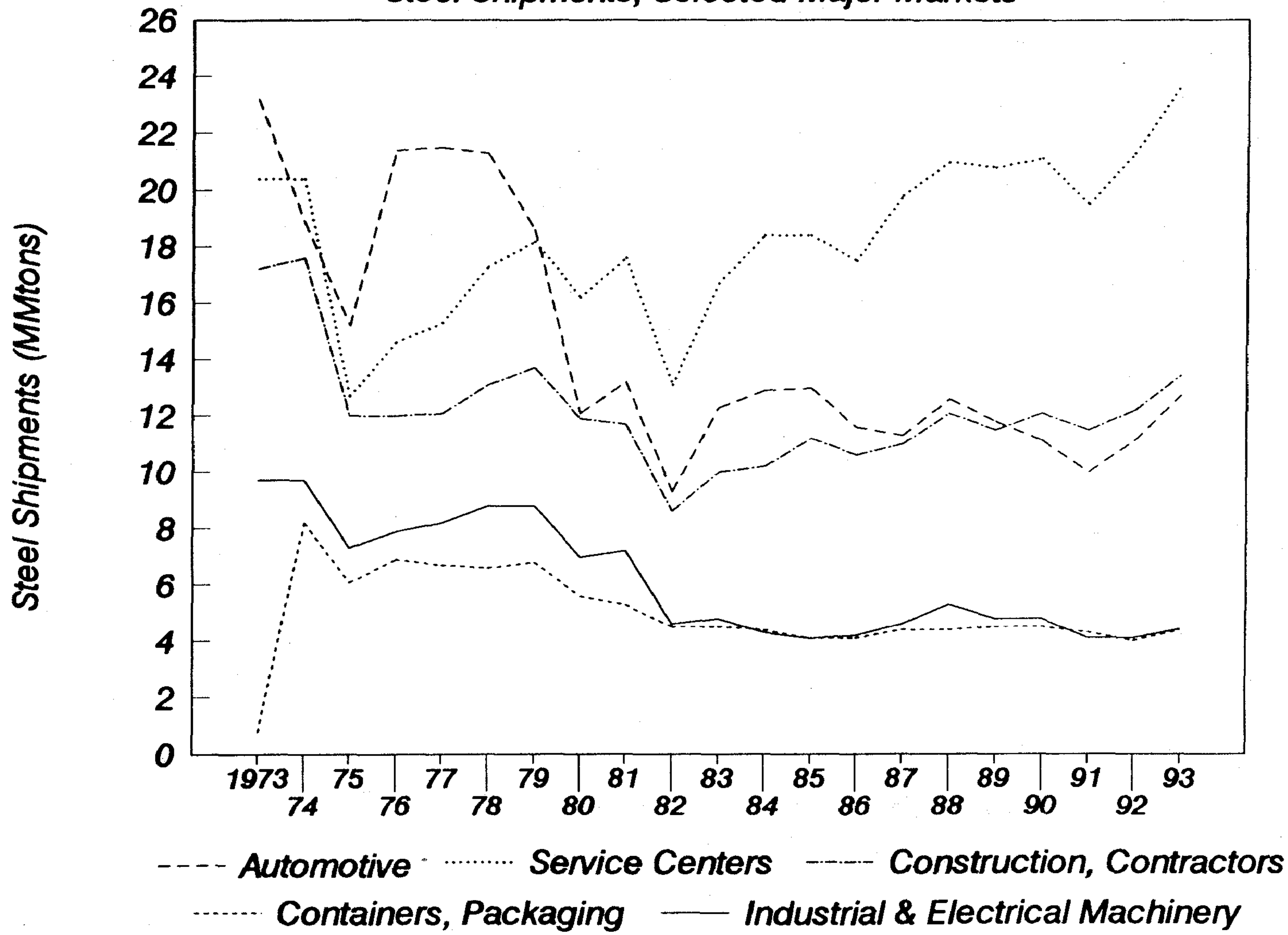


Source: American Iron & Steel Institute

Figure 2-12

U.S. Iron and Steel Industry

Steel Shipments, Selected Major Markets

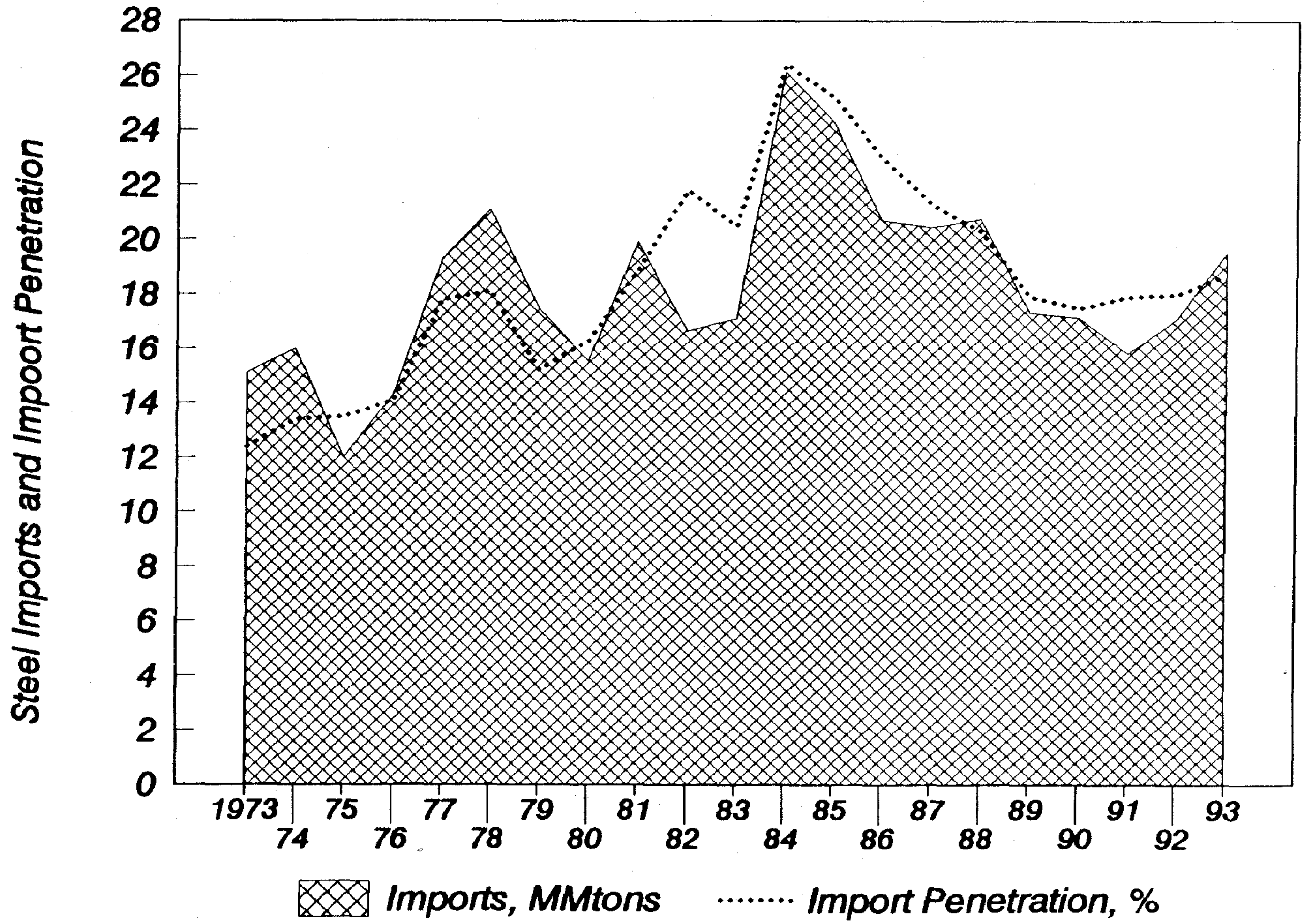


Source: American Iron & Steel Institute

Figure 2-13

US Iron and Steel Industry

United States Steel Imports and Import Penetration (1973 - 1993)

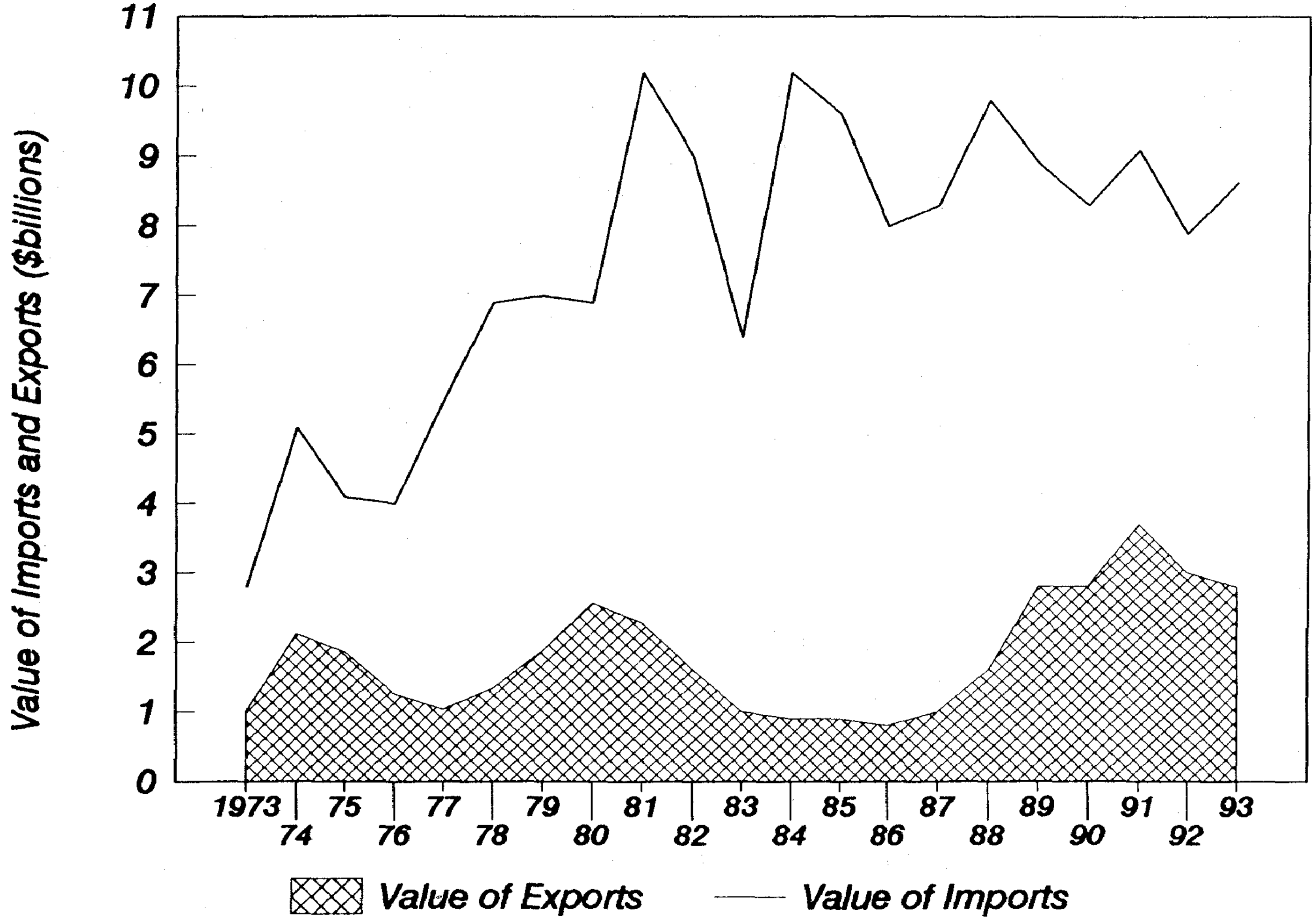


Source: American Iron & Steel Institute

Figure 2-14

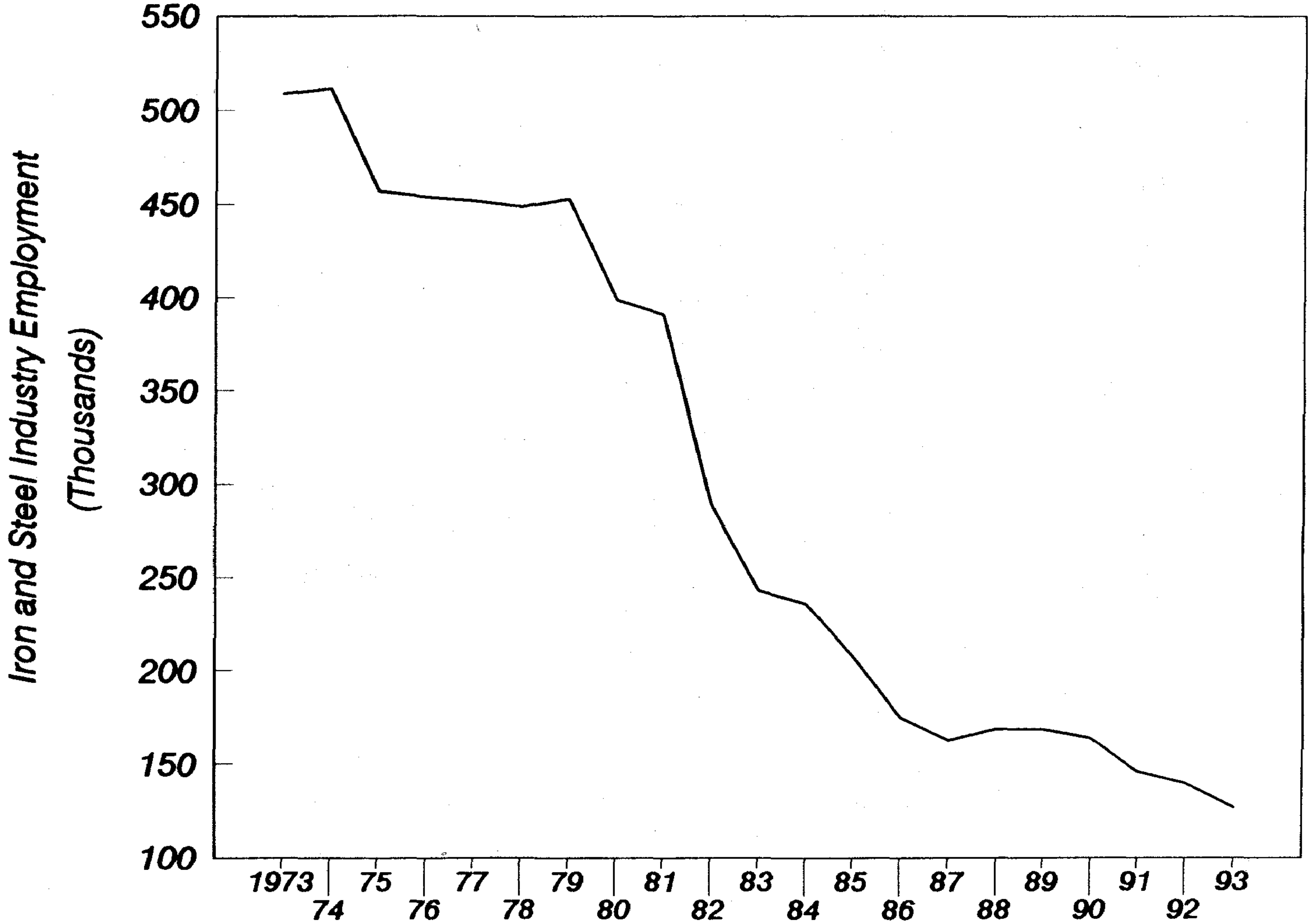
U.S. Iron and Steel Industry

Value of Imports and Exports (1973 - 1993)



Source: American Iron & Steel Institute

Figure 2-15
U.S. Iron and Steel Industry
Direct Employment (1973 - 1993)

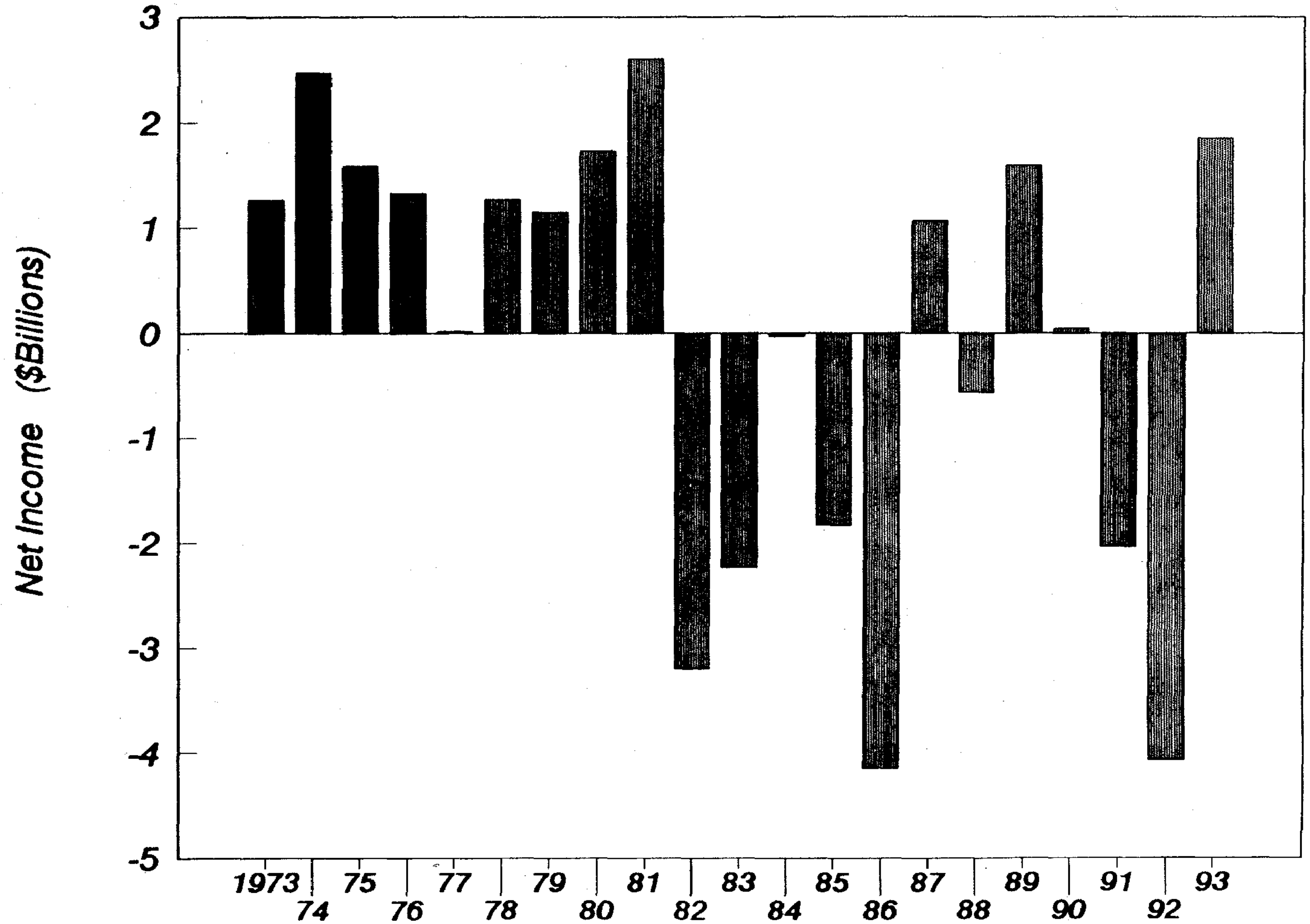


Source: American Iron & Steel Institute

Figure 2-16

U.S. Iron and Steel Industry

Net Income by Reporting Companies (1973 - 1993)

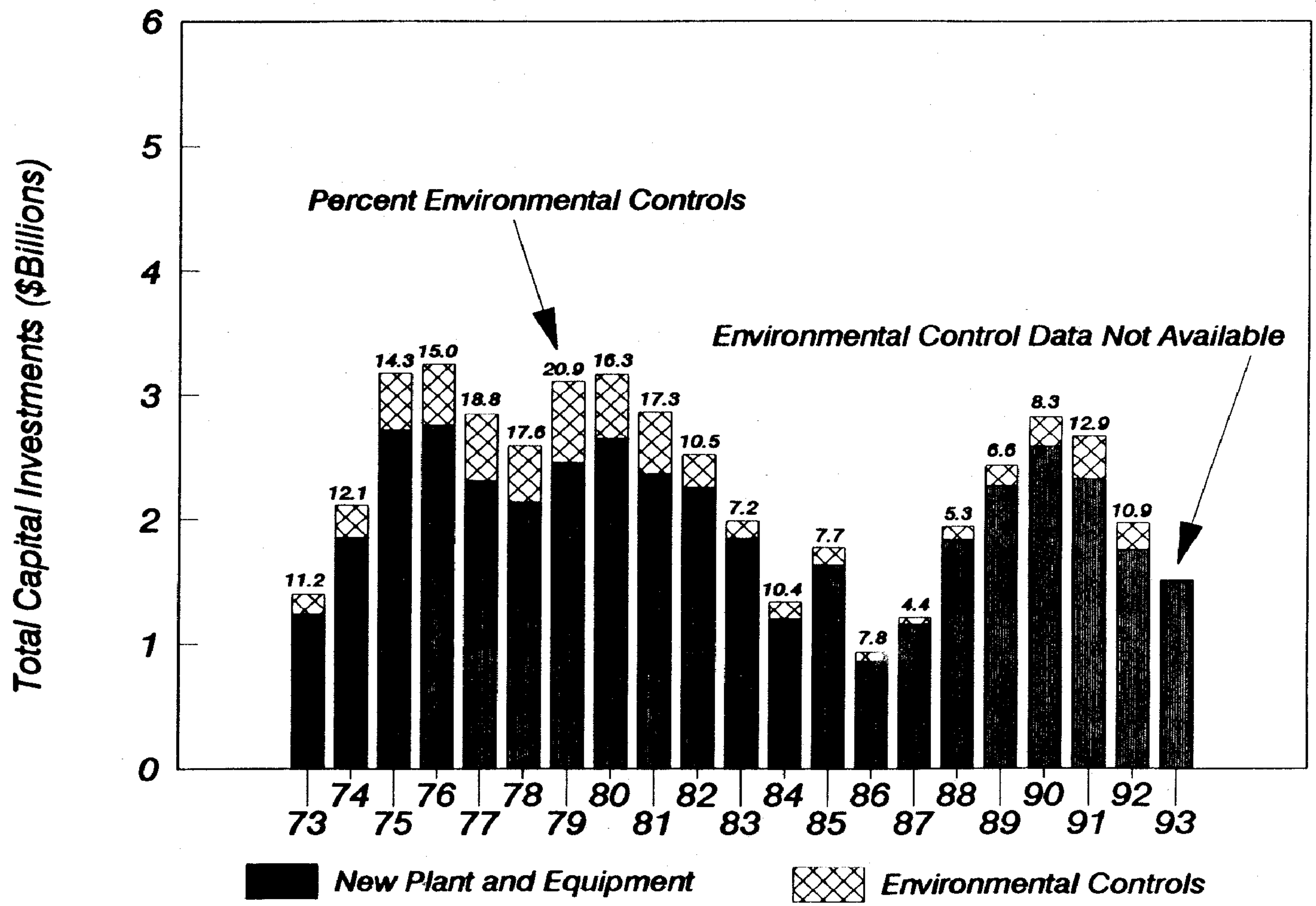


Source: American Iron & Steel Institute

Figure 2-17

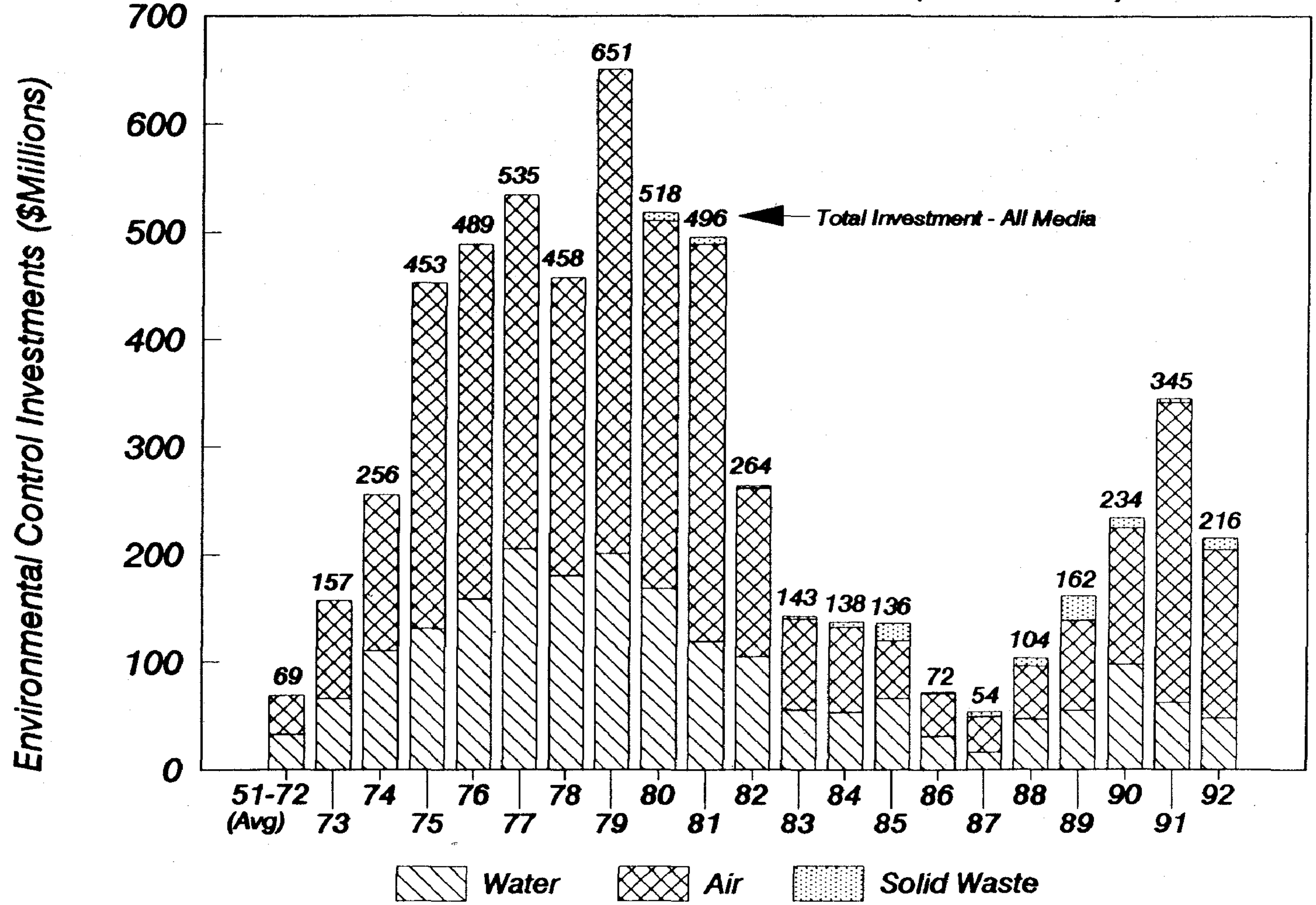
U. S. Iron and Steel Industry

Capital Investments (1973 - 1993)



Source: American Iron & Steel Institute

Figure 2-18
U.S. Iron and Steel Industry
Environmental Control Investments (1951 - 1992)



Source: American Iron & Steel Institute

3.0 BACKGROUND OF CURRENT REGULATION

3.1 Prior Regulations

EPA promulgated two regulations applicable to the iron and steel industry prior to the current effluent limitations guidelines and standards at 40 CFR Part 420. The first was promulgated on June 28, 1974 (Phase 1), and included Best Practicable Control Technology Currently Available (BPT) and Best Available Technology Economically Achievable (BAT) effluent limitations guidelines, and New Source Performance Standards (NSPS) and Pretreatment Standards for New Sources (PSNS) for the following basic steelmaking operations:[31]

- By-product Cokemaking
- Sintering
- Blast Furnace (Ferromanganese)
- BOF (Wet)
- Open Hearth Furnace (Wet)
- Continuous Casting
- Beehive Cokemaking
- Blast Furnace (Iron)
- BOF (Semi-wet)
- Open Hearth Furnace (Semi-wet)
- Vacuum Degassing

The terms "Semi-wet" and "Wet" refer to semi-wet and wet air pollution control systems for the different types of steelmaking furnaces.

In response to several petitions for review, the U.S. Court of Appeals for the Third Circuit remanded the regulation to the Agency on November 7, 1975.[32] The Court rejected all technical challenges to the BPT effluent limitations guidelines, but ruled that the BAT effluent limitations guidelines and NSPS for certain subcategories were not demonstrated. The Court also ruled that EPA had not adequately considered the impact of plant age on the cost or feasibility of retrofitting pollution control equipment, did not assess the impact of the regulation on water scarcity in arid and semi-arid regions, and failed to make adequate "net/gross" provisions for pollutants found in intake waters.

On March 26, 1976, EPA promulgated BPT effluent limitations guidelines and proposed BAT effluent limitations guidelines and NSPS and PSNS for the following steel forming and finishing operations:[33]

Hot Forming - Primary	Hot Forming - Section
Hot Forming - Flat	Hot Forming - Pipe and Tube
Pickling - Sulfuric Acid	Pickling - Hydrochloric Acid
Cold Rolling	Hot Coatings - Galvanizing
Hot Coatings - Terne	Combination Acid Pickling
Scale Removal	Wire Pickling and Coating
Continuous Alkaline Cleaning	Miscellaneous Runoffs - Storage Piles, Casting and Slagging

In response to several petitions for review, the U.S. Court of Appeals for the Third Circuit also remanded this regulation to the Agency on September 14, 1977.[34] The Court again rejected all technical challenges to the BPT effluent limitations guidelines; however, it again questioned the regulation on the age/retrofit and water scarcity issues. It also invalidated the regulation as it applied to the specialty steel industry for lack of proper notice. The Court directed EPA to reevaluate its estimates of compliance costs with regard to certain "site-specific" factors and to reexamine its economic impact analysis. Finally, the Court also ruled that EPA had no authority to exempt certain steel mills located in the Mahoning Valley of Ohio from the regulation.

The current regulation at 40 CFR Part 420 was proposed on January 7, 1981, and was promulgated on May 22, 1982.[1,35] The regulation was last amended in May 1984 through a negotiated Settlement Agreement with the iron and steel industry and the NRDC in response to challenges to the May 27, 1982 promulgation.[1,2,3]

3.2 Applicability

Section 420.01(a) presents the following general statement of applicability for Part 420:

> ***"(a) The provisions of this part apply to discharges and to the introduction of pollutants into a publicly owned treatment works resulting from production operations in the Iron and Steel Point Source Category."***

Section 420.01(b) provided a temporary exclusion from Part 420 for 21 steel mills or parts of steel mills that were identified as having central treatment facilities at the time Part 420 was promulgated. Section 420.01(b) is reviewed in detail in Section 3.6.1 below.

In promulgating Part 420 in 1982, EPA addressed three court-remanded issues from EPA's initial attempts to promulgate effluent limitations guidelines in 1974 and 1976:

- Inclusion of site-specific costs;
- Impact of plant age on the costs or feasibility of retrofitting control facilities; and
- Impact of the regulation on the consumptive loss of water.

In response to these issues, EPA modified its costing methodology to include site-specific costs to the extent they could be reasonably estimated, evaluated whether costs to retrofit control facilities at "older" mills would be disproportionately higher than similar costs for the industry as a whole, and evaluated the potential consumption of water that might occur as a result of compliance with the regulation. Aside from the temporary central treatment exclusion provided for selected mills at §420.01(b), which were promulgated independently of the remand issues, no exclusions from Part 420 were provided for mills on the basis of age, size, complexity, or geographic location as a result of the remand issues.

The applicability statement presented in §420.01(a), and many of the applicability statements for specific subparts of the regulation, are broad and include virtually all facilities which manufacture or process coke, iron, steel, or semi-finished steel products. As described in Section 4.1, some changes may need to be considered for small, stand-alone facilities that may perform operations on finished or semi-finished steel that are subject to Part 420.

3.3 Subcategorization

When promulgating Part 420 in 1982, EPA revised the subcategorization scheme of the iron and steel industry from that specified in the 1974 and 1976 regulations to more accurately reflect major types of production operations and to attempt to simplify implementation of the regulation by permit writers and the industry. The following factors were considered in revising the subcategorization scheme:

- Manufacturing processes and equipment;
- Raw materials;
- Final products;
- Wastewater characteristics;
- Wastewater treatment methods;
- Size and age of facilities;
- Geographic location;
- Process water usage and discharge rates; and
- Costs and economic impacts.

EPA found that the type of manufacturing process was the most significant factor, and subsequently divided the industry into the twelve process subcategories (subparts) listed below:

A.	Cokemaking	E.	Vacuum Degassing
B.	Sintering	F.	Continuous Casting
C.	Ironmaking	G.	Hot Forming
D.	Steelmaking	H.	Salt Bath Descaling
I.	Acid Pickling	K.	Alkaline Cleaning
J.	Cold Forming	L.	Hot Coating

These subcategories were further divided into subdivisions and segments as shown in Table 3-1.

These processes and electroplating operations conducted at steel mills are briefly described in Sections 2.1.1 through 2.1.13. As described in Section 4.2, the current industry subcategorization as reflected in Part 420 could be reorganized to more effectively regulate nonintegrated steel producers; to include operations currently regulated under Part 433 - Metal Finishing; to address new continuous strip steel finishing mills that include new metal coatings and combinations of operations that currently fall under Parts 420 and 433; and to delete obsolete manufacturing processes.

3.4 Technology Bases for the Regulation

The technologies considered by EPA for establishing the effluent limitations guidelines and standards contained in Part 420 are, for the most part, based upon a combination of process water flow reduction and conventional end-of-pipe wastewater treatment technologies. Because of the capital-intensive nature of the industry and the lack of commercially available new cokemaking, ironmaking, steelmaking, forming, or steel finishing technologies that could be applied on an industry-wide basis, EPA did not consider process change as a basis for the BAT effluent limitations guidelines and NSPS and PSNS contained in the current Part 420. As described in Section 6, there may now be opportunities to establish revised BAT and NSPS for certain operations based upon process changes.

When promulgating Part 420, EPA established Best Conventional Pollutant Control Technology (BCT) effluent limitations guidelines only for the hot forming subcategory at a level equivalent to BPT. BCT was not promulgated for any other subcategories. For all subcategories except cokemaking, PSES for nonconventional and toxic pollutants were set equal to BAT, and PSNS were set equal to NSPS. PSES for cokemaking were based upon physical/chemical treatment as opposed to a combination of physical/chemical treatment and biological treatment for BAT.

Appendix A contains a series of schematic diagrams showing the technologies considered by EPA in developing the effluent limitations guidelines and standards for each subcategory.[8] Following are brief summaries of the selected major model technologies for BPT and BAT/NSPS for each subcategory:

Cokemaking

- **BPT**. Recycle of final cooler water, dissolved gas floatation for benzol plant wastewaters, free and fixed ammonia stripping, equalization, and single-stage activated sludge.

- **BAT**. BPT plus recycle of ammonium crystallizer water and modify single-stage activated sludge to two-stage activated sludge with nitrification.

Sintering

- **BPT**. Clarification and recycle (92%) of air emission control scrubber water and sludge dewatering.

- **BAT/NSPS**. Recycle system blowdown treatment comprising metals precipitation, two-stage alkaline chlorination, and dechlorination.

Ironmaking

- **BPT**. Clarification, cooling, and recycle (96%) for blast furnace gas cleaning and gas cooling waters, and sludge dewatering.

- **BAT/NSPS**. Increased recycle (98%) and recycle system blowdown treatment comprising metals precipitation, two-stage alkaline chlorination, and dechlorination.

Steelmaking

- **BPT**. Clarification and recycle (95% BOF - Suppressed Combustion; 90% BOF - Open Combustion; 94% Open Hearth Furnace; 95% EAF) of steelmaking wet air emission control scrubber water, and sludge dewatering. Recycle to extinction of gas conditioning water for BOFs and EAFs equipped with semi-wet air emission control systems.

- **BAT/NSPS**. Recycle system blowdown treatment comprising metals precipitation and pH control for steelmaking furnaces with wet air emission control systems.

Vacuum Degassing

- **BPT**. Sedimentation and recycle (98%) for condenser contact cooling waters.

- **BAT/NSPS**. Recycle system blowdown treatment comprising metals precipitation and pH control.

Continuous Casting

- **BPT**. Closed loop cooling for casting machine and mold cooling water systems; sedimentation, filtration, cooling, and recycle (96.3%) for spray water.

- **BAT/NSPS**. Increased recycle (99.3%) and recycle system blowdown treatment for spray water comprising metals precipitation and pH control.

Hot Forming

- **BPT/BCT**. Sedimentation and oil skimming, partial recycle of scale pit effluents (Primary Mills - 61%; Section Mills - 58%; Flat Mills - 60%; Pipe and Tube Mills - 77%), clarification and filtration, and sludge dewatering.

- **BAT**. Not promulgated because of low toxic metals loadings and high cost of high-rate recycle.

- **NSPS**. Sedimentation, partial recycle of primary scale pit effluents, clarification, cooling, additional recycle (to 96%), recycle system blowdown filtration, and sludge dewatering.

Salt Bath Descaling

- **BPT**. Oxidizing: Reduction of hexavalent chromium, oil skimming, metals precipitation, and sludge dewatering.

  BPT. Reducing: Two-stage chlorination, metals precipitation, and sludge dewatering.

- **BAT/NSPS**. Effluent limitations guidelines and standards based upon BPT technologies.

Acid Pickling

- **BPT**. Recycle of fume scrubber waters, equalization, oil skimming, metals precipitation, and sludge dewatering.

- **BAT/NSPS**. Acid regeneration plant absorber vent scrubber recycle, and countercurrent cascade pickling rinses.

Cold Forming - Cold Rolling

- **BPT**. Primary oil removal, emulsion breaking, dissolved gas flotation, and sludge dewatering. Contract hauling of waste rolling solutions for limited applications.

- **BAT/NSPS**. Effluent limitations guidelines and standards based upon BPT technologies.

Alkaline Cleaning

- **BPT**. Oil skimming, pH control, and clarification.

- **BAT**. Not promulgated because of low toxic pollutant loadings.

- **NSPS**. Standards based upon BPT technologies with additional flow reduction.

Hot Coating

- **BPT**. Reduction of hexavalent chromium, equalization and oil removal, metals precipitation, and pH control.

- **BAT/NSPS**. Recycle of fume scrubber waters.

3.5 Regulated Pollutants

Table 3-2 presents, by subcategory, the conventional, nonconventional, and priority (or toxic) pollutants regulated by Part 420. The regulated pollutants were selected based upon process wastewater characteristics in each subcategory in terms of pollutant loadings and concentrations, whether controlling certain pollutants would result in comparable control of similar pollutants (e.g., limitations for lead and zinc based upon metals precipitation technology would control other metals not directly limited), and whether co-treatment of compatible wastewaters would be encouraged by limiting the same pollutants in different subcategories. A principal concern expressed by the Agency was the potential for dilution of toxic metal and toxic organic pollutants from co-mingling and co-treatment of incompatible wastewaters.[36]

EPA regulated the pollutants in Table 3-2 and grouped the following subcategories to attempt to restrict indiscriminate mixing of incompatible wastewaters and dilution of toxic pollutants:

Group	Subcategories
1	Cokemaking
2	Sintering, Ironmaking
3	Steelmaking, Vacuum Degassing, Continuous Casting, Acid Pickling (H_2SO_4, HCl), Cold Rolling, Alkaline Cleaning, Hot Coating
4	Specialty Steel Operations: Salt Bath Descaling, Acid Pickling (Combination), Cold Rolling

This aspect of the regulation is reviewed in more detail in Sections 3.6 and 4.4 with the Central Treatment provisions set out at §420.01(b).

3.6 General Provisions

The General Provisions of the regulation contain the applicability statement described above at §420.01(a); the temporary central treatment exclusion for selected facilities and parts of facilities at §420.01(b); general definitions at §420.02; an alternative effluent limitations provision for BPT, BCT, and BAT, otherwise known as the "water bubble", at §420.03; a statement of basis for determining the appropriate production level for calculating mass-based pretreatment standards at §420.04; a pretreatment standards compliance date at §420.05; and a provision that would allow pretreatment removal credits for phenols (4AAP) under certain circumstances, at §420.06.

Because of their actual and potential significance in the regulatory framework for iron and steel mills, the temporary central treatment exemption at §420.01(b) and the "water bubble" rule at §420.03 are reviewed separately below and in Section 4.4. The general applicability statement at §420.01(a) and the applicability statements for selected subcategories are reviewed in Section 4.1.

The General Provision regarding the appropriate production rate for establishing mass categorical pretreatment standards is a more refined statement of the production basis used to determine mass NPDES permit effluent limitations set out at §122.45(b). For the iron and steel industry, most NPDES permits and pretreatment standards have been computed based on the daily average production for the month with the highest production that occurred over the prior five years at the time of permit issuance. Because of the cyclical nature of operations at most steel mills, this approach results in what may be inflated effluent limitations or pretreatment standards in some cases. This issue is reviewed in Section 4.4.

Because the recently promulgated removal credits provisions of the pretreatment regulations at §403.7 specifically list the priority pollutant phenol as being eligible for removal credits, and do not list the nonconventional pollutant phenols (4AAP), General Provision §420.06 regarding possible removal credits for phenols (4AAP) does not appear to be applicable at this time.

3.6.1 <u>Central Treatment</u>

During development of the current Part 420, the industry requested that EPA develop a subcategory for "central treatment" facilities (i.e., facilities that provide treatment for wastewaters from multiple subcategories). In the promulgation of Part 420, EPA did not include a central treatment subcategory. Upon examination of this issue, the Agency found that numerous combinations of centralized treatment systems were used by the industry.[37] Many treated wastewaters were compatible (i.e., the mix of pollutants present was such that the treatment provided would be essentially the same as that provided if the wastewaters were treated separately, or that certain wastewaters could be effectively pretreated for selected pollutants and then mixed and co-treated with similar wastewaters). EPA also found other types of centralized treatment facilities where incompatible wastewaters were mixed and co-treated without pretreatment. In many of these systems, mass discharges of pollutants were much higher than could be achieved if only compatible wastewaters were co-treated and incompatible wastewaters were treated separately. The principal issue raised by the industry was that the cost to retrofit separate treatment facilities at mills with certain types of centralized treatment facilities would be excessive when compared to the Agency's estimated costs of compliance.

Because EPA could not resolve cost issues at mills with centralized treatment facilities during development of Part 420, it established a scheme in the proposed regulation whereby alternative, less stringent limitations could be obtained for mills or parts of mills provided the owners or operators made certain demonstrations regarding the costs to retrofit pollution control facilities. Seven mills or parts of mills were identified by EPA from a list of 35 mills provided by the industry as possibly qualifying for such alternative effluent limitations. Based upon comments received in response to the proposed regulation, EPA expanded the list to 21 mills in the final regulation.

Section 420.01(b) provided that these facilities were ***temporarily*** excluded from Part 420 provided that the owner or operator made the required demonstrations set out in the regulation. These included an estimate of the cost to fully comply with Part 420 and estimates of the effluent limitations that could be achieved if the owner or operator were to spend an amount equal to the Agency's model treatment system cost estimate to comply with Part 420. The regulation also required supplemental wastewater quality, production, and other data. Although §420.01(b) does not address the extent of the temporary exclusion, the preamble to the regulation at 47 FR 23267 stated that the Agency's intent was that the temporary exclusion was not to exceed one year from date of promulgation.

As described more fully in Section 4.4, none of the 21 facilities listed in §420.01(b) received alternative, less stringent effluent limitations or pretreatment standards through the mechanism established by the regulation. Because the central treatment provision remains in the regulation, the owners or operators of two listed facilities are currently attempting to use §420.01(b) as a vehicle to obtain less stringent NPDES permit effluent limitations than would otherwise be required under Part 420.

3.6.2 Water Bubble

Section 420.03 (commonly known as the "water bubble" rule) provides a mechanism whereby dischargers with multiple outfalls may discharge greater quantities of pollutants from outfalls where treatment costs are high in exchange for a larger decrease in discharges from outfalls at the same plant where treatment costs are less. The regulation provides that there can be only intraplant trades and no interplant trades; that only like pollutants can be traded (e.g., zinc for zinc, not zinc for lead or ammonia-N); that minimum net reductions of 10% for toxic and nonconventional pollutants and 15% for conventional pollutants must be achieved; and, that trades within certain subcategories are restricted (cokemaking and cold rolling). These restrictions were included to ensure there would be no inadvertent excess discharge of toxic organic pollutants from these operations in implementing the water bubble rule.

Although the water bubble rule has not been used by many mills, the present value of the cost reductions of intraplant trading at seven mills was recently estimated at $122.7 million (1993 dollars).[38] Possible modifications to the water bubble rule are reviewed in Section 4.4.

At the time the current Part 420 was under review for promulgation, U.S. EPA evaluated whether to develop a water bubble type rule for other industrial categories including petroleum refining, organic chemicals, pulp and paper, and metal finishing. The Agency found that a water bubble rule would not be effective for these and other categories because most manufacturing facilities in these categories do not have multiple process wastewater treatment facilities and multiple outfalls that are characteristic of integrated steel mills.

Table 3-1

Iron and Steel Manufacturing Subcategories, Subdivisions, and Segments

Subpart/Subcategory	Subdivision	Segment
A. Cokemaking	By-product	Iron and steel
		Merchant
	Beehive	None
B. Sintering	None	None
C. Ironmaking	Iron blast furnace	None
	Ferromanganese blast furnace	None
D. Steelmaking	Basic oxygen furnace	Semi-wet
		Wet-suppressed combustion
		Wet-open combustion
	Open Hearth Furnace	Wet
	Electric Arc Furnace	Semi-wet
		Wet
E. Vacuum Degassing	None	None
F. Continuous Casting	None	None

Table 3-1 (Continued)

Iron and Steel Manufacturing Subcategories, Subdivisions, and Segments

Subpart/Subcategory	Subdivision	Segment
G. Hot Forming	Primary	Carbon and specialty mills without scarfers
		Carbon and specialty mills with scarfers
	Section	Carbon mills
		Specialty mills
	Flat	Hot strip and sheet mills
		Carbon plate mills
		Specialty plate mills
	Pipe and tube mills	None
H. Salt Bath Descaling	Oxidizing	Batch: sheet, plate
		Batch: rod, wire, bar
		Batch: pipe, tube
		Continuous
	Reducing	Batch
		Continuous

Table 3-1 (Continued)

Iron and Steel Manufacturing Subcategories, Subdivisions, and Segments

Subpart/Subcategory	Subdivision	Segment
I. Acid Pickling	Sulfuric acid	Rod, wire, coil
		Bar, billet, bloom
		Strip, sheet, plate
		Pipe, tube, other
		Fume scrubber
	Hydrochloric acid	Rod, wire, coil
		Strip, sheet, plate
		Pipe, tube, other
		Fume scrubber
		Acid regeneration
	Combination acid	Rod, wire, coil
		Bar, billet, bloom
		Strip, sheet, plate - continuous
		Strip, sheet, plate - batch
		Pipe, tube, other
		Fume scrubber

Table 3-1 (Continued)

Iron and Steel Manufacturing Subcategories, Subdivisions, and Segments

Subpart/Subcategory	Subdivision	Segment
J. Cold Forming	Cold rolling	Recirculation: single stand
		Recirculation: multiple stands
		Combination
		Direct application: single stand
		Direct application: multiple stands
	Cold worked pipe and tube	Water solutions
		Oil solutions
K. Alkaline Cleaning	Batch	None
	Continuous	None
L. Hot Coating	Galvanizing, terne, and other metal coatings	Strip, sheet, and miscellaneous products
		Wire products and fasteners
	Fume Scrubbers	None

Table 3-2

Iron and Steel Manufacturing Processes
Pollutants Limited by 40 CFR Part 420

Pollutants	Cokemaking	Sintering	Ironmaking	Steelmaking	Vacuum Degassing	Continuous Casting	Hot Forming	Salt Bath Descaling	Acid Pickling	Cold Forming	Alkaline Cleaning	Hot Coating
Total Suspended Solids	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Oil & Grease	✓	✓				✓	✓		✓	✓	✓	✓
Ammonia-N	✓	✓	✓									
Total Cyanide	✓	✓	✓					✓				
Phenols (4AAP)	✓	✓	✓									
Total Metals												
Chromium									✓	✓		
Chromium +6								✓				✓
Lead		✓	✓	✓	✓	✓			✓	✓		✓
Nickel									✓	✓		
Zinc		✓	✓	✓	✓	✓		✓	✓	✓		✓
Toxic Organics												
Benzene	✓											
Benzo-a-pyrene	✓											
Naphthalene	✓									✓		
Tetrachloroethylene										✓		