EPA
United States
Environmental Protection
Agency

Development Document for Final Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category

April 2002

U.S. Environmental Protection Agency
Office of Water (4303T)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

EPA-821-R-02-004

United States
Environmental Protection
Agency

Development Document for Final Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category

EPA 821-R-02-004

Christine Todd Whitman
Administrator

G. Tracy Mehan, III
Assistant Administrator, Office of Water

Geoffrey H. Grubbs
Director, Office of Science and Technology

Sheila E. Frace
Director, Engineering and Analysis Division

Donald F. Anderson
Acting Chief, Chemical Engineering Branch

William Anderson and George Jett
Project Managers

Yu-Ting Guilaran
Project Engineer

Jade Lee-Freeman
Statistician

April 2002

U.S. Environmental Protection Agency, Office of Water
Washington, DC 20460

ACKNOWLEDGMENT AND DISCLAIMER

This report has been reviewed and approved for publication by the Engineering and Analysis Division, Office of Science and Technology. The Agency would like to acknowledge the contributions of the Engineering and Analysis Division staff toward the development of this technical document.

This report was prepared with the technical support of Eastern Research Group, Inc. and statistical support of Science Applications International Corporation (SAIC), under the direction and review of the Office of Science and Technology. Neither the United States Government nor any of its employees, contractors, subcontractors, or their employees make any warrant, expressed or implied, or assume any legal liability or responsibility for any third party's use of or the results of such use of any information, apparatus, product, or process discussed in this report, or represents that its use by such party would not infringe on privately owned rights.

The primary contact regarding questions or comments on this document is:

George Jett
U.S. EPA Engineering and Analysis Division (4303T)
1200 Pennsylvania Avenue NW
Washington, DC 20460

(202) 566-1070 (telephone)
(202) 566-1053 (fax)
jett.george@epa.gov

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

Page

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

Page

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

Page

SECTION 1

APPLICABILITY AND SUMMARY OF FINAL REGULATION

This section presents a brief overview of the Iron and Steel Category, discusses the applicability of the effluent limitations guidelines and standards for the category, and presents the applicability interface between the final rule and other regulations for the metals industry. This section also briefly summarizes the final rule and describes the Agency's efforts to protect confidential business information.

1.1 Applicability

The Iron and Steel Category comprises sites that produce raw materials used in ironmaking and steelmaking or produce finished or semifinished steel products. Operations include cokemaking, sintering, ironmaking, steelmaking, ladle metallurgy, vacuum degassing, continuous and ingot casting, hot forming, salt bath and electrolytic descaling, acid pickling, cold forming, alkaline cleaning, hot coating, direct-reduced ironmaking, briquetting, and forging.

Manufacturing operations that may be subject to the promulgated Iron and Steel rule are generally reported under one or more of the following North American Industry Classification System (NAICS) codes (Reference 1-1):

- 324199, Other Petroleum and Coal Products Manufacturing;
- 331111, Iron and Steel Mills;
- 331210, Iron and Steel Pipe and Tube Manufacturing from Purchased Steel;
- 331221, Rolled Steel Shape Manufacturing; and
- 332812, Metal coating, engraving (except jewelry and silverware), and allied services to manufacturers.

Specifically, the promulgated Iron and Steel effluent limitations guidelines and standards apply to wastewater discharges resulting from the following manufacturing operations:

- By-product recovery and other cokemaking operations manufacturing metallurgical coke (both furnace and foundry coke);
- Sintering, briquetting, and other beneficiation or agglomeration operations conducted by heating iron-bearing materials (e.g., iron ore, mill scale, blast furnace flue dust, blast furnace wastewater treatment sludge), limestone, coke fines, and other materials in a traveling grate combustion system to produce a beneficiate or agglomerate for charging to a blast furnace;

- Ironmaking operations in which iron ore and other iron-bearing materials are reduced to molten iron in a blast furnace;

- Direct-reduced ironmaking in which iron pellets are produced through a reaction of iron ore with hot reducing gases;

- Basic oxygen furnace (BOF) steelmaking, ladle metallurgy, vacuum degassing, and continuous casting operations at integrated steel mills. The rule also applies to BOF steelmaking conducted at any location;

- Electric arc furnace (EAF) steelmaking, ladle metallurgy, vacuum degassing and continuous casting operations conducted at non-integrated steel mills. The final rule also applies to EAF steelmaking conducted at any location;

- Hot forming operations conducted at integrated steel mills, non-integrated steel mills, and stand-alone hot forming mills;

- Steel forging operations performed at iron and steel mills; and

- Carbon, alloy, and stainless steel finishing operations, including salt bath and electrolytic sodium sulfate descaling, acid pickling, cold forming, alkaline cleaning, hot coating and continuous annealing at integrated, non-integrated, and stand-alone facilities.

1.2 **<u>Applicability Interface With Other Regulations</u>**

Several existing regulations currently establish effluent limitations guidelines and standards for the metals industry. Regulations covering nonferrous materials, including aluminum forming (40 CFR Part 467), copper forming (40 CFR Part 468), nonferrous metals manufacturing (40 CFR Part 421), and nonferrous metals forming (40 CFR Part 471) do not interface with the effluent limitations guidelines and standards promulgated for the Iron and Steel Category. Regulations that cover ferrous materials, however, do interface with the final rule for the Iron and Steel Category.

For facilities with process operations in more than one category, National Pollutant Discharge Elimination System (NPDES) permit writers must use a building-block approach to develop technology-based effluent limitations. Similarly, pretreatment control authorities must use the combined wastestream formula (Reference 1-2) to develop pretreatment requirements for facilities with process operations in more than one category. Permit writers and control authorities should refer to the applicability statements of the regulations for further clarification.

1.2.1 Electroplating

Facilities that are covered by the Electroplating Category and discharge to a publicly owned treatment works (POTW) are regulated under 40 CFR Part 413. This category comprises indirect discharging job shop electroplating and independent printed circuit board manufacturers that were in operation prior to July 15, 1983. The electroplating rule specifically excludes continuous strip electroplating operations conducted at indirect discharging iron and steel facilities; therefore, the electroplating rule does not overlap with the final Iron and Steel rule.

1.2.2 Metal Finishing

Wastewater discharges from facilities within the Metal Finishing Category are regulated under 40 CFR Part 433. This category comprises facilities that perform any of the following six metal finishing operations on any basis material: electroplating, electroless plating, anodizing, coating (chromating, phosphating, and coloring), chemical etching and milling, and printed circuit board manufacturing. The Metal Finishing rule establishes effluent limitations guidelines and standards for 40 surface treatment operations at facilities within this category.

1.2.3 Coil Coating

Wastewater discharges from facilities within the Coil Coating Category are regulated under 40 CFR Part 465. Coil coating facilities typically clean, conversion coat, and apply organic polymeric materials (such as paint) to continuous strips of metal coil (typically steel, galvanized metal, or aluminum). The Coil Coating Category comprises facilities that perform at least two of these three operations. The Iron and Steel rule is not intended to regulate mild acid or mild alkaline cleaning operations conducted at coil coating facilities, nor is it intended to regulate conversion coating or the application of organic polymeric material to steel; therefore, the promulgated Iron and Steel rule does not overlap with the Coil Coating rule.

1.2.4 Ferroalloy Manufacturing

Wastewater discharges from facilities Within the Ferroalloy Manufacturing Category are regulated under 40 CFR Part 424. This category comprises facilities that smelt ferroalloys in electric furnaces or other devices with wet air pollution control, recover and process furnace slag, produce calcium carbide in covered electric furnaces with and without wet air pollution control and manufacture electrolytic manganese products and electrolytic chromium products. A ferroalloy is an iron-bearing product, not within the range of those products called steel, which contains a considerable amount of one or more alloying elements, such as manganese, silicon, phosphorus, vanadium, and chromium. The Iron and Steel Category does not cover any ferroalloy manufacturing operations.

1.2.5 Metal Molding and Casting

Wastewater discharges from facilities within the Metal Molding and Casting Category are regulated under 40 CFR Part 464. This category comprises facilities that remelt, mold, and cast aluminum, copper, zinc, and ferrous metals and alloys into intermediate or finished products. The Iron and Steel rule does not overlap with the Metal Molding and Casting rule.

1.3 <u>Summary of Proposed Regulation</u>

On October 31, 2000, the EPA Administrator signed proposed revisions to technology-based effluent limitations guidelines and standards for wastewater discharges from new and existing iron and steel facilities. The proposed rule was published in the Federal Register on December 27, 2000 (65 FR 81964). EPA proposed to alter the applicability and scope of the existing rule by adding electroplating operations and by including direct iron reduction, briquetting, and forging operations. In addition, EPA proposed excluding from the iron and steel guideline in Part 420 some wire, cold forming, and hot dip coating operations. In a proposed rule for the Metal Products and Machinery (MP&M) industrial category published on January 3, 2001 (66 FR 424), EPA proposed to address these operations under Part 438.

The Agency proposed to revise the subcategorization scheme to create seven subcategories of iron and steel facilities based on co-treatment of compatible waste streams. This would have replaced the present structure of 12 subcategories. The proposed subcategorization approach would have reflected the way treatment systems are run in the iron and steel industry. EPA proposed the following seven subcategories:

Subpart	Subcategory	Segment
Subpart A	Cokemaking Subcategory	By-product Non-recovery
Subpart B	Ironmaking Subcategory	Blast Furnace Sintering
Subpart C	Steelmaking Subcategory	
Subpart D	Integrated and Stand-Alone Hot Forming Mills Subcategory	Carbon and Alloy Stainless
Subpart E	Non-Integrated Steelmaking and Hot Forming Operations Subcategory	Carbon and Alloy Stainless
Subpart F	Steel Finishing Subcategory	Carbon and Alloy Stainless
Subpart G	Other Operations Subcategory	Direct-Reduced Ironmaking Forging Briquetting

For most of the subcategories, except for cokemaking, finishing, and the newly added subcategory for other operations, the Agency proposed limits based on improved performance and operation of the same technologies that were the basis for the limits and standards promulgated in 1982 and amended in 1984. Consequently, the proposed limitations were more stringent than the limitations promulgated in 1982. For the cokemaking subcategory, EPA proposed BAT limits based on a technology option that was essentially the same as the 1982 technology basis but included an additional treatment step -- alkaline chlorination. For finishing, EPA proposed limits based on the 1982 technology basis with the addition of counter-current rinsing and acid purification.

For many of the proposed subcategories, wastewater flow reduction steps, in concert with better performance of the blowdown treatment systems, provided the primary basis for the proposal limits and standards. The proposed rule included the following features:

- EPA proposed two different BAT approaches for the carbon and alloy segment of the integrated and stand-alone hot forming subcategory. The options differed in the amount of time that facilities in the segment would have to achieve BAT limitations. Under one option, a facility would be subject to BAT limitations as soon as these limitations are placed in the NPDES permit. Under the other option, a facility could obtain additional time to achieve BAT limitations.

- The Agency proposed zero discharge as NSPS for the non-integrated steelmaking and hot forming subcategory.

- EPA considered defining a reasonable measure of actual production for calculating NPDES and pretreatment permit production rates.

- EPA proposed regulating, among others, mercury and selenium based on toxicity and presence in cokemaking wastewater.

- EPA proposed regulating 2,3,7,8-tetrachlorodibenzofuran (2,3,7,8-TCDF) in sinter plant wastewater and requiring compliance monitoring either after the primary treatment of sinter plant wastewater or after sinter plant and blast furnace wastewater discharges are cotreated, but before sinter plant wastewater is combined with any other process or non-process discharges.

- EPA considered developing a limit, based on acid purification technology or product substitution, for nitrate/nitrite (in the form of nitrate-nitrite-N) for stainless steel finishing operations with nitric acid and combination acid pickling.

- EPA considered waiving the pretreatment standards for ammonia as nitrogen for blast furnace wastewater indirectly discharged to POTWs that have the capability to conduct nitrification.

- EPA proposed revising the units of pollutant limitations from kilograms of allowable pollutant discharge per thousand kilograms of production (kg/kkg), also expressed as pounds of allowable pollutant discharge per thousand pounds of production (lbs/1,000 lbs), to pounds of allowable pollutant discharge per ton of production (lbs/ton).

- EPA proposed making the following revisions to the 1982 “Water Bubble” provision, but leaving the remainder unchanged:

  - Allow trades for cold rolling operations,

  - Allow trades for cokemaking operations, but only when more stringent limits result,

  - Prohibit trades for sintering operations when less stringent limits result, and

  - Prohibit trades for oil and grease.

- While the 1982 regulation often prompts permit writers and control authorities to apply pH limitations at internal discharge monitoring locations, prior to additional treatment or mixing with other wastewater discharges, the proposed rule allows permit writers and control authorities to establish pH effluent limitations at final outfalls such that redundant and unnecessary pH neutralization can be avoided.

The presentation in the remainder of this Technical Development Document will be organized around the proposed subcategorization scheme. The proposed subcategorization scheme was the basis on which EPA evaluated the technology options described and on which EPA made its final determinations regarding the content of the promulgated rule.

1.4 Summary of Final Regulation

EPA has decided to revise effluent limitations guidelines and standards only for current Subpart A (cokemaking), Subpart B (sintering), Subpart C (ironmaking), and Subpart D (steelmaking), and to promulgate new effluent limitations guidelines and standards for new Subpart M (other operations).

As a result of EPA’s technical and economic review, EPA is promulgating revised BAT limitations, NSPS and pretreatment standards for the cokemaking by-product recovery segment based on technologies that are different than those proposed. Specifically, EPA is promulgating effluent limits based primarily on ammonia still and biological treatment with nitrification for direct dischargers and pretreatment standards based primarily on ammonia still treatment for indirect dischargers.

For the cokemaking subcategory, today's rule combines the "iron and steel" and "merchant" segments into a newly-created "by-product recovery" cokemaking segment for most regulatory purposes, although EPA is retaining the "iron and steel" and "merchant" segments for purposes of reflecting the existing BPT limitations. EPA concluded that this was appropriate because the production processes, wastewater characteristics, and wastewater flow rates from all by-product recovery cokemaking operations, including merchant facilities, are similar.

EPA is also eliminating the segment in BAT for by-product coke plants with physical chemical treatment systems. EPA has determined that technology basis for BAT limitations promulgated in today's rule are technically and economically achievable for all direct discharging by-product coke plants.

EPA is not establishing limitations and standards for selenium, mercury, or thiocyanate, nor is it establishing pretreatment standards for phenol in cokemaking subcategory. EPA is establishing limitations for phenols (4AAP) in the cokemaking subcategory.

For the sintering subcategory, EPA is revising the current regulation to add limitations and standards for one additional pollutant, 2,3,7,8-TCDF, while keeping the rest of the limits unchanged. The technology basis for new TCDF limitations and standards for the sintering subcategory remains unchanged from the proposal and is the same as the technology basis for the 1982 regulations with the addition of mixed-media filtration. EPA is also establishing limitations of no discharge of process wastewater pollutants for new and existing direct dischargers and new and existing indirect dischargers for sintering operations with dry air pollution control systems.

EPA is codifying language providing that the ammonia as nitrogen pretreatment standards do not apply to cokemaking, ironmaking, and sintering facilities discharging to POTWs with nitrification capability.

For the steelmaking subcategory, EPA is revising BPT, BCT, BAT, and PSES limitations for the semi-wet basic oxygen furnace (BOF) operations to allow discharge of process wastewater, when merited by safety considerations. EPA is allowing discharge of process wastewater because certain safety concerns currently prevent some sites from balancing the water applied for BOF gas conditioning with evaporative losses to achieve zero discharge. Also in the steelmaking subcategory, for the semi-wet EAF operations, EPA is establishing limitations of no discharge of process wastewater pollutants for new direct dischargers and existing and new indirect dischargers, making these limitations equivalent to the previously promulgated BPT, BCT, and BAT limitations applicable to semi-wet electric arc furnace (EAF) operations. EPA identified none of the safety or production concerns discussed for semi-wet BOF operations.

EPA is establishing, as proposed, the limitations and standards for the Other Operations subcategory.

Due to the small number of subcategories affected by today's rule, the Agency has decided to retain the 1982 subcategory structure with the addition of an "other operations" subcategory. As a result, the final rule covers the following 13 subcategories:

Subcategory	Description
Subcategory A	Cokemaking (includes by-product and non-recovery operations)
Subcategory B	Sintering (includes wet and dry air pollution control operations)
Subcategory C	Ironmaking
Subcategory D	Steelmaking (includes basic oxygen furnace and electric arc furnace operations)
Subcategory E	Vacuum degassing
Subcategory F	Continuous casting
Subcategory G	Hot forming
Subcategory H	Salt bath descaling
Subcategory I	Acid pickling
Subcategory J	Cold forming
Subcategory K	Alkaline cleaning
Subcategory L	Hot coating
Subcategory M	Other operations (includes forging, direct-reduced ironmaking, and briquetting operations)

EPA is eliminating segments for the following obsolete operations: beehive cokemaking, ferromanganese blast furnaces, and open hearth furnaces.

EPA is promulgating the following revisions to the "Water Bubble" provision:

- Allow trades for cold rolling operations;
- Allow trades for cokemaking operations, but only when more stringent limits result;
- Allow trades for Subpart M operations;
- Prohibit trades for 2,3,7,8-TCDF;
- Eliminate the net reduction provision;

- Prohibit trades for oil and grease; and
- Allow trades for new as well as existing sources.

1.5 Protection of Confidential Business Information

EPA recognizes that certain data in the rulemaking record have been claimed as confidential business information (CBI). The Agency has withheld CBI from the public record in the Water Docket. In addition, the Agency has withhold from disclosure some data not claimed as CBI because the release of these data could indirectly reveal CBI. Furthermore, EPA has aggregated certain data in the public record, masked facility identities, or used other strategies to prevent the disclosure of CBI. The Agency's approach to CBI protection ensures that the data in the public record both explain the basis for the final rule and provide the opportunity for public comment, without compromising data confidentiality.

1.6 References

1-1 North American Industry Classification System, U.S. Office of Management and Budget. Washington, DC, 1997.

1-2 U.S. Environmental Protection Agency. Guidance Manual for the Use of Production-Based Pretreatment Standards and the Combined Wastestream Formula. Washington, DC, September 1985.

SECTION 2

BACKGROUND

This section provides background information on the development of revised effluent limitations guidelines and standards for the Iron and Steel Category. Sections 2.1 and 2.2 discuss the legal authority and legislative background for the rule. Section 2.3 presents references for the Iron and Steel Category rulemaking activities.

2.1 Legal Authority

EPA is revising effluent limitations guidelines and standards for the Iron and Steel Category under the authority of Sections 301, 304, 306, 307, 308, 402, and 501 of the Clean Water Act, 33 U.S.C. 1311, 1314, 1316, 1317, 1318, 1342, and 1361.

2.1.1 Legislative Background

Congress adopted the Clean Water Act (CWA) to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Section 101(a), 33 U.S.C. 1251(a)). To achieve this goal, the CWA prohibits the discharge of pollutants into navigable waters except in compliance with the statute. The CWA confronts the problem of water pollution on a number of different fronts. Its primary reliance, however, is on establishing restrictions on the types and amounts of pollutants discharged from various industrial, commercial, and public sources of wastewater.

Congress recognized that regulating only those sources that discharge effluent directly into the nation's waters would not be sufficient to achieve the goals of the CWA. Consequently, the CWA requires EPA to promulgate nationally applicable pretreatment standards that restrict pollutant discharges for those facilities that discharge wastewater indirectly through sewers flowing to publicly owned treatment works (POTWs) (Section 307(b) and (c), 33 U.S.C. 1317(b) and (c)). National pretreatment standards are established for wastewater pollutants that may pass through or interfere with POTW operations. Generally, pretreatment standards are designed to ensure that wastewater from direct and indirect industrial dischargers are subject to similar levels of treatment. In addition, POTWs are required to implement local treatment limits applicable to their industrial indirect dischargers to satisfy any local requirements (40 CFR 403.5).

Direct dischargers must comply with effluent limitations in National Pollutant Discharge Elimination System (NPDES) permits; indirect dischargers must comply with pretreatment standards. These limitations and standards are established by regulation for categories of industrial dischargers and are based on the degree of control that can be achieved using various levels of pollution control technology.

Best Practicable Control Technology Currently Available (BPT) -- Section 304(b)(1) of the CWA

In establishing the effluent limitations guidelines and standards for the Iron and Steel Category, EPA generally defines BPT effluent limitations for conventional, non-conventional, and priority pollutants. In specifying BPT, EPA looks at a number of factors. EPA first considers the cost of achieving effluent reductions in relation to the effluent reduction benefits. The Agency also considers the age of equipment and facilities, the processes employed and any required process changes, engineering aspects of the control technologies, non-water quality environmental impacts (including energy requirements), and other factors the Agency deems appropriate (CWA 304(b)(1)(B)). Traditionally, EPA establishes BPT effluent limitations based on the average of the best performances of facilities within the industry of various ages, sizes, processes, or other common characteristics. Where, however, existing performance is uniformly inadequate, EPA may require higher levels of control than currently in place in an industrial category if the Agency determines that the technology can be practically applied.

Best Conventional Pollutant Control Technology (BCT) -- Section 304(b)(4) of the CWA

The 1977 amendments to the CWA required EPA to identify effluent reduction levels for conventional pollutants associated with BCT technology for discharges from existing industrial point sources. In addition to other factors specified in Section 304(b)(4)(B), the CWA required that EPA establish BCT limitations after consideration of a two-part "cost reasonableness" test. EPA explained its methodology for the development of BCT limitations in July 1986 (51 FR 24974).

Section 304(a)(4) designates the following as conventional pollutants: biochemical oxygen demand, total suspended solids, fecal coliform, pH, and any additional pollutants defined by the Administrator as conventional. The Administrator designated oil and grease as an additional conventional pollutant on July 30, 1979 (44 FR 44501).

Best Available Technology Economically Achievable (BAT) -- Section 304(b)(2) of the CWA

In general, BAT effluent limitations guidelines represent the best economically achievable performance of facilities in the industrial subcategory or category. The factors considered in assessing BAT include the cost of achieving BAT effluent reductions, the age of equipment and facilities involved, the process employed, potential process changes, and non-water quality environmental impacts, including energy requirements. The Agency retains considerable discretion in assigning the weights of these factors. BAT limitations may be based on effluent reductions attainable through changes in a facility's processes and operations. As with BPT, where existing performance is uniformly inadequate, BAT may require a higher level of performance than is currently being achieved based on technology transferred from a different subcategory or category. BAT may be based upon process changes or internal controls, even when these technologies are not common industry practice.

New Source Performance Standards (NSPS) -- Section 306 of the CWA

NSPS reflect effluent reductions that are achievable based on the best available demonstrated control technology. New facilities have the opportunity to install the best and most efficient production processes and wastewater treatment technologies. As a result, NSPS should represent the most stringent controls attainable through the application of the best available control technology for all pollutants (that is, conventional, non-conventional, and priority pollutants). In establishing NSPS, EPA is directed to take into consideration the cost of achieving the effluent reduction and any non-water quality environmental impacts and energy requirements.

Pretreatment Standards for Existing Sources (PSES) -- Section 307(b) of the CWA

PSES are designed to prevent the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of POTWs. The CWA authorizes EPA to establish pretreatment standards for pollutants that pass through POTWs or interfere with treatment processes or sludge disposal methods at POTWs. Pretreatment standards are technology-based and analogous to BAT effluent limitations guidelines.

The General Pretreatment Regulations, which set forth the framework for the implementation of categorical pretreatment standards, are found at 40 CFR Part 403. Those regulations contain a definition of pass-through that address local rather than national instances of pass-through and establish pretreatment standards that apply to all non-domestic dischargers (see 52 FR 1586, January 14, 1987).

Pretreatment Standards for New Sources (PSNS) -- Section 307(c) of the CWA

Like PSES, PSNS are designed to prevent the discharges of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of POTWs. PSNS are to be issued at the same time as NSPS. New indirect dischargers have the opportunity to incorporate into their facilities the best available demonstrated technologies. The Agency considers the same factors in promulgating PSNS as it considers in promulgating NSPS.

2.1.2 Section 304(m) Requirements and Litigation

Section 304(m) of the CWA, added by the Water Quality Act of 1987, requires EPA to establish schedules for (1) reviewing and revising existing effluent limitations guidelines and standards; and (2) promulgating new effluent limitations guidelines and standards. On January 2, 1990, EPA published an Effluent Guidelines Plan (55 FR 80) that established schedules for developing new and revised effluent limitations guidelines and standards for several industry categories, one of which was the Iron and Steel Category.

The Natural Resources Defense Council (NRDC) and Public Citizen, Inc. filed suit against the Agency, alleging violation of Section 304(m) and other statutory authorities requiring promulgation of effluent limitations guidelines and standards (Reference 2-1). Under the terms of a consent decree dated January 31, 1992, which settled the litigation, EPA agreed to, among other things, conduct a study of the Iron and Steel industry. This study, which is discussed in Section 2.2.3 of this document, was completed in 1995. After the study, the Agency named the Iron and Steel rule as one of the rules to be developed under the consent decree. On November 18, 1998, the court approved modifications to the consent decree to revise the deadline for the Iron and Steel rule to October 2000 for proposal and April 2002 for final action.

2.2 History of Iron and Steel Category Rulemaking Activities

This section presents a brief history of Iron and Steel Category rulemaking activities. Section 2.2.1 discusses prior Iron and Steel Category wastewater discharge regulations. Section 2.2.2 discusses the current Iron and Steel rule. Section 2.2.3 discusses the Preliminary Study of the Iron and Steel Category. Section 2.2.4 discusses the Proposed Regulation, Section 2.2.5 the Notice of Data Availability, and Section 2.2.6 the Extension to the Public Comment Period.

2.2.1 Prior Regulations

On June 28, 1974, EPA promulgated effluent limitations for BPT and BAT, NSPS, and PSNS for basic steelmaking operations (Phase I) of the integrated steel industry (39 FR 24114-24133, 40 CFR Part 420, Subparts A-L). The regulation covered the following 12 subcategories of the industry:

- By-product cokemaking;
- Beehive cokemaking;
- Sintering;
- Blast furnace (iron);
- Blast furnace (ferromanganese);
- Basic oxygen furnace (semi-wet air pollution control methods);
- Basic oxygen furnace (wet air pollution control methods);
- Open hearth furnace;
- Electric arc furnace (semi-wet air pollution control methods);
- Electric arc furnace (wet air pollution control methods);
- Vacuum degassing; and
- Continuous casting and pressure slab molding.

In response to several petitions for review, the United States Court of Appeals for the Third Circuit remanded that regulation on November 7, 1975 (Reference 2-2). While the court rejected all technical challenges to the BPT limitations, it held that the BAT effluent limitations and NSPS for certain subcategories were “not demonstrated.” In addition, the court questioned the entire regulation on the grounds that EPA had failed to adequately consider the impact that plant age had on the cost or feasibility of retrofitting pollution controls, had failed to assess the impact of the regulation on water scarcity in arid and semi-arid regions of the country, and had failed to make adequate "net/gross" provisions for pollutants found in intake water supplies. The court also held that the "form" of the regulation was improper because the regulation did not provide "ranges" of limitations to be selected by permit issuers. This judgement, however, was amended (Reference 2-3).

On March 29, 1976, EPA promulgated BPT effluent limitations and proposed BAT effluent limitations, NSPS, and PSNS for steel forming and finishing operations (Phase II) within the steel industry (39 FR 12990-13030, 40 CFR Part 420, Subparts M-Z). The regulation covered the following 14 subcategories of the industry:

- Hot forming - primary;
- Hot forming - section;
- Hot forming - flat;
- Pipe and tube;
- Pickling - sulfuric acid - batch and continuous;
- Pickling - hydrochloric acid - batch and continuous;
- Cold rolling;
- Hot coating - galvanizing;
- Hot coating - terne;
- Miscellaneous runoff - storage piles, casting, and slagging;
- Combination acid picking - batch and continuous;
- Scale removal - Kolene and Hydride;
- Wire pickling and coating; and
- Continuous alkaline cleaning.

The U.S. Court of Appeals for the Third Circuit remanded that regulation on September 14, 1977 (Reference 2-4). While the court again rejected all technical challenges to the BPT limitations, it again questioned the regulation in regard to the age/retrofit and water scarcity issues. In addition, the court invalidated the regulation for lack of proper notice to the specialty steel industry and directed EPA to reevaluate its cost estimates in light of "site-specific costs" and reexamine its economic impact analysis. The court also held that the Agency had no statutory authority to exempt plants in the Mahoning Valley region of Eastern Ohio from compliance with the BPT limitations.

On January 28, 1981, the Agency promulgated General Pretreatment Regulations applicable to existing and new indirect dischargers within the Iron and Steel industry and other major industries (40 CFR Part 403, 47 FR 4518).

2.2.2 Current Regulation

On May 27, 1982, EPA promulgated effluent limitations for BPT, BAT, BCT, and NSPS, PSES, and PSNS for the Iron and Steel Category (47 FR 23258, 40 CFR Part 420). The regulation covered the following 12 subcategories of the industry:

- Cokemaking;
- Sintering
- Ironmaking;
- Steelmaking;
- Vacuum degassing;
- Continuous casting;
- Hot forming;
- Salt bath descaling;
- Acid pickling;
- Cold forming;
- Alkaline cleaning; and
- Hot coating.

The 1982 regulation was the first promulgated by EPA under the 1977 amendments to the CWA, and thus was the first to distinguish between conventional, non-conventional, and priority pollutants in the regulatory scheme established by the 1977 amendments.

The American Iron and Steel Institute, certain members of the Iron and Steel industry, and the NRDC filed petitions to review the 1982 regulation. Their challenges were consolidated into one lawsuit by the Third Circuit Court of Appeals (Reference 2-5). On February 4, 1983, the parties in the consolidated lawsuit entered into a comprehensive settlement agreement that resolved all issues raised by the petitioners. In accordance with the settlement agreement, EPA modified and clarified certain parts of the Iron and Steel rule and published additional preamble language regarding the rule.[1] The Iron and Steel rule was amended on May 17, 1984 (49 FR 21024). Some of the modifications made to the rule include the following:

- EPA included a method for calculating production-based pretreatment standards. This method largely mirrored the method given at 40 CFR 122.45(b)(2) for calculating production-based effluent limitations for direct dischargers.

- While the "Water Bubble" provision in the 1982 rule provided that the alternative effluent limitations established under the provision must result in *no increase* in the discharge of pollutants beyond that allowed by the generally applicable limitations, the provision was amended to provide that alternative effluent limitations must result in a specified *decrease* in the discharge of traded pollutants from the amount allowed by the generally applicable limitations.

---

[1] EPA also agreed to take final action on an amendment to the General Pretreatment Regulations (40 CFR Part 403) to permit the reclassification of noncontact cooling water flows contaminated with significant quantities of pollutants from "dilute" to "unregulated" for purposes of the combined wastestream formula at 40 CFR 403.6 (e).

- EPA included a provision that removal credits may be granted for phenols (4AAP) when used as an indicator or surrogate pollutant.

- BAT, NSPS, PSES, and PSNS effluent limitations and standards for lead and zinc were raised slightly in the ironmaking and sintering subcategories.

- EPA modified BAT effluent limitations and PSES for total cyanide and established a new segment for existing indirect blast furnace dischargers. The new segment contained standards identical to the generally applicable PSES except that the promulgated ammonia-N and phenols (4AAP) standards were less stringent.

- BPT, BAT, NSPS, PSES, and PSNS effluent limitations and standards for zinc were raised slightly in the sulfuric and hydrochloric acid pickling segments of the acid pickling subcategory.

- While the 1982 regulation limited all cold worked pipe and tube operations to zero discharge for BPT, BAT, BCT, NSPS, PSES, and PSNS, EPA modified the rule to permit nominal discharges (rather than contract hauling) of spent oil or water solution and to specify that limitations and standards for types of process wastewater not covered under the 1982 regulation were to be developed on a case-by-case basis.

- EPA modified effluent limitations and standards for zinc under the hot coating subcategory, provided that facilities achieving zinc discharge levels more stringent than the amended limitations and standards continued to do so. The amended rule also provided that the limitations could be used as a basis for determining alternative limitations under the "Water Bubble" provision, even for those facilities achieving discharge levels more stringent than the amended limitations and standards.

EPA temporarily excluded 21 facilities from the provisions of the 1982 rule due to economic considerations, provided the owner(s) or operator(s) of the facilities requested that the Agency consider establishing alternative effluent limitations and supplied EPA with information consistent with 40 CFR 420.01(b) on or before July 26, 1982.

2.2.3 Preliminary Study of the Iron and Steel Category

EPA was required by the terms of the 1992 consent decree with the NRDC to initiate preliminary reviews of a number of categorical effluent limitations guidelines and standards on a set schedule. In compliance with the requirement, EPA published the "Preliminary Study of the Iron and Steel Category" (EPA 821-R-95-037) in September 1995. The study included:

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

The study found that the Iron and Steel industry had evolved during the decade following the 1984 amendments to the Iron and Steel rule. The study found that the industry had made improvements in manufacturing techniques, water conservation, pollution prevention, and wastewater treatment practices. The study also found that the industry had consolidated and modernized in response to domestic and world competition. While integrated mills continued to decrease in size in response to changes in demand, the market for non-integrated mills using steel scrap as their primary material continued to expand due to improvements in the quality of steel manufactured from scrap. Cokemaking operations were declining due to changes in ironmaking processes, while direct-reduced ironmaking was increasing. Also, continuous casting became the new industry standard due to the increased energy efficiency of the process compared with piecemeal casting.

Overall, the study found that the industry was operating with greater efficiency. Pollutant loadings had decreased due to increased wastewater recycle rates on manufacturing processes and improved wastewater treatment processes. At the time of the study, many better-performing mills were discharging wastewater loadings far below the 1982 standards; however, not all of the industry had improved wastewater treatment or implemented proactive pollution prevention practices. At the time of the study, some mills continued to discharge in excess of the 1982 rule.

2.2.4 Proposed Regulation

On October 31, 2000, the EPA Administrator signed proposed revisions to technology-based effluent limitations guidelines and standards for wastewater discharges from new and existing iron and steel facilities. The proposed rule was published in the Federal Register on December 27, 2000 (65 FR 81964). EPA proposed to alter the applicability and scope of the existing rule by adding electroplating operations and by including direct iron reduction, briquetting, and forging operations. In addition, EPA proposed excluding from the iron and steel guideline in Part 420 some wiring, cold forming, and hot dip coating operations. In a proposed rule for the Metal Products and Machinery (MP&M) industrial category published on January 3, 2001 (66 FR 424) EPA proposed to address these operations under Part 438.

The Agency proposed to revise the subcategorization scheme to create seven subcategories of iron and steel facilities based on co-treatment of compatible waste streams. This would have replaced the present structure of 12 subcategories. The proposed subcategorization approach reflected the way treatment systems are generally run in the iron and steel industry. EPA proposed the following seven subcategories:

Subpart	Subcategory	Segment
Subpart A	Cokemaking Subcategory	By-product Non-recovery
Subpart B	Ironmaking Subcategory	Blast Furnace Sintering
Subpart C	Steelmaking Subcategory	
Subpart D	Integrated and Stand-Alone Hot Forming Mills Subcategory	Carbon and Alloy Stainless
Subpart E	Non-Integrated Steelmaking and Hot Forming Operations Subcategory	Carbon and Alloy Stainless
Subpart F	Steel Finishing Subcategory	Carbon and Alloy Stainless
Subpart G	Other Operations Subcategory	Direct-Reduced Ironmaking Forging Briquetting

For most of the subcategories, except for cokemaking, finishing, and the newly added subcategory for other operations, the Agency proposed limits based on improved performance and operation of the same technology basis used to establish limits and standards in the 1982 rule. Consequently, the proposed limitations were more stringent than the limitations promulgated in 1982. For the cokemaking subcategory, EPA proposed BAT limits based on a technology option that was essentially the same as the 1982 technology option but included an additional treatment step -- alkaline chlorination. For finishing, EPA proposed limits based on the 1982 technology basis with the addition of counter-current rinsing and acid purification.

For many of the proposed subcategories, wastewater flow reduction steps, in concert with better performance of the blowdown treatment systems, provided the primary basis for the proposal limits and standards. The proposed options were presented in the Federal Register at 65 FR 81968-69, December 27, 2000 and in the Proposed Technical Development Document (EPA-821-B-00-011) in Section 14 (Reference 2-6).

Additionally, the proposed regulation provided notice of EPA's intent to delist a number of obsolete manufacturing operations from Part 420. These operations are shut down, the equipment has generally been dismantled, and production is not likely to ever resume in the United States. These operations are Beehive Coke Ovens (Part 420.12 (c), Part 420.13 (c), Part 420.14 (c), Part 420.15 (c), 420.16 (c), and 420.17 (c)); Ferromanganese blast furnace (Part

420.32(b), Part 420.33(b), 420.34(b), 420.35(b), and 420.36(b)); and Open Hearth Furnace (420.42 (c), and 420.43(c), 420.44 (d), 420.45 (c), 420.46(d), and 420.47(d)).

The proposed regulation is available on line at: **www.epa.gov/ost/ironsteel/notices.html.**

2.2.5 Notice of Data Availability

On February 14, 2001, EPA published a Notice of Data Availability (NODA) at 66 FR 10253. This notice provided additional discussion and clarification on some of the issues raised in the proposal. For example, the notice discussed EPA's new finding that phenol does not pass through POTWs, and indicated that EPA was rethinking its proposal to establish a nation-wide limit on ammonia from steel finishing operations.

The NODA also provided notice of changes to certain portions of the proposed regulation and accompanying preamble to eliminate inconsistencies. Finally, it corrected potentially confusing typographical errors and extended the proposal's comment period from February 26, 2001 to March 26, 2001. The February NODA is located on line at: **www.epa.gov/ost/ironsteel/reg.html**.

2.2.6 Extension to Public Comment Period

On April 4, 2001, EPA published a notice (66 FR 17842) extending the comment period to April 25, 2001.

2.2.7 Public Outreach

Public outreach began early in the process for the re-visitation of Part 420. The Agency visited 37 mills in order to get a better understanding of the current state of the iron and steel industry. The two purposes of the preliminary visits were to get assistance on preparation of the 308 survey and to search for candidate sampling mills. We needed a better understanding on what kinds of questions we needed to ask, how to ask them, what kind of data was available, where, who to ask, and other useful information such as current performance levels of treatment systems. All this information was use to prepare an Information Collection Request (ICR), which contained the 308 survey questionnaires, for OMB review. The OMB approved the ICR on March 3, 1998 (OMB Control No. 2040-0193).

Once we began to receive the 1997 database from the survey responses, the Agency prepared some preliminary summary information, and held a series of public meeting with stakeholders to discuss data submitted. Significant meetings were held in both Washington, D.C. and Chicago during 1998, 1999, and 2000 to reach a larger audience. Many additional meetings were held with stakeholders to reach the regulated community and to seek technical advise from the industry. At these meetings we sought the advice of all stakeholders on what they believed needed to be revised with Part 420, how this should be done, and sought their assistance in achieving this goal. We often presented information on pollutants of concern, candidate treatment systems performance levels from better performing mills, and some preliminary estimates of attainability. On every occasion possible, some requested by the industry, some requested by the Agency staff, staff either went to the trade associations offices or participated via conference call to keep the dialogue open. These working session were essential to get a better understanding of their issues. At all meetings, the staff provided updates on the development of the study, exchanged ideas and, where appropriate, presented aggregate information to continue the dialogue.

The Agency also set up a website (**www.epa.gov/ost/ironsteel**) specifically to keep the public informed the about the development of the iron and steel regulation. The website contained background information on the purpose of the study, the current 1982 regulation, the preliminary study, all Federal Register notices related to this action, a complete copy of the ICR, news and stakeholder information such as minutes of meetings and action related to this activity, Agency contacts, links to trade associations, as well as other information. All documents presented at the public meetings were placed on the website and the website was kept up to date.

The Agency also invited many other stakeholders including members of the environmental community into our discussions. On some occasions, the Agency paid the travel of several stakeholders to attend these meeting in order to get input from all concerned stakeholders.

After the revised regulation was proposed, EPA continued to our outreach efforts. Staff presented aggregate information at several national conventions, held a public meeting on February 20, 2001, answered hundreds of phone calls. The staff completely complied with all written requests submitted by industry representative, within the bounds of 40 CFR Part 2, Subpart B, including providing plant-specific detailed costing when disclosure would not compromise confidential business information claims. The Agency made a special effort to keep the industry technical community involved since we felt it was essential to have their technical expertise available. We had a series of meetings in April 2001 and another in November 2001 to get a better understanding of their concerns with the proposed regulation. Every effort, within reason, was made to bring all stakeholders into the process to get a picture of the current iron and steel industry.

2.3 References

2-1 NRDC *et al.* v. Whitman, Civ. No. 89-2980 (D.D.C.).

2-2 American Iron and Steel Institute, et al. v. EPA, 526 F.2d 1027 (3d Cir. 1975).

2-3 American Iron and Steel Institute, et al. v. EPA, 560 F.2d 589 (3d Cir. 1977).

2-4 American Iron and Steel Institute, et al. v. EPA, 568 F.2d 284 (3d Cir. 1977).

2-5 National Steel Corp. v. EPA, No. 82-3225 and Consolidated Cases.

2-6 U.S. Environmental Protection Agency. Development Document for the Proposed Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category. EPA 821-B-00-011, Washington, DC, December 2000.

SECTION 3

DATA COLLECTION

EPA collected and evaluated information and data from various sources in the course of developing today's final effluent limitations guidelines and standards for the iron and steel industry. EPA used these data to develop the industry profile, to determine the applicability of the rule, to subcategorize the industry, and to determine wastewater characteristics, technology options, compliance costs, pollutant loading reductions, and non-water quality environmental impacts. This section discusses the following data collection activities:

- Base year, for developing industry characteristics (Section 3.1);
- Surveys, including descriptions of the survey instruments and determination of survey recipients (Section 3.2);
- Site visits, including descriptions of the types of sites visited, the geographical locations, and the manufacturing processes at the sites visited (Section 3.3);
- Sampling episodes, including the types of sites sampled, the manufacturing processes and treatment systems sampled, and the sampling process (Section 3.4);
- Other data sources (Section 3.5);
- Public participation, including meetings with stakeholders from industry trade associations, individual steel companies, environmental groups, and nongovernmental organizations (Section 3.6);
- Summary of post-proposal data collected, including data submitted with comments on the proposed rule and data requested by the Agency (Section 3.7); and
- References (Section 3.8).

3.1 <u>Base Year</u>

EPA's effluent limitations guidelines studies typically use a base year for developing the industry characteristics that provide the basis for consistent technical, economic, and environmental assessments. When the iron and steel study data gathering efforts were initiated, 1997 was the most current year for gathering relatively complete, accurate information on manufacturing processes, waste management practices, in-place wastewater treatment technology, wastewater characteristics, costs of wastewater management and treatment practices, production levels, and pollutant loadings as well as economic and financial conditions. EPA took a “snap-shot” of the industry to develop the costs for various wastewater treatment technology options, pollutant reduction benefits, and economic impacts for each option. Therefore, the impacts would correspond to the concurrent industry characteristics. As is the case for most effluent guidelines, for the final rule, EPA continued to use the base year information (from 1997) in its engineering analyses unless indicated otherwise. This is appropriate because it allows EPA to maintain a consistent database upon which to base its analyses.

3.2 Surveys

The principal source of information and data used in developing effluent limitations guidelines and standards is the industry response to surveys distributed by EPA under the authority of Section 308 of the Clean Water Act. EPA designed these surveys to obtain information concerning manufacturing operations, wastewater generation and treatment, discharge practices, and analytical data. The Agency also developed related surveys to obtain financial data for use in assessing economic impacts and the economic achievability of technology options.

EPA developed an Information Collection Request (ICR) entitled U.S. Environmental Protection Agency Collection of 1997 Iron and Steel Industry Data that explains the regulatory basis and intended use of the industry surveys. The Office of Management and Budget (OMB) approved the ICR in August 1998 (OMB Control No. 2040-0193, approval expired 08/31/2001) (Reference 3-1). The Agency published three Federal Register notices announcing:

(1) the intent to distribute the surveys (62 FR 54453; October 20, 1997);

(2) the submission of the ICR to the OMB (63 FR 16500; April 3, 1998); and

(3) OMB's approval of the ICR (63 FR 47023; September 3, 1998) (References 3-2 through 3-4).

The Agency consulted with industry trade associations and visited a number of sites to develop the survey instruments and to ensure an accurate mailing list.

EPA distributed four industry surveys:

- U.S. EPA Collection of 1997 Iron and Steel Industry Data (detailed survey);

- U.S. EPA Collection of 1997 Iron and Steel Industry Data (Short Form) (short survey);

- U.S. EPA Collection of Iron and Steel Industry Wastewater Treatment Capital Cost Data (cost survey); and

- U.S. EPA Analytical and Production Data Follow-Up to the Collection of 1997 Iron and Steel Industry Data (analytical and production survey).

In October 1998, EPA mailed the detailed survey to 176 iron and steel sites and the short survey to 223 iron and steel sites. EPA designed the detailed survey for those iron and steel sites that perform any iron and steel manufacturing process. Those sites include integrated and non-integrated steel mills, as well as sites that were initially identified as stand-alone cokemaking plants, stand-alone sinter plants, stand-alone direct-reduced ironmaking plants, stand-alone hot forming mills, and stand-alone finishing mills. The short survey is an abbreviated version of the detailed survey. It was designed for stand-alone iron and steel sites with the exceptions of those that received the detailed survey. EPA mailed the cost survey and the analytical and production survey to subsets of the facilities that received the detailed or short survey to obtain more detailed information on wastewater treatment system costs, analytical data, and facility production. EPA mailed the cost survey to 90 iron and steel sites and the analytical and production survey to 38 iron and steel sites.

The detailed and short surveys were divided into two parts: Part A: Technical Information and Part B: Financial and Economic Information. The “Part A” technical questions in the detailed survey comprised four sections, with Sections 3 and 4 being combined in the short survey, as follows:

- Section 1: General Site Information;

- Section 2: Manufacturing Process Information;

- Section 3: In-Process and End-of-Pipe Wastewater Treatment and Pollution Prevention Information; and

- Section 4: Wastewater Outfall Information.

The financial and economic information in Part B of the detailed survey also comprised four sections, as shown below:

- Section 1: Site Identification;
- Section 2: Site Financial Information;
- Section 3: Business Entity Financial Information; and
- Section 4: Corporate Parent Financial Information.

Part B of the short survey contained a single section for site identification and financial information. More detailed descriptions of financial data collection and analysis are included in the Economic Analysis of Final Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category (Reference 3-5).

The detailed survey requested detailed descriptions of all manufacturing processes and treatment systems on site. The short survey contained manufacturing process questions for only forming and finishing operations. EPA eliminated the cokemaking, ironmaking, and steelmaking questions from the short survey because those processes were not applicable to the facilities that received the short survey. The Agency also reduced the amount of detail requested in the short survey. EPA used the detailed descriptions of hot forming mills from the integrated, non-integrated, and stand-alone hot forming mills to make assumptions about industry trends.

Part A Section 1 requested site contacts and addresses and general information regarding manufacturing operations, age, and location. The Agency used this information to develop the proposed subcategorization and applicability statements.

Part A Section 2 requested information on products, types of steel produced, production levels, unit operations, chemicals and coatings used, quantity of wastewater discharged from unit operations, miscellaneous wastewater sources, flow rates, pollution prevention activities, and air pollution control. The Agency used these data to evaluate manufacturing processes and wastewater generation, to develop the model production-normalized flow rates, and to develop regulatory options. EPA also used these data to develop the proposed subcategorization and applicability and to estimate compliance costs and pollutant removals associated with the regulatory options EPA considered for the final rule.

Part A Section 3 requested detailed information (including diagrams) on the wastewater treatment systems and discharge flow rates, monitoring analytical data, and operating and maintenance cost data (including treatment chemical usage). The Agency used these data to identify treatment technologies-in-place, to determine regulatory options, and to estimate compliance costs and pollutant removals associated with the regulatory options considered for the final rule.

Part A Section 4 requested permit information, discharge locations, wastewater sources to each outfall, flow rates, regulated pollutants and limits, and permit monitoring data. EPA used this information to calculate baseline or current loadings for each facility. The Agency also used this information to calculate the pollutant loadings associated with the regulatory options considered for the final rule.

The cost survey requested detailed capital cost data on selected wastewater treatment systems installed since 1993, including equipment, engineering design, and installation costs. (EPA chose 1993 because 1997 was the base year for the detailed and short surveys, and this provided the Agency with a five year range for collecting cost data on recently installed treatment systems.) EPA incorporated these data into a costing methodology and used them to determine incremental investment costs and incremental operating and maintenance costs associated with the regulatory options considered for the final rule.

The analytical and production survey requested detailed daily analytical and flow rate data for selected sampling points, and monthly production data and operating hours for selected manufacturing operations. The Agency used the analytical data collected to estimate baseline pollutant loadings and pollutant removals from facilities with treatment-in-place similar to the technology options considered for the final rule, to evaluate the variability associated with iron and steel industry discharges, and to establish effluent limitations guidelines and standards. The Agency used the production data collected to evaluate the production basis for applying the proposal in National Pollutant Discharge Elimination System (NPDES) permits and pretreatment control mechanisms.

EPA mailed the iron and steel industry surveys by mail to facilities that were identified from the following sources:

- Association of Iron and Steel Engineers' 1997 and 1998 Directories: Iron and Steel Plants Volume 1, Plants and Facilities (Reference 3-6);
- Iron and Steel Works of the World (11th and 12th editions) directories (Reference 3-7);
- Iron and Steel Society's The Steel Industry of Canada, Mexico, and the United States: Plant Locations (Reference 3-8);
- Member lists from the following trade associations:
  - American Coke and Coal Chemicals Institute (Reference 3-9),
  - American Galvanizers Association (Reference 3-10),
  - American Iron and Steel Institute (Reference 3-11),
  - American Wire Producers Association (Reference 3-12),
  - Cold Finished Steel Bar Institute (Reference 3-13),
  - Specialty Steel Industry of North America (Reference 3-14),
  - Steel Manufacturers Association (Reference 3-15),
  - Steel Tube Institute of North America (Reference 3-16), and
  - Wire Association International (Reference 3-17);
- Dun & Bradstreet Facility Index Database (Reference 3-18);
- EPA's Permit Compliance System (PCS) Database (Reference 3-19);
- EPA's Toxic Release Inventory (TRI) Database (Reference 3-20);
- Iron and Steel Society's Iron and Steelmaker "Roundup" editions (Reference 3-21);
- 33 Metalproducing "Roundup" editions (Reference 3-22);
- 33 Metalproducing "Census of the North American Steel Industry" (Reference 3-23); and
- Thomas Register (Reference 3-24).

The Agency cross-referenced these sources with one another to develop a list of individual sites. Based on these sources, EPA identified 822 candidate facilities to receive surveys. These candidates include some steel finishing facilities that EPA may include in the Metal Products and Machinery (MP&M) Category under 40 CFR Part 438. To minimize the burden on the respondents, EPA grouped facilities into 12 strata. In general, EPA determined the strata based on its understanding of the manufacturing processes at each facility. Table 3-1 presents the stratification of the iron and steel industry for the surveys.

Depending on the amount or type of information EPA required for the rulemaking, EPA either solicited information from all facilities within a stratum (i.e., a census or "certainty" stratum) or selected a random sample of facilities within a stratum (i.e., statistically sampled stratum). EPA sent a survey to all facilities in the certainty strata (strata 5 and 8) because the Agency determined it was necessary to capture the size, complexity, or uniqueness of the steel operations at these sites. EPA also sent surveys to all facilities in strata 1 through 4 (all cokemaking sites, integrated steelmaking sites, and sintering and direct-reduced ironmaking sites) because of the relatively low number of sites in each stratum and because of the size, complexity, and uniqueness of raw material preparation and steel manufacturing operations at these sites. The Agency statistically sampled the remaining sites in strata 6, 7, and 9 through 12. EPA calculated survey weights for each selected facility based on the facility's probability of selection. If the Agency sent a survey to every facility in a stratum, each selected facility represents only itself and has a survey weight of one (1). For statistically sampled strata, each selected facility represents itself and other facilities within that stratum that were not selected to receive an industry survey. These facilities have survey weights greater than one (1). See Appendix A for more details.

Of the 822 candidate facilities, EPA mailed either a detailed survey or a short survey to 399 facilities.[1] Detailed survey recipients included integrated mills, non-integrated mills, stand-alone cokemaking sites, stand-alone sintering sites, stand-alone direct-reduced ironmaking sites, stand-alone hot forming sites, and stand-alone finishing sites. Short survey recipients included stand-alone cold forming sites, stand-alone pipe and tube sites, stand-alone hot dip coating sites, and stand-alone wire sites. Section 5 describes these types of sites. EPA received 378 completed surveys, including those from 33 sites that certified that they were not engaged in iron and steel activities. Eleven survey recipients did not respond and, thus, are considered nonrespondents. The non-respondents consisted of non-integrated sites, stand-alone pipe and tube sites, and stand-alone wire sites. Finally, EPA did not receive responses from another ten survey recipients: seven of these sites were closed (i.e., the surveys were undeliverable), two sites were considered part of a third site owned by the same company (i.e., responses regarding the operations from those two sites were included with the response for the third site), and one site received two surveys under two mailing addresses and completed only one survey.

---

[1] Before the surveys were actually mailed, the Agency notified potential survey recipients. One site, randomly selected from stratum 12 and notified that it would be receiving a survey, notified the Agency that it was not engaged in iron and steel activities. The Agency decided not to mail a survey to that site. Therefore, this site was not included in the 399 facilities receiving surveys.

One hundred fifty-four of the returned surveys were from sites with operations that were later determined to be within the proposed scope of the MP&M Category. Similarly, two recipients of MP&M surveys were determined to be within the scope of the Iron and Steel Category. Therefore, the Agency used the data from 191 returned surveys and the two MP&M industry surveys in the development of the final rule.

Once the Agency completed a review of the detailed and short surveys and defined the technology options, EPA identified survey respondents who had installed wastewater treatment systems in the last 10 years (since 1990) that were similar to the technology options and mailed them the cost survey. Of the 90 cost survey recipients, 88 returned completed surveys. EPA selected 38 facilities to receive the analytical and production survey who had indicated in the detailed or short survey that: (1) they had treatment trains similar to the treatment technology options, (2) they had collected analytical data for that treatment train, (3) they had a treatment train with a dedicated outfall from which EPA could evaluate performance, and (4) they did not add excessive dilution water to the outfall before sampling. All 38 analytical and production survey recipients returned completed surveys. EPA included in the public record all information and data collected in the surveys for which sites have not asserted claims of confidential business information under 40 CFR Part 2, Subpart B.

3.3 Site Visits

EPA conducted 67 site visits at iron and steel facilities in 19 states and Canada between January 1997 and June 1999. In response to comments received on the proposed rule, the Agency conducted an additional seven site visits at iron and steel facilities in five states between January and November 2001. Some of the additional site visits were to sites that had previously been visited by the Agency. Table 3-2 presents the number of sites visited in each state. However, sites that were visited more than once were not counted more than once.

The purpose of the site visits was to collect information about each site's manufacturing processes, water management practices, and treatment technologies, and to evaluate each facility for potential inclusion in the sampling program. EPA also used information collected during site visits to help develop the industry surveys. EPA selected sites to visit based on the type of site (as described in Section 5.1), the manufacturing operations at each facility, the type of steel produced (carbon, alloy, stainless), and the wastewater treatment operations. The Agency wanted to visit all types of iron and steel manufacturing operations as well as all types of wastewater treatment operations, including recently installed treatment systems. Before EPA received any completed surveys, the Agency used information collected from the sources used to develop the survey database to select sites to visit. After EPA evaluated the completed surveys, the Agency used information provided by the sites to select additional sites to visit. Table 3-3 summarizes the number of sites visited both before and after proposal for each type of site. However, sites that were visited more than once were not counted more than once.

EPA collected detailed information during each site visit on the manufacturing processes, wastewater generation, in-process treatment and recycling systems, wastewater management practices and pollution prevention, end-of-pipe treatment technologies, and, if the facility was a candidate for sampling, the logistics of collecting samples. The Agency observed the following manufacturing processes: coke plants, sinter plants, briquetting plants, blast furnaces, direct-reduced ironmaking plants, an iron carbide plant, basic oxygen furnaces, electric arc furnaces, vacuum degassers, ladle metallurgy stations, continuous and ingot casting facilities, hot forming mills (including forging mills), and cold forming mills. The Agency also observed acid pickling, descaling, and surface cleaning and coating operations (i.e., manufacturing lines or areas with acid cleaning, alkaline cleaning, annealing, electroplating, and/or hot dip coating operations). Table 3-4 summarizes the number of sites visited both before and after proposal that performed any of these manufacturing processes. However, sites that were visited more than once were not counted more than once.

EPA observed in-process wastewater treatment and recycling systems, pretreatment systems, and end-of-pipe wastewater treatment systems that were either dedicated to a manufacturing process or shared by multiple processes. The Agency observed the following wastewater treatment operations: biological treatment, metals precipitation, solids settling, alkaline chlorination, and filtration systems.

In response to comments received on the proposed rule, the Agency visited seven additional sites for the following reasons:

- Additional coke plants - To better understand coke plant wastewater sources and how flows might be reduced, and to review physical/chemical treatment and biofiltration at coke plants to understand the differences between these technologies and conventional activated sludge systems;

- Additional hot strip mill wastewater treatment systems - To determine modifications required to achieve the proposed BAT limitations; and

- Additional finishing operations - To assess rinsewater flow rates for finishing operations; to understand how finishing operation flow rates relate to product quality considerations; to determine typical flow control equipment and monitoring practices necessary to operate rinses effectively at finishing lines; and to collect investment cost and operating and maintenance cost data for flow controls and the installation of countercurrent rinse tanks on finishing lines.

EPA included in the public record all information and data collected during site visits for which sites have not asserted claims of confidential business information under 40 CFR Part 2, Subpart B.

3.4 Sampling

After evaluating information obtained during the site visits, EPA conducted wastewater sampling at 16 sites between June 1997 and June 1999. EPA selected these sites using the following criteria:

- The site performed operations either currently regulated under 40 CFR Part 420 or identified in the Preliminary Study or otherwise identified as iron and steel operations;
- The site performed high-rate recycling, in-process treatment, or end-of-pipe treatment operations that EPA believed may represent potential model pollutant control technology; and
- The site's compliance monitoring data indicated that it was among the better performing pollutant control systems in the industry, based on comparisons of monitoring data from other facilities with limits from the 1982 regulation in their permits.

In response to comments received on the proposed rule, EPA conducted wastewater sampling at four additional sites between November 2000 and April 2001. EPA selected these additional sites for the following reasons:

- As a collaborative effort between the American Iron and Steel Institute and EPA, to supplement the 1997/1998 sampling results by further characterizing raw sinter plant wastewater, specifically the amount of dioxins and furans generated by this industry, and to evaluate wastewater treatment system performance; and
- To further characterize untreated wastewater generated by continuous casting and hot forming operations at non-integrated steel mills.

Table 3-5 shows the type and number of manufacturing processes sampled during the EPA sampling program, both before and after proposal.

During the 16 initial sampling episodes, EPA collected samples of untreated process wastewater (treatment system influents), treatment system effluents, source water to characterize background concentrations, and other samples to characterize the performance of individual treatment units. During the additional four sampling episodes, EPA collected samples of untreated process wastewater (treatment system influents), treatment system effluents, and source water to characterize background concentrations. Table 3-6 summarizes all of the treatment systems sampled during the sampling program.

In general, the Agency collected 24-hour composite samples from wastewater sampling points each day of each sampling episode. Exceptions to this rule included samples collected for volatile organics analysis and oil and grease (O&G), which EPA collected as multiple grab samples over each 24-hour period (laboratory personnel composited the volatile organics samples before analysis, while EPA mathematically composited the O&G analytical results after the analyses were performed). EPA collected a one-time grab sample from each water source contributing to the manufacturing processes sampled. The Agency collected all waste oil and treatment system sludge samples as one-time grab samples.

EPA analyzed wastewater samples for up to approximately 300 analytes spanning the following pollutant classes: conventional, priority, and nonconventional pollutants, including metals, volatile organic compounds, semivolatile organic compounds, and dioxins and furans. Analyte selection was based on knowledge of the manufacturing processes and raw materials used. EPA generally collected samples using the following protocol:

- Five consecutive days of samples for conventionals, nonconventional and priority metals, and certain other nonconventional pollutants, including total suspended solids (TSS), total dissolved solid (TDS), chlorides, fluorides, sulfates, total organic carbon (TOC), chemical oxygen demand (COD), total Kjeldahl nitrogen (TKN), nitrate/nitrite, ammonia as nitrogen, and total phenols;

- Five consecutive days of samples from biological treatment systems for five-day biochemical oxygen demand (BOD$_5$) and five-day carbonaceous biochemical oxygen demand (CBOD$_5$);

- Five consecutive days of samples of cokemaking, blast furnace ironmaking, and sintering wastewater for total sulfide, thiocyanate, amenable cyanide, total cyanide, and weak acid dissociable (WAD) cyanide;

- Five consecutive days of samples of cokemaking wastewater for organics and dioxins/furans;

- Three days of samples, usually consecutive, of all noncokemaking wastewater for organics;

- Two days of samples, usually consecutive, of blast furnace ironmaking, sintering, and basic oxygen furnace steelmaking wastewater for dioxins/furans;

- Five consecutive days of samples from carbon and alloy steel finishing treatment systems containing chromium-bearing wastewater from electroplating or hot coating operations, and from stainless steel finishing treatment systems for hexavalent chromium; and

- On six occasions (one cokemaking plant, two sintering operations, one direct-reduced ironmaking plant, and two non-integrated steel mills), the Agency performed a one-day raw wastewater characterization sampling for pollutants of concern.

Table 3-7 shows the EPA analytical methods used and parameters analyzed for during the sampling program, the manufacturing processes for which the analyte or analyte group was analyzed, and the general frequency with which samples were collected during the sampling program. EPA analyzed one-time grab waste oil and sludge samples for metals, volatile and semivolatile organic compounds, total phenols, and dioxins/furans, depending on the treatment system from which they were collected. Table 3-8 lists the specific analytes included within the following analyte groups: dioxins/furans, metals, volatile organics, and semivolatile organics.

EPA used the analytical results from untreated samples to characterize the industry, develop the list of pollutants of concern, and develop raw wastewater characteristics. EPA used data from both untreated wastewater samples, intermediate treatment samples, and treated effluent samples to evaluate treatment system performance, develop pollutant loadings and removals, and develop the technology options for the iron and steel industry. EPA used data collected from treated effluent sampling points to calculate the long-term averages (LTAs) and limitations for each of the regulatory options considered for the final rule. During each sampling episode, EPA also collected flow rate data corresponding to each sample collected and production information from each associated manufacturing operation for use in calculating pollutant loadings and production-normalized flow rates. EPA included in the public record all information and data collected during sampling episodes for which sites have not asserted claims of confidential business information under 40 CFR Part 2, Subpart B, or that would not otherwise disclose confidential business information because of small strata sizes or previously released information.

3.5 Other Data Sources

EPA evaluated existing data sources to collect technical and financial information about the iron and steel industry, as discussed below.

The Agency collected technical information from iron and steel industry trade journals published from 1985 through 1997 as well as information from Iron and Steel Society conference proceedings. Trade journals included Iron and Steel Engineer, published by the Association of Iron and Steel Engineers (AISE) (Reference 3-25), Iron and Steelmaker, published by the Iron and Steel Society (ISS) (Reference 3-26), and New Steel (formerly Iron Age), published by Chilton Publications (Reference 3-27). EPA obtained the following types of information from these sources: storm-water and wastewater issues, new and existing wastewater treatment technologies, wastewater treatment and manufacturing equipment upgrades and installations, and company mergers, acquisitions, and joint ventures. EPA also used these sources to identify facilities for potential site visits.

EPA consulted the following publications: Census Manufacturers - Industry Series and Current Industrial Reports (U.S. Bureau of the Census) (References 3-28 and 3-29); World Steel Dynamics (Paine Webber) (References 3-30 through 3-36); and The Annual Statistical Report (American Iron and Steel Institute) (Reference 3-37). These sources provided a variety of financial information, ranging from aggregate data on employment and payroll to steel shipments by product, grade, and market.

The Agency performed searches on the following on-line databases: Pollution Abstracts, Water Resources Abstracts, Engineering Index, Material Business File, National Technical Information Service (NTIS), Enviroline, Compendex, and Metadex (References 3-38 through 3-45) to collect information on wastewater treatment technology and pollution prevention practices used in the iron and steel industry. The Agency also searched EPA's TRI (Reference 3-20) and PCS databases (Reference 3-19) to determine what pollutants were reported by the industry. In addition, the Agency reviewed secondary sources, including data, reports, and analyses published by government agencies; reports and analyses published by the iron and steel industry and its associated organizations; and publicly available financial information compiled by both government and private organizations to collect additional financial information.

The Agency used the Fate of Priority Pollutants in Publicly Owned Treatment Works (Reference 3-46), commonly referred to as the “50-POTW Study,” as the primary source of POTW percent removal data, described in more detail in the POTW pass-through methodology in Section 12.2.2. However, the 50-POTW Study did not contain data for all pollutants subject to the pass-through analysis. Therefore, EPA obtained additional data from EPA’s National Risk Management Research Laboratory (NRMRL)’s Treatability Database (formerly called the Risk Reduction Engineering Laboratory (RREL) Treatability Database) (Reference 3-47). Finally, EPA used data submitted in comments on the proposal from POTWs that accept iron and steel wastewater to supplement the POTW pass-through analysis.

3.6 Public Participation

EPA encouraged participation of all interested parties throughout the development of the iron and steel category effluent limitations guidelines and standards. EPA conducted outreach with the following trade associations, which represent the vast majority of iron and steel facilities: American Iron and Steel Institute (AISI), Steel Manufacturers Association (SMA), Specialty Steel Industry of North America (SSINA), Cold Finished Steel Bar Institute (CFSBI), Wire Association International, Incorporated (WAI), American Wire Producers Association (AWPA), Steel Tube Institute of North America (STINA), American Galvanizers Association, Incorporated (AGA), and American Coke and Coal Chemicals Institute (ACCCI). EPA met on several occasions with various industry representatives to discuss aspects of the regulation development. EPA also participated in industry meetings and presented updates on the status of the regulation development.

Because some facilities affected by the revised rulemaking are indirect dischargers, the Agency made a concerted effort to consult with pretreatment coordinators and state and local entities who will be responsible for implementing the iron and steel regulation.

EPA sponsored five stakeholder meetings between December 1998 and January 2000. Four were held in Washington, D.C. and one was held in Chicago, Illinois. The primary objectives of the meetings were to present the Agency's thinking regarding the technology bases for the proposed revisions to 40 CFR Part 420 and to seek dialogue, discuss issues, and obtain new ideas from interested stakeholders, including industry representatives and members of environmental groups such as the Natural Resources Defense Council (NRDC), the Environmental Defense Fund (now Environmental Defense), Atlantic States Legal Foundation, Friends of the Earth, and Save the Dunes.

During the stakeholder meetings, EPA presented process flow diagrams showing preliminary technology options and potential best management practices (BMPs) that may be incorporated into a revised Part 420 and/or included in NPDES permit and pretreatment guidance. The presentations were organized by type of manufacturing process. In addition to soliciting comments on the preliminary options, EPA requested ideas from the stakeholders to identify useful incentives for greater pollution control.

At the meetings, EPA encouraged participants to supplement their oral statements with written comments and supporting data. In that regard, EPA provided a set of data quality protocols for use when submitting data for the iron and steel rulemaking effort. This handout, along with all other handouts and meeting summaries, is posted on EPA's iron and steel industry web site at *http://www.epa.gov/OST/ironsteel/*. All of the materials presented at the stakeholder meetings, as well as meeting summaries and any written comments from participants not containing confidential business information, are also in the public record.

Following the publication of the proposal, the Agency held a pretreatment hearing and public meeting on February 20, 2001 in Washington, D.C. to summarize the proposed rulemaking, to provide answers to questions posed by the audience, and to listen to comments pertaining to the proposed pretreatment standards. During the public meeting portion, the Agency presented a summary of the proposal, including background information on the effluent guidelines, the purpose of the rule, the general applicability and interface with the MP&M rule, data collection activities, subcategorization, proposed technology options, proposed regulated pollutants, total costs and removals, general implementation, and economic impacts. Following the public meeting, the Agency held the pretreatment hearing. Two representatives from three of the major trade associations (AISI, SSINA, and SMA) provided orals comments. These comments are included in Section 12.2 of the Iron and Steel Administrative Record.

EPA met with members of ACCCI on February 6, 2001. During this meeting, members of the trade association presented general information on the merchant coke industry and information on the economic effects of increased imports, decreased demand for coke, new and continuing regulatory burdens in addition to this rule, and coke battery upgrades, repairs, and rehabilitation on the merchant coke industry. All of the materials presented at this meeting are included in Section 12.3.1 of the Iron and Steel Administrative Record.

Between April 20 and 26, 2001, the Agency met with members of SMA, SSINA, and AISI in a series of meetings over four days. During the meetings, EPA presented plots showing facility production-normalized flows for each subcategory and segment to complement discussions of the Agency's rationale for developing production-normalized flows. Industry representatives provided several handouts to complement discussions of issues related to alkaline chlorination design and performance, variability in cokemaking wastewater sources and volumes, variability in hot forming wastewater flow and intake water quality, and general stainless steel production processes. All of the materials presented at these meetings, as well as summaries of the meetings, are included in Section 12.3.2 of the Iron and Steel Administrative Record.

EPA met with members of ACCCI, AISI, SMA, and SSINA on November 15, 2001 as a follow-up to the April meetings. The intent of this meeting was to provide an overview of EPA activities subsequent to proposal in response to public comments. A summary of this meeting is included in Section 12.3.3 of the Iron and Steel Administrative Record.

All of the materials presented at all of the meetings following the publication of the proposal, as well as meeting summaries, data submitted, and any written comments from participants not containing confidential business information, are in the public record.

3.7 **<u>Summary of Post-Proposal Data Collected</u>**

EPA received 42 comments on the iron and steel proposal. From these comments, EPA obtained additional data and information from the industry and POTWs, including monitoring data and information related to cost of treatment and pass-through of pollutants at POTWs. Monitoring data submitted included the following:

- Five years of effluent data from a POTW that receives cokemaking wastewater;

- Three and a half years of average monthly influent data, effluent data, and the percent removal for ammonia and phenol from a POTW that receives cokemaking wastewater;

- A summary of aeration tank influent and effluent data and biofilter effluent data for thiocyanate from a POTW that receives cokemaking wastewater;

- A summary of existing effluent quality data for the nine merchant coke plants;

- One year of biweekly self-monitoring effluent data from a finishing treatment system without alkaline precipitation and ferric coprecipitation;

- One week of self-monitoring grab samples of the influent to and the effluent from a chromium (VI) reduction system; and

- A summary of influent and effluent pollutant concentrations and pollutant removal percent removal rates for all of the proposed regulated pollutants from a POTW that receives wastewaters from all of the subcategories.

EPA used these data to supplement its analyses and findings for the final rule.

The Agency also received comparisons of the industry estimates for costs to achieve the proposed BAT limitations and the estimates calculated by EPA for the nine merchant coke plants, two integrated mills, and a stand-alone cokemaking plant. Where appropriate, the Agency used these data to revise the cost estimates to achieve compliance with BAT.

The Agency requested and received self-monitoring data from six non-integrated steelmaking sites, ironmaking data from one integrated mill, and ammonia still influent data from two coke plants and effluent data from one coke plant. From the industry meetings following publication of the proposal, EPA received three years of monthly hot forming mill treatment plant effluent data (1998 to 2000) for zinc, five years of daily cokemaking treatment plant effluent data for thiocyanate, five years of discharge monitoring reports (DMR) data from a cokemaking treatment plant, and three years of DMR data from a cokemaking treatment plant as well as influent data for cyanide and selenium. EPA used these data to augment its datasets used to develop the model LTAs, to update the site-specific and average subcategory baseline pollutant concentrations, to further assess ammonia still operation, and to supplement other analyses and findings for the final rule.

All of the data submitted that do not contain confidential business information are in the public record.

3.8 References

3-1 U.S. Environmental Protection Agency. Information Collection Request, U.S. Environmental Protection Agency Collection of 1997 Iron and Steel Industry Data. EPA ICR 1830.01. Washington, DC, March 1998.

3-2 Agency Announcement of Information Collection Activities: 1997 Iron and Steel Industry Survey (EPA ICR No. 1830.01). Federal Register: October 20, 1997 (Volume 62, Number 202, Pages 54453-54454).

3-3 Agency Announcement of Information Collection Activities: Submission for OMB Review; Comment Request; Collection of 1997 Iron and Steel Industry Data (EPA ICR 1830.01). Federal Register: April 3, 1998 (Volume 63, Number 64, Pages 16500-16501).

3-4 Agency Information Collection Activities; OMB Responses. Federal Register: September 3, 1998 (Volume 63, Number 171, Page 47023-47024).

3-5 U.S. Environmental Protection Agency. Economic Analysis of Final Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category, EPA 821-R-02-006, Washington, DC, December 2000.

3-6 Association of Iron and Steel Engineers. Directory: Iron and Steel Plants Volume 1, Plants and Facilities. Pittsburgh, PA, 1997 and 1998.

3-7 Iron and Steel Works of the World (11th and 12th edition). Metal Bulletin Books Ltd., Surrey, England, 1994 and 1997.

3-8 Iron and Steel Society. The Steel Industry of Canada, Mexico, and the United States: Plant Locations. Warrendale, PA, 1995.

3-9 American Coke and Coal Chemicals Institute. Member List. 1997.

3-10 American Galvanizers Association. Member List. 1997.

3-11 American Iron and Steel Institute. Member List. 1998.

3-12 American Wire Producers Association. Member List. 1997.

3-13 Cold Finished Steel Bar Institute. Member List. 1997.

3-14 Specialty Steel Industry of North America. Member List. 1997.

3-15 Steel Manufacturers Association. Member List. 1997.

3-16 Steel Tube Institute of North America. Member List. 1997.

3-17 Wire Association International. Member List. 1997.

3-18 Dun & Bradstreet. Facility Index Database. 1997.

3-19 U.S. EPA. Permit Compliance System (PCS) Database.

3-20 U.S. EPA. Toxic Release Inventory (TRI) Database. 1995.

3-21 Iron and Steel Society. Iron and Steelmaker, “Roundup: Electric Arc Furnace,” May 1996 and May 1997; “Roundup: Blast furnace,” August 1996 and August 1997; “Roundup: Continuous Caster,” November 1996 and November 1997.

3-22 33 Metalproducing. “Roundup.” Penton Publications, Cleveland, OH, May 1989 and May 1991.

3-23 33 Metalproducing. "Census of the North American Steel Industry." Penton Publications, Cleveland, OH, March 1996, July 1996, September 1996, October 1996, November 1996, and March 1997.

3-24 Thomas Register. Thomas Publishing Company, New York, NY, 1996.

3-25 Association of Iron and Steel Engineers (AISE). Iron and Steel Engineer. Pittsburgh, PA, 1985 through 1997.

3-26 Iron and Steel Society (ISS). Iron and Steelmaker. Warrendale, PA, 1985 through 1997.

3-27 New Steel (formerly Iron Age). Chilton Publications. 1985 through 1997.

3-28 U.S. Bureau of the Census. Census Manufacturers - Industry Series. 1992.

3-29 U.S. Bureau of the Census. Current Industrial Reports. 1992.

3-30 Paine Webber. World Steel Dynamics. "Steel's Thin-Slab/ Flat-Rolling Revolution: Provoking Changed." January 1996.

3-31 Paine Webber. World Steel Dynamics. "Steel Dynamics Inc. Progress Report." May 1996.

3-32 Paine Webber. World Steel Dynamics. "PriceTrack # 55." April 1997.

3-33 Paine Webber. World Steel Dynamics. "Trico Steel: Raising the Ante in Steel's Flat-Rolling Revolution." June 1997.

3-34 Paine Webber. World Steel Dynamics. " PriceTrack #56." August 1997.

3-35 Paine Webber. World Steel Dynamics. "Flat-Rolled Process-by-Process Costs." December 1997.

3-36 Paine Webber. World Steel Dynamics. "Long Product Process-by-Process Costs." December 1997.

3-37 American Iron and Steel Institute. The Annual Statistical Report. 1997.

3-38 Pollution Abstracts (on-line).

3-39 U.S. Geological Survey. Water Resources Abstracts (on-line).

3-40 Engineering Index (on-line).

3-41 Material Business File (on-line).

3-42 U.S. Environmental Protection Agency. National Technical Information Service (NTIS) (on-line).

3-43 Congressional Information Service, Inc. Enviroline (on-line).

3-44 Engineering Information, Inc. Compendex (on-line).

3-45 Cambridge Scientific Abstracts. Metadex (on-line).

3-46 U.S. Environmental Protection Agency. Fate of Priority Pollutants in Publicly Owned Treatment Works. EPA 440/1-82/303. Washington, DC, September 1982.

3-47 U.S. Environmental Protection Agency. National Risk Management Research Laboratory (NRMRL) Treatability Database Version 5.0. Cincinnati, OH, 1994.

3-48 U.S. Environmental Protection Agency. Preliminary Study of the Iron and Steel Category, 40 CFR Part Effluent Limitations Guidelines and Standards. EPA 821-R-95-037, Washington, DC, September 1995.

3-49 U.S. Environmental Protection Agency. Development Document for the Proposed Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category. EPA 821-B-00-011, Washington, DC, December 2000.

Table 3-1

Iron And Steel Industry Survey Strata

Stratum Number	Stratum Name	Number of Sites in Stratum	Number of Sites Receiving Surveys
1	Integrated steel sites with cokemaking	9	9
2	Integrated steel sites without cokemaking	12	12
3	Stand-alone cokemaking sites	16	16
4	Stand-alone direct-reduced ironmaking and sintering sites	5	5
5	Detailed survey certainty stratum (a)(b)	60	60
6	Non-integrated steel sites	69	40
7	Stand-alone finishing sites and stand-alone hot forming sites	54	35
8	Short survey certainty stratum (b)(c)(d)	13	13
9	Stand-alone cold forming sites (d)	62	37
10	Stand-alone pipe and tubes sites (d)	164	59
11	Stand-alone hot coating sites (d)	106	49
12	Stand-alone wire sites (d)	252	67
	Total	**822**	**402**

(a) This stratum includes facilities from strata 6 and 7.
(b) These strata each include data transferred from one site that received an MP&M survey.
(c) This stratum includes facilities from strata 9 through 12.
(d) These strata include returned surveys from the 154 sites with operations that were later determined to be within the scope of the proposed MP&M Category.

Table 3-2

Number of Sites Visited in Each State and in Canada

State	Number of Sites Visited
Alabama	7
Arizona	1
Arkansas	1
California	2
Canada	2
Illinois	6
Indiana	9
Kentucky	1
Louisiana	1
Maryland	2
Michigan	3
New York	2
Ohio	10
Oregon	1
Pennsylvania	12
South Carolina	1
Texas	2
Utah	2
Virginia	2
West Virginia	3

Table 3-3

Number of Sites Visited for Each Type of Site

Type of Site	Number of Sites Visited
Integrated mill with cokemaking	10
Integrated mill without cokemaking	10
Stand-alone cokemaking plant	15
Stand-alone sintering plant (a)	1
Stand-alone direct-reduced ironmaking plant (b)	1
Non-integrated mill	16
Stand-alone hot forming mill	1
Stand-alone finishing mill	11
Stand-alone pipe and tube mill	4
Stand-alone iron carbide mill	1

(a) EPA visited seven additional sintering plants at integrated mills.
(b) EPA visited one additional direct-reduced ironmaking mill at a non-integrated mill.

Table 3-4

Number of Sites Visited With Each Type of Manufacturing Process

Manufacturing Process	Number of Sites Visited with Each Type of Manufacturing Process
Cokemaking	25
Sintering	8
Briquetting	4
Blast furnace ironmaking	20
Direct-reduced ironmaking	2
Iron carbide	1
Basic oxygen furnace steelmaking	19
Electric arc furnace steelmaking	19
Vacuum degassing	18
Ladle metallurgy	34
Casting (a)	33
Hot forming (b)	36
Cold forming	34
Acid pickling or descaling	28
Surface cleaning and coating (c)	28

(a) Casting operations include ingot casting and continuous casting.
(b) Hot forming operations include hot rolling, forging, seamless pipe and tube, and butt-welded pipe and tube operations.
(c) Surface cleaning and coating operations include acid cleaning, alkaline cleaning, annealing, electroplating, and hot coating operations.

Table 3-5

Manufacturing Processes Sampled

Manufacturing Process	Number of Processes Sampled
Cokemaking	4
Sintering	4
Blast furnace ironmaking	3
Direct-reduced ironmaking	1
Basic oxygen furnace steelmaking	5
Vacuum degassing	2
Continuous casting	8
Hot forming (a)	9
Descaling	2
Acid pickling	7
Cold forming	5
Surface cleaning or coating (b)	4

(a) Hot forming operations sampled include hot rolling, seamless pipe and tube, and butt-welded pipe and tube operations.
(b) Surface cleaning and coating operations include acid cleaning, alkaline cleaning, annealing, electroplating, and hot coating operations.

Table 3-6

Treatment Systems Sampled

Treatment System	Treatment System Description	Samples Collected
1	Coke plant treatment system with ammonia stripping and biological treatment	Ammonia still influent, ammonia still effluent, biological treatment system effluent
2	Coke plant treatment system with ammonia stripping and biological treatment	Ammonia still influent, ammonia still effluent, biological treatment system effluent
3	Coke plant treatment system with ammonia stripping, biological treatment, and sand and granular activated carbon filtration	Flushing liquor, by-products recovery wastewater, equalization tank effluent, biological treatment system effluent, sand filter effluent, carbon filter effluent
4	Coke plant treatment system with ammonia stripping and biological treatment	Ammonia still influent, ammonia still effluent, biological treatment system effluent
5	Sinter plant treatment system	Sinter plant untreated wastewater, treatment system effluent
6	Sinter plant treatment and high-rate recycle system	Sinter plant untreated wastewater, treatment system effluent
7	Blast furnace and sinter plant treatment system	Sinter plant untreated wastewater, combined recycle water
8	Blast furnace and sinter plant blowdown treatment and high-rate recycle system	Blast furnace scrubber untreated wastewater, sinter plant scrubber untreated wastewater, blast furnace treatment blowdown, sinter plant treatment blowdown, combined final effluent, treatment system filter cake
9	Blast furnace treatment and high-rate recycle system	Blast furnace untreated wastewater, recycle wastewater, filter press sludge
10	Blast furnace treatment and high-rate recycle system	Blast furnace untreated wastewater, treatment system blowdown, treatment system filter cake
11	Direct-reduced iron treatment and high-rate recycle system	Clarifier influent, sand filter influent, treatment system effluent
12	Basic oxygen furnace treatment and high-rate recycle system	Basic oxygen furnace untreated wastewater, recycle water
13	Basic oxygen furnace blowdown treatment system	Classifier effluent, thickener effluent, treatment system effluent, vacuum filter cake

Table 3-6 (Continued)

Treatment System	Treatment System Description	Samples Collected
14	Steelmaking (vacuum degasser, continuous caster) treatment and high-rate recycle system	Vacuum degasser untreated wastewater, clarifier overflow, filter effluent, continuous caster untreated wastewater, treatment system effluent
15	Basic oxygen furnace treatment and high-rate recycle system	Basic oxygen furnace untreated wastewater, untreated gas cooling water, thickener overflow, drum filter sludge, filter press sludge
16	Steelmaking (basic oxygen furnaces, vacuum degasser, continuous casters) treatment and high-rate recycle system	Continuous caster untreated wastewater, vacuum degasser untreated wastewater, clarifier underflow, thickener underflow, treatment system blowdown
17	Continuous caster treatment and high-rate recycle system	Scale pit influent
18	Continuous caster treatment and high-rate recycle system	Scale pit influent
19	Continuous caster treatment and high-rate recycle system	Scale pit influent, treatment system effluent
20	Continuous caster treatment and high-rate recycle system	Continuous caster untreated wastewater, sand filter effluent
21	Continuous caster treatment and high-rate recycle system	Continuous caster scale pit influent, sand filter effluent
22	Continuous caster treatment and high-rate recycle system	Continuous caster untreated wastewater, treatment system effluent, scale pit waste oil
23	Hot strip mill treatment and high-rate recycle system	Hot strip mill untreated wastewater, treatment system effluent
24	Hot strip mill treatment and high-rate recycle system	Continuous caster untreated wastewater, vacuum degasser untreated wastewater, hot strip mill untreated wastewater, treatment system blowdown
25	Hot strip mill treatment and high-rate recycle system	Roughing mill untreated wastewater, finishing mill untreated wastewater, roughing mill sand filter effluent, finishing mill sand filter effluent, waste oil
26	Hot strip mill blowdown treatment and high-rate recycle system	Hot strip mill untreated wastewater, treatment system blowdown

Table 3-6 (Continued)

Treatment System	Treatment System Description	Samples Collected
27	Hot strip mill treatment and high-rate recycle system	Hot mill scale pit influent, treatment system effluent, scale pit waste oil
28	Hot mill treatment and high-rate recycle system	Hot mill untreated wastewater, treatment system effluent, blowdown treatment system effluent, scale pit waste oil
29	Hot strip mill treatment and high-rate recycle system	Sand filter influent, treatment system effluent
30	Oily wastewater treatment system	Oily wastewater influent, treatment system effluent
31	Plate mill treatment system	Scale pit influent, scale pit effluent, scale pit waste oil
32	Rolling mill treatment and high-rate recycle system	Scale pit influent
33	Rolling mill treatment and high-rate recycle system	Scale pit influent
34	Steel finishing chemical precipitation system	Acid pickling untreated wastewater, galvanizing untreated wastewater, sand filter influent, sand filter effluent
35	Steel finishing chemical precipitation system with chromium reduction pretreatment	Acid pickling untreated wastewater, chromium reduction pretreatment influent, chromium reduction pretreatment effluent, sand filter influent, sand filter effluent
36	Steel finishing chemical precipitation system with chromium reduction pretreatment	Acid pickling untreated wastewater, cold forming untreated wastewater, electrogalvanizing untreated wastewater, hot dip coating untreated wastewater, oily wastewater, chromium reduction pretreatment effluent, intermediate treatment, final effluent
37	Steel finishing chemical precipitation system	Acid pickling untreated wastewater, cold forming untreated wastewater, treatment system influent, treatment system effluent
38	Steel finishing chemical precipitation system with chromium reduction pretreatment	Acid pickling untreated wastewater, descaling untreated wastewater, chromium reduction pretreatment effluent, treatment system effluent
39	Steel finishing chemical precipitation system	Electroplating solution, treatment system influent, clarifier effluent, sand filter effluent

Table 3-6 (Continued)

Treatment System	Treatment System Description	Samples Collected
40	Steel finishing chemical precipitation system	Acid pickling untreated wastewater, oily wastewater, treatment system effluent
41	Steel finishing chemical precipitation system with oily wastewater pretreatment and chromium pretreatment	Continuous annealing untreated wastewater, alkaline cleaning untreated wastewater, electroplating untreated wastewater, hot dip coating untreated wastewater, acid pickling untreated wastewater, oily wastewater pretreatment influent, oily wastewater pretreatment effluent, chromium reduction pretreatment influent, chromium reduction pretreatment effluent, treatment system influent, treatment system effluent
42	Steel finishing chemical precipitation system	Acid pickling untreated wastewater, electrogalvanizing untreated wastewater, treatment system effluent

Table 3-7

Analytical Methods Used During Sampling Program

EPA Method	Parameter	Manufacturing Processes	Typical Sampling Frequency (Days/Episode)
160.2	Total suspended solids (TSS)	All	5
160.1	Total dissolved solids (TDS)	All	5
325.1, 325.2, or 325.3	Chlorides	All	5
340.1, 340.2, or 340.3	Fluorides	All	5
375.1, 375.3, or 375.4	Sulfates	All	5
150.1	pH	All	5
415.1	Total organic carbon (TOC)	All	5
410.1, 410.2, or 410.4	Chemical oxygen demand (COD)	All	5
351.1, 351.2, 351.3, or 351.4	Total Kjeldahl nitrogen (TKN)	All	5
353.1, 353.2, or 353.3	Nitrate/nitrite	All	5
350.1, 350.2, or 350.3	Ammonia as nitrogen	All	5
405.1 or 5210B	Five-day biochemical oxygen demand (BOD_5)	Cokemaking	5
405.1 or SM5210	Five-day carbonaceous biochemical oxygen demand ($CBOD_5$)	Cokemaking	5
1664	Hexane extractable material (oil and grease)	All	5
1664	Silica-gel treated hexane extractable material (total petroleum hydrocarbons)	All	5
420.1 or 420.2	Total phenols	All	5
376.1, 376.2, or D4658	Total sulfide	Cokemaking, blast furnace ironmaking, sintering	5
4500CN Part M	Thiocyanate	Cokemaking, blast furnace ironmaking, sintering	5

Table 3-7 (Continued)

EPA Method	Parameter	Manufacturing Processes	Typical Sampling Frequency (Days/Episode)
335.1, 335.2, and 1677	Cyanide (amenable), cyanide (total), and weak acid dissociable cyanide (WAD), respectively	Cokemaking, blast furnace ironmaking, sintering	5
1613B	Dioxins/furans	Cokemaking, blast furnace ironmaking, sintering, basic oxygen furnace steelmaking	2 (blast furnace ironmaking, sintering, basic oxygen furnace steelmaking) 5 (cokemaking)
218.4	Hexavalent chromium	Chromium-bearing electroplating and hot coating wastewater from carbon and alloy finishing operations, stainless steel finishing operations	5
1620	Metals	All	5
1624C	Volatile organics	All	3 5 (cokemaking)
1625C	Semivolatile organics	All	3 5 (cokemaking)

Table 3-8

Analytes Included Within Analyte Groups

DIOXINS/FURAN ANALYTES	
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	1,2,3,7,8-PENTACHLORODIBENZOFURAN
1,2,3,7,8-PENTACHLORODIBENZO-P-DIOXIN	2,3,4,7,8-PENTACHLORODIBENZOFURAN
1,2,3,4,7,8-HEXACHLORODIBENZO-P-DIOXIN	1,2,3,4,7,8-HEXACHLORODIBENZOFURAN
1,2,3,6,7,8-HEXACHLORODIBENZO-P-DIOXIN	1,2,3,6,7,8-HEXACHLORODIBENZOFURAN
1,2,3,7,8,9-HEXACHLORODIBENZO-P-DIOXIN	1,2,3,7,8,9-HEXACHLORODIBENZOFURAN
1,2,3,4,6,7,8-HEPTACHLORODIBENZO-P-DIOXIN	2,3,4,6,7,8-HEXACHLORODIBENZOFURAN
OCTACHLORODIBENZO-P-DIOXIN	1,2,3,4,6,7,8-HEPTACHLORODIBENZOFURAN
2,3,7,8-TETRACHLORODIBENZOFURAN	
METAL ANALYTES	
ALUMINUM	MANGANESE
ANTIMONY	MERCURY
ARSENIC	MOLYBDENUM
BARIUM	NICKEL
BERYLLIUM	SELENIUM
BORON	SILVER
CADMIUM	SODIUM
CALCIUM	THALLIUM
CHROMIUM	TIN
COBALT	TITANIUM
COPPER	VANADIUM
IRON	YTTRIUM
LEAD	ZINC
MAGNESIUM	

Table 3-8 (Continued)

VOLATILE ORGANIC ANALYTES	
ACRYLONITRILE	TRANS-1,4-DICHLORO-2-BUTENE
BENZENE	TRIBROMOMETHANE
BROMODICHLOROMETHANE	TRICHLOROETHENE
BROMOMETHANE	TRICHLOROFLUOROMETHANE
CARBON DISULFIDE	VINYL ACETATE
CHLOROACETONITRILE	VINYL CHLORIDE
CHLOROBENZENE	1,1-DICHLOROETHANE
CHLOROETHANE	1,1-DICHLOROETHENE
CHLOROFORM	1,1,1-TRICHLOROETHANE
CHLOROMETHANE	1,1,1,2-TETRACHLOROETHANE
CIS-1,3-DICHLOROPROPENE	1,1,2-TRICHLOROETHANE
CROTONALDEHYDE	1,1,2,2-TETRACHLOROETHANE
DIBROMOCHLOROMETHANE	1,2-DIBROMOETHANE
DIBROMOMETHANE	1,2-DICHLOROETHANE
DIETHYL ETHER	1,2-DICHLOROPROPANE
ETHYL CYANIDE	1,2,3-TRICHLOROPROPANE
ETHYL METHACRYLATE	1,3-BUTADIENE, 2-CHLORO
ETHYLBENZENE	1,3-DICHLOROPROPANE
IODOMETHANE	1,4-DIOXANE
ISOBUTYL ALCOHOL	2-BUTANONE
M-XYLENE	2-CHLOROETHYLVINYL ETHER
METHYL METHACRYLATE	2-HEXANONE
METHYLENE CHLORIDE	2-PROPANONE
o+p XYLENE	2-PROPEN-1-OL
TETRACHLOROETHENE	2-PROPENAL
TETRACHLOROMETHANE	2-PROPENENITRILE, 2-METHYL-
TOLUENE	3-CHLOROPROPENE
TRANS-1,2-DICHLOROETHENE	4-METHYL-2-PENTANONE
TRANS-1,3-DICHLOROPROPENE	

Table 3-8 (Continued)

SEMIVOLATILE ORGANIC ANALYTES	
ACENAPHTHENE	DY-N-OCTYL PHTHALATE
ACENAPHTHYLENE	DY-N-PROPYLNITROSAMINE
ACETOPHENONE	DIBENZO(A,H)ANTHRACENE
ALPHA-TERPINEOL	DIBENZOFURAN
ANILINE	DIBENZOTHIOPHENE
ANILINE, 2,4,5-TRIMETHYL-	DIETHYL PHTHALATE
ANTHRACENE	DIMETHYL PHTHALATE
ARAMITE	DIMETHYL SULFONE
BENZANTHRONE	DIPHENYL ETHER
BENZENETHIOL	DIPHENYLAMINE
BENZIDINE	DIPHENYLDISULFIDE
BENZO(A)ANTHRACENE	ETHANE, PENTACHLORO-
BENZO(A)PYRENE	ETHYL METHANESULFONATE
BENZO(B)FLUORANTHENE	ETHYLENETHIOUREA
BENZO(GHI)PERYLENE	FLUORANTHENE
BENZO(K)FLUORANTHENE	FLUORENE
BENZOIC ACID	HEXACHLOROBENZENE
BENZONITRILE, 3,5-DIBROMO-4-HYDROXY-	HEXACHLOROBUTADIENE
BENZYL ALCOHOL	HEXACHLOROCYCLOPENTADIENE
BETA-NAPHTHYLAMINE	HEXACHLOROETHANE
BIPHENYL	HEXACHLOROPROPENE
BIPHENYL, 4-NITRO	HEXANOIC ACID
BIS(2-CHLOROETHOXY)METHANE	INDENO(1,2,3-CD)PYRENE
BIS(2-CHLOROETHYL) ETHER	ISOPHORONE
BIS(2-CHLOROISOPROPYL) ETHER	ISOSAFROLE
BIS(2-ETHYLHEXYL) PHTHALATE	LONGIFOLENE
BUTYL BENZYL PHTHALATE	MALACHITE GREEN
CARBAZOLE	MESTRANOL
CHRYSENE	METHAPYRILENE
CROTOXYPHOS	METHYL METHANESULFONATE
DY-N-BUTYL PHTHALATE	N-DECANE

Table 3-8 (Continued)

SEMIVOLATILE ORGANIC ANALYTES (CONTINUED)	
N-DOCOSANE	PENTACHLOROPHENOL
N-DODECANE	PENTAMETHYLBENZENE
N-EICOSANE	PERYLENE
N-HEXACOSANE	PHENACETIN
N-HEXADECANE	PHENANTHRENE
N-NITROSODI-N-BUTYLAMINE	PHENOL
N-NITROSODIETHYLAMINE	PHENOL, 2-METHYL-4,6-DINITRO-
N-NITROSODIMETHYLAMINE	PHENOTHIAZINE
N-NITROSODIPHENYLAMINE	PRONAMIDE
N-NITROSOMETHYLETHYLAMINE	PYRENE
N-NITROSOMETHYLPHENYLAMINE	PYRIDINE
N-NITROSOMORPHOLINE	RESORCINOL
N-NITROSOPIPERIDINE	SAFROLE
N-OCTACOSANE	SQUALENE
N-OCTADECANE	STYRENE
N-TETRACOSANE	THIANAPHTHENE
N-TETRADECANE	THIOACETAMIDE
N-TRIACONTANE	THIOXANTHE-9-ONE
N,N-DIMETHYLFORMAMIDE	TOLUENE, 2,4-DIAMINO-
NAPHTHALENE	TRIPHENYLENE
NITROBENZENE	TRIPROPYLENEGLYCOL METHYL ETHER
o-ANISIDINE	1-BROMO-2-CHLOROBENZENE
o-CRESOL	1-BROMO-3-CHLOROBENZENE
o-TOLUIDINE	1-CHLORO-3-NITROBENZENE
o-TOLUIDINE, 5-CHLORO-	1-METHYLFLUORENE
p-CHLOROANILINE	1-METHYLPHENANTHRENE
p-CRESOL	1-NAPHTHYLAMINE
p-CYMENE	1-PHENYLNAPHTHALENE
p-DIMETHYLAMINOAZOBENZENE	1,2-DIBROMO-3-CHLOROPROPANE
p-NITROANILINE	1,2-DICHLOROBENZENE
PENTACHLOROBENZENE	1,2-DIPHENYLHYDRAZINE

Table 3-8 (Continued)

SEMIVOLATILE ORGANIC ANALYTES (CONTINUED)	
1,2,3-TRICHLOROBENZENE	2,3,6-TRICHLOROPHENOL
1,2,3-TRIMETHOXYBENZENE	2,4-DICHLOROPHENOL
1,2,4-TRICHLOROBENZENE	2,4-DIMETHYLPHENOL
1,2,4,5-TETRACHLOROBENZENE	2,4-DINITROPHENOL
1,2,3,4-DIEPOXYBUTANE	2,4-DINITROTOLUENE
1,3-DICHLORO-2-PROPANOL	2,4,5-TRICHLOROPHENOL
1,3-DICHLOROBENZENE	2,4,6-TRICHLOROPHENOL
1,3,5-TRITHIANE	2,6-DI-TER-BUTYL-P-BENZOQUINONE
1,4-DICHLOROBENZENE	2,6-DICHLORO-4-NITROANILINE
1,4-DINITROBENZENE	2,6-DICHLOROPHENOL
1,4-NAPHTHOQUINONE	2,6-DINITROTOLUENE
1,5-NAPHTHALENEDIAMINE	3-METHYLCHOLANTHRENE
2-(METHYLTHIO)BENZOTHIAZOLE	3-NITROANILINE
2-CHLORONAPHTHALENE	3,3’-DICHLOROBENZIDINE
2-CHLOROPHENOL	3,3’-DIMETHOXYBENZIDINE
2-ISOPROPYLNAPHTALENE	3,6-DIMETHYLPHENANTHRENE
2-METHYLBENZOTHIOAZOLE	4-AMINOBIPHENYL
2-METHYLNAPHTHALENE	4-BROMOPHENYL PHENYL ETHER
2-NITROANILINE	4-CHLORO-2-NITROANILINE
2-NITROPHENOL	4-CHLORO-3-METHYLPHENOL
2-PHENYLNAPHTALENE	4-CHLOROPHENYLPHENYL ETHER
2-PICOLINE	4-NITROPHENOL
2,3-BENZOFLUORENE	4,4’-METHYLENEBIS(2-CHLOROANILINE)
2,3-DICHLOROANILINE	4,5-METHYLENE PHENANTHRENE
2,3-DICHLORONITROBENZENE	5-NITRO-O-TOLUIDINE
2,3,4,6-TETRACHLOROPHENOL	7,12-DIMETHYLBENZ(A)ANTHRACENE

SECTION 4

ANALYTICAL METHODS AND BASELINE VALUES

This section describes the analytical methods associated with the concentration data used to develop the limitations and standards for the iron and steel industry. In today's rule, EPA is regulating only a subset of the pollutants discussed in this section. Depending on the subcategory and whether a facility is a direct or indirect discharger, the regulated pollutants are: ammonia as nitrogen, benzo(a)pyrene, oil and grease as hexane extractable material (HEM), naphthalene, phenols (4AAP), 2,3,7,8-tetrachlorodibenzofuran (TCDF), total cyanide, and total suspended solids (TSS). EPA has included discussion of other pollutants in this section because EPA used the data in its pollutants of concern analyses presented elsewhere in this document.

This section discusses the methods used to analyze the samples that EPA and the industry collected from iron and steel wastewater. Section 3 discusses these sampling efforts. This section also discusses how EPA used the results of its wastewater analyses for purposes of calculating the limitations and standards in today's rule (Section 14 describes the methodology used for those calculations).

Section 4.1 briefly describes baseline values for the pollutants and their importance. Section 4.2 describes the reporting conventions laboratories used in expressing the results of the analysis. Sections 4.3 and 4.4 further explain nominal quantitation limits and baseline values, respectively. Section 4.5 describes the specific analytical methods and the corresponding baseline value for pollutants used in EPA's pollutants of concern analyses and in developing the limitations and standards. Table 4-1 summaries the analytical methods and baseline values discussed in Section 4.5. This table also identifies each pollutant by Chemical Abstract Registry number, indicates whether the samples were collected by EPA or by industry, and lists the nominal quantitation value for the method used. Section 4.6 describes the requirements for laboratory analysis in compliance monitoring for today's regulations.

4.1 Explanation and Importance of Baseline Values

The database that EPA used to calculate the limitations and standards consists of two types of analytical data: 1) data collected and analyzed by EPA ("sampling episodes"), and 2) industry-supplied data ("self-monitoring episodes"). EPA consistently used the same method to analyze all samples for a particular pollutant, as shown in Table 4-1. The methods used for the industry-supplied data varied. Generally, industry used either EPA methods from Methods for Chemical Analysis of Water and Wastes (MCAWW) (Reference 4-1) or the American Public Health Association's Standard Methods for the Examination of Water and Wastewater (References 4-2 and 4-3).

As described further in Section 4.4, in using this database, EPA compared the reported concentrations for each pollutant to a baseline value. EPA used a single baseline value for each pollutant in these comparisons for both EPA sampling episodes and industry self-monitoring episodes. EPA used the nominal quantitation limits associated with the analytical methods employed in its sampling episodes as the basis for determining each "baseline value." EPA determined that this was appropriate because EPA consistently used a single method for each pollutant while industry used a range of different methods. Consequently, the baseline value for each pollutant generally is the nominal quantitation limit associated with the analytical method EPA used to analyze that pollutant in its sampling episodes.

In general, the term "nominal quantitation limit" describes the smallest quantity of an analyte that can be measured reliably with a particular analytical method. In some cases, however, EPA used a value lower than the nominal quantitation limit as the baseline value because submitted data demonstrated that reliable measurements could be obtained at a lower level. In a few instances, EPA concluded that the nominal quantitation limit for a specified method was less than the level that laboratories could reliably achieve. For those pollutants, EPA modified the nominal quantitation limit upward and used a higher value as the baseline value. Section 4.3 discusses these instances and the nominal quantitation limit for each pollutant further.

4.2 Reporting Conventions Associated with Analytical Results

Most of the analytical data were reported as liquid concentrations in weight/volume units (e.g., micrograms per liter (μg/L)). In a few instances, the results were provided in weight/weight solids units (e.g., milligrams per kilogram (mg/kg)). In those instances, EPA converted the solids results into weight/volume units by using a conversion factor based upon the percent of solids in the sample. In addition, EPA converted data supplied in weight/time units to weight/volume units.[1]

The laboratories expressed the result of the analysis either numerically or as "not quantitated"[2] for a pollutant in a sample. When the result is expressed numerically, then the pollutant was quantitated[3] in the sample. For example, for a hypothetical pollutant X, the result would be reported as "15 μg/L" when the laboratory quantitated the amount of pollutant X in the sample as being 15 μg/L. For the nonquantitated results for each sample, the laboratories reported a "sample-specific quantitation limit."[4] For example, for the hypothetical pollutant X, the result would be reported as "<10 μg/L" when the laboratory could not quantitate the amount of pollutant X in the sample. That is, the analytical result indicated a value less than the sample-specific quantitation limit of 10 μg/L, meaning the actual amount of pollutant X in that sample is

---

[1] Some facilities reported the results in lbs/day and included the flow rates for each day. EPA used this information to convert the results to mg/L.

[2] Elsewhere in this document and in the preamble to the rule, EPA refers to pollutants as "not detected" or "nondetected." This section uses the term "not quantitated" or "nonquantitated" rather than nondetected.

[3] Elsewhere in this document and in the preamble to the rule, EPA refers to pollutants as "detected." This section uses the term "quantitated" rather than detected.

[4] Elsewhere in this document and in the preamble to the rule, EPA refers to a "sample-specific quantitation limit" as a "sample-specific detection limit" or, more simply, as a "detection limit."

between zero (i.e., the pollutant is not present) and 10 μg/L. The sample-specific quantitation limit for a particular pollutant is generally the smallest quantity in the calibration range that can be measured reliably in any given sample. If a pollutant is reported as not quantitated in a particular wastewater sample, it does not mean that the pollutant is not present in the wastewater, merely that analytical techniques (whether because of instrument limitations, pollutant interactions or other reasons) do not permit its measurement at levels below the sample-specific quantitation limit.

In its calculations, EPA generally substituted the value of the reported sample-specific quantitation limit for each nonquantitated result. In a few cases when the sample-specific quantitation limit was less than the baseline value, EPA substituted the baseline value for the nonquantitated result. In a few instances when the quantitated value was below the baseline value, EPA considered these values to be nonquantitated in the statistical analyses and substituted the baseline value for the measured value. Section 4.3 further discusses these cases.

4.3 Nominal Quantitation Limits

Protocols used for determining nominal quantitation limits in a particular method depend on the definitions and conventions that EPA used at the time the method was developed. As stated previously, the nominal quantitation limit is the smallest quantity of an analyte that can be reliably measured with a particular method. The nominal quantitation limits associated with the EPA methods addressed in the following sections fall into three general categories. The first category includes Methods 1613B, 1625, and 1664, which use the minimum level (ML) definition as the lowest level at which the entire analytical system must give a recognizable signal and an acceptable calibration point for the analyte. The second category pertains specifically to Method 1620, and is explained in detail in Section 4.5.2. The third category pertains to the remainder of the methods, in which a variety of terms are used to describe the lowest level at which measurement results are quantitated. These include the classical wet chemistry methods and several EPA methods for the determination of metals and organics. In some cases (especially with the classical wet chemistry analytes), the methods are older (1970s and 1980s) and different concepts of quantitation apply. These methods typically list a measurement range or lower limit of measurement. The terms differ by method and, as discussed in subsequent sections, the levels presented do not always represent the lowest levels laboratories can currently achieve. For those methods associated with a calibration procedure, the laboratories demonstrated through a low point calibration standard that they were capable of reliable quantitation at method-specified (or lower) levels. In such cases, these nominal quantitation limits are operationally equivalent to the ML (though not specifically identified as such in the methods). In the case of titrimetric or gravimetric methods, the laboratory adhered to the established lower limit of the measurement range published in the methods. Section 4.5 presents details of the specific methods.

4.4 Comparisons to Baseline Values

EPA performed two types of comparisons of the concentration data to the baseline values. For the proposal, EPA performed a third type of comparison in which the metals (i.e., those measured by EPA Method 1620) and TSS baseline values were compared to the option long-term averages used to calculate the limitations and standards. However, for today's rule, EPA has not provided any limitations and standards for any metal and the TSS levels were high enough that it was not necessary to perform the comparison. Thus, only the two types of comparisons involving baseline values for today's rule are described below.

4.4.1 Individual Data Values

When the baseline value was based upon method-defined minimum levels of Methods 1613B, 1625, or 1664 (see Section 4.5.1), EPA compared the individual concentration values to the baseline values. For these methods, the baseline values are based upon MLs that were developed through interlaboratory studies to determine the lowest measurable level (Section 4.5.1 provides a more precise definition).

Before using the data measured by these methods, EPA compared each analytical result (i.e., quantitated value or sample-specific quantitation limit for a non-quantitated value) to the baseline value for the pollutant. The objective of this comparison was to identify any results reported below the method-defined ML of quantitation. Results reported below the method-defined ML were changed to the ML to ensure that all results used by EPA were quantitatively reliable. In addition, any quantitated value changed to the ML was also considered to be nonquantitated[5] in calculating the limitations and standards and in EPA's pollutants of concern analyses. In most cases, the quantitated values and sample-specific quantitation limits were equal to or greater than the baseline values. If EPA had data from multiple methods for a particular analyte (e.g., naphthalene) and one of those methods (e.g., 1625) had an ML, then EPA performed this comparison for all of the data for that analyte.

An example of this comparison: Suppose a facility's dataset had five values for HEM, of which two were nonquantitated with sample-specific quantitation limits of 2 mg/L and 6 mg/L and the remaining three values were quantitated at 4 mg/L, 25 mg/L, and 50 mg/L. In the comparison, EPA compared the baseline value of 5 mg/L for HEM to all five values of HEM in the facility's dataset. Because the sample-specific quantitation limit of 2 mg/L is less than 5 mg/L, EPA changed this sample-specific quantitation limit to 5 mg/L and considered the value to be a sample-specific quantitation limit (i.e., nonquantitated) rather than a quantitated value. Likewise, EPA changed the quantitated value of 4 mg/L to 5 mg/L. The remaining sample-specific quantitation limit of 6 mg/L and the two quantitated values of 25 mg/L and 50 mg/L remained the same because they were greater than the baseline value of 5 mg/L.

4.4.2 Assessment of Treatability of Influent

As explained in Section 14, in the "LTA test," EPA compared a multiple of the baseline value to influent concentrations to determine if the influent concentrations were at treatable levels for all pollutants. If the influent concentrations were determined to be below treatable levels, then the corresponding effluent data were excluded from the analyses.

---

[5] As explained in Appendix E, EPA applied different statistical assumptions to quantitated and nonquantitated results.

4.5 Analytical Methods

In developing the limitations and standards and in its pollutants of concern analyses, EPA generally used only data from analytical methods approved for compliance monitoring or those that EPA has used for decades in support of effluent limitations guidelines and standards development. (The remainder of this section refers to such methods as 'NPDES-approved'[6] or 'nonapproved.') Unless otherwise stated, Standard Methods references are based on the 18th edition, which is the edition currently approved for NPDES monitoring. Table 4-1 summarizes the analytical methods, the associated pollutants measured by the method, the nominal quantitation levels, and the baseline levels. The following subsections provide additional information supporting Table 4-1 which is located at the end of Section 4. (The subsections are listed in order by method number, except for Method 420 which is in Section 4.5.16.)

4.5.1 Methods 1613B, 1625, 1664 (2,3,7,8-TCDF, Benzo(a)pyrene, Naphthalene, Phenol, HEM)

As stated earlier, Method 1613B for dioxins, Method 1625 for semivolatile organic compounds, and Method 1664 for HEM[7] and silica gel treated n-hexane extractable material (SGT-HEM)[8] use the ML concept for quantitation of the pollutants measured by the methods. The ML is defined as the lowest level at which the entire analytical system must give a recognizable signal and an acceptable calibration point for the analyte. When an ML is published in a method, the Agency has demonstrated that at least one well-operated laboratory can achieve the ML, and when that laboratory or another laboratory uses that method, the laboratory is required to demonstrate, through calibration of the instrument or analytical system, that it can make measurements at the ML.

For these three NPDES-approved analytical methods, if a quantitated value or sample-specific quantitation limit was reported with a value less than the ML specified in a method, EPA substituted the value of the ML and assumed that the measurement was nonquantitated. For example, if the ML was 10 μg/L and the laboratory reported a quantitated value of 5 μg/L, EPA assumed that the concentration was nonquantitated with a sample-specific quantitation limit of 10 μg/L.

Of the analytes measured by these methods, today's rule includes limitations and standards for 2,3,7,8-TCDF (Method 1613B); benzo(a)pyrene and naphthalene (Method 1625); and HEM (Method 1664). None of the reported values from these methods were less than the ML; therefore, no substitutions were made to data from EPA's sampling episodes. However, in

---

[6] NPDES is the acronym for the National Pollutant Discharge Elimination System.

[7] As explained in Section 14.1, EPA excluded oil and grease data determined by analytical methods that required freon, an ozone depleting agent. Thus, this section does not describe those analytical methods.

[8] SGT-HEM measures nonpolar material (i.e., n-hexane extractable material that is not absorbed by silica gel). Method 1664 measures both oil and grease and nonpolar material.

calculating the limitations and standards for naphthalene, EPA also included data generated from Method 625 (see Section 4.5.14).

4.5.2 Method 1620 and 200.7 (Metals)

Method 1620 for metals determination uses the concept of an instrument detection limit (IDL), which is defined as “the smallest signal above background noise that an instrument can detect reliably.”[9] EPA used Method 1620 to determine metals in the samples collected during its sampling episodes. While Method 1620 is not an NPDES-approved method, it represents a consolidation of several NPDES-approved methods including Method 200.7 (inductively coupled plasma atomic emission (ICP) spectroscopy for trace elements) and Method 245.1 (mercury by cold vapor atomic absorption technique). Some industry-supplied results for chromium, lead, nickel, and zinc were determined by Method 200.7. Other industry-supplied results for metals were determined by Methods 239.2, 245.1, 3120B, and 3130B, as discussed in Sections 4.5.5 through 4.5.8.

Data reporting practices for Method 1620 analysis follow conventional metals reporting practices used in other EPA programs, in which values are required to be reported at or above the IDL. In applying Method 1620, each analytical laboratory participating in EPA’s data gathering efforts determines IDLs on a quarterly basis. The IDL is, therefore, laboratory-specific and time-specific. Although Method 1620 contains MLs, these MLs predate EPA’s recent refinement of the ML concept described in Section 4.3. The ML values associated with Method 1620 are based on a consensus reached by EPA and laboratories during the 1980s regarding levels that could be considered reliable quantitation limits when using Method 1620. These limits do not reflect advances in technology and instrumentation since the 1980s. Consequently, EPA used the IDLs as the lowest values for reporting purposes, with the general understanding that reliable results can be produced at or above the IDL.

The Agency used the Method 1620 ML values as the baseline values for the metal analytes, with the exception of lead. In Method 1620, lead has an ML of 5 μg/L for graphite furnace atomic absorption (GFAA) spectroscopy analysis; EPA determined, however, that it was not necessary to measure down to such low levels, and that lead could instead be analyzed by inductively coupled plasma atomic emission (ICP) spectroscopy. Consequently, for the purposes of EAD’s data gathering efforts, the required ML (and baseline value) for lead was adjusted to 50 μg/L. EPA used the laboratory-reported quantitated values and sample-specific quantitation limits, which captured concentrations down to the IDLs, in calculating the long-term averages for the pollutants of concern analyses.

4.5.3 Method 160.2, 209C, and 2540D (Total Suspended Solids)

Total suspended solids (TSS) was determined by Method 160.2 for samples collected by EPA and some samples collected by the industry. Industry also used Method 209C

---

[9] Keith, L.H., W. Crummett, J. Deegan, R.A. Libby, J.K. Taylor, G. Wentler. “Principles of Environmental Analysis,” Analytical Chemistry, Volume 55, 1983, Page 2217.

and 2540D to measure TSS. Methods 160.2 and 2540D are NPDES-approved and are essentially identical methods. While it is not currently NPDES-approved, Method 209C for TSS appears in the 15th and 16th editions of Standard Methods and was approved in the CFR in 1986. Since then, the method numbers have been updated in more recent editions of Standard Methods and in the CFR, but the analytical procedures in Method 209C are identical to those of Method 2540D. Therefore, EPA determined that the data from all three methods should produce similar results and thus are usable for the purposes of rulemaking development.

Because EPA used Method 160.2 for its sampling episodes, the Agency selected the nominal quantitation limit of 4 mg/L from Method 160.2 as the baseline value. In calculating the limitations and standards, EPA used the laboratory-reported quantitated values and sample-specific quantitation limits. For the proposal, if the option long-term average for TSS was less than the baseline value, EPA substituted the baseline value for the long-term average. In today's rule, the option long-term averages were at or above the baseline value and thus no substitutions were required.

4.5.4 Method 218.4 (Hexavalent Chromium)

For EPA sampling episodes, hexavalent chromium was determined by Method 218.4, an NPDES-approved procedure that utilizes atomic absorption for the determination of hexavalent chromium after chelation and extraction. In developing the option long-term averages for the pollutants of concern analyses, EPA included industry-supplied data for which industry did not cite the analytical methods used. Industry also supplied data determined by Method 3120B. Because of concerns about the use of this method (see Section 4.5.7), EPA excluded these data from the calculation of the option long-term averages for the pollutants of concern analyses.

In Method 218.4, the nominal quantitation limit or lower limit of the measurement range is 0.01 mg/L. Because EPA used this method, this nominal quantitation limit was used as the baseline value for all hexavalent chromium results.

4.5.5 Method 239.2 (Lead)

In its pollutants of concern analyses for lead, EPA included industry-supplied data from Method 239.2. This NPDES-approved method utilizes atomic absorption as the determinative technique to measure lead. Its nominal quantitation limit of 0.005 mg/L is expressed in the method as the lower limit of the measurement range.[10] For the pollutants of concern analyses, EPA used the baseline value of 0.05 mg/L from Method 1620 (see Section 4.5.2).

---

[10] This method refers to the lower value of the "optimum concentration range."

4.5.6 Method 245.1 (Mercury)

In developing the option long-term averages for the pollutants of concern analyses for mercury, EPA included industry-supplied data from Method 245.1. This NPDES-approved method utilizes cold vapor atomic absorption as the determinative technique to measure mercury. Its nominal quantitation limit of 0.0002 mg/L is expressed in the method as the lower limit of the measurement range.[11] The industry-supplied mercury data included results lower than the baseline value (see Section 4.5.2). EPA used these data as reported in its pollutants of concern analyses.

4.5.7 Method 3120B (Chromium and Hexavalent Chromium)

Industry-supplied results for chromium and hexavalent chromium were determined by Method 3120B, an inductively coupled plasma (ICP) method. Its nominal quantitation limit of 0.01 mg/L is cited in the method as the lower limit of the measurement range.

Method 3120B is NPDES-approved for chromium determination, and EPA included these data in calculating the chromium option long-term averages for the pollutants of concern analyses. None of the chromium data from Method 3120B had quantitated values or sample-specific quantitation limits lower than the baseline value of 0.01 mg/L from Method 1620 (see Section 4.5.2).

Because of EPA's concerns about the quality of the hexavalent chromium measurements from Method 3120B, EPA excluded these measurements from its pollutants of concern analyses. Method 3120B is used for determination of total metals (including chromium), but is not typically used for hexavalent chromium determination. It is technically possible to analyze for hexavalent chromium by this method if, during sample preparation, the hexavalent chromium is separated from other forms of chromium (i.e., Cr^{+3}). After proposal, EPA contacted the facility to determine if the appropriate procedures were followed in determining hexavalent chromium concentrations, and to determine if all quality assurance/quality control (QA/QC) criteria were met, but this information was not made available to EPA.

4.5.8 Method 3130B (Lead, Zinc)

Method 3130B was used to determine lead and zinc in some industry-supplied data. Method 3130B is an anodic stripping voltammetry (ASV) method that does not require sample digestion. EPA excluded these data in its pollutants of concern analyses because the associated laboratory reports and QA/QC data were not provided to EPA. This information was necessary to determine whether samples were acid digested to ensure that lead and zinc complexes were broken down to a detectable form and to reduce analytical interferences. Also, it was not possible to determine whether the results were associated with acceptable laboratory and matrix QA/QC. Furthermore, as there are no NPDES-approved ASV methods for the

---

[11] This method calls it a detection limit.

determination of lead or zinc in wastewater, EPA required additional information to assess whether application of the ASV method to wastewater effluents analyzed was appropriate (i.e., not subject to substantial interferences).

4.5.9 Method 335.2 (Total Cyanide)

EPA and industry determined total cyanide using Method 335.2, an NPDES-approved method. Method 335.2 uses either titrimetric or colorimetric procedures to measure total cyanide. In addition to these data, EPA used data from one facility that used Methods 335.3 and 335.4. Method 335.2 is manual; Method 335.3 is automated; and Method 335.4 uses different digestion. However, all three versions are similar and provide comparable results.

The nominal quantitation limit for Method 335.2 is expressed in the method as the lower limit of the measurement range.[12] Because EPA used Method 335.2, the Agency used its nominal quantitation limit of 0.02 mg/L as the baseline value for all total cyanide results. Although some laboratories have demonstrated that they can quantitate to lower levels, none of the total cyanide data determined from Method 335.2 had quantitated values or sample-specific quantitation limits lower than the baseline value.

For total cyanide, industry also used the NPDES-approved 4500-CN procedures for sample analysis. In the listings of data for the proposal, EPA has identified this procedure with three different references provided by industry: 4500-CNC; 4500 CN E; and 4500-CNE. Method 4500-CNC refers to the distillation process used to prepare samples for analysis, and Methods 4500 CN E and 4500-CNE refer to the colorimetric method of total cyanide determination. EPA compared the data determined from these analyses to the baseline value of 0.02 mg/L associated with the nominal quantitation limit from Method 335.2. These values were used as reported in calculating the limitations and standards.

4.5.10 Method 340.2 (Fluoride)

For samples collected by EPA, fluoride was determined by Method 340.2, an NPDES-approved potentiometric method that uses a fluoride electrode. Industry did not supply any additional data for this analyte. The nominal quantitation limit of 0.1 mg/L for Method 340.2 is expressed in the method as the lower limit of the measurement range.[13] This nominal quantitation limit was used as the baseline value for fluoride.

---

[12] The method states that it is "sensitive to about 0.02 mg/L for the colorimetric procedure; the titrimetric procedure is used for measuring concentrations above 1 mg/L;" hence, these values represent the lower limit of the measurement range.

[13] The method states that "Concentrations from 0.1... may be measured."

4.5.11 Methods 350.2, 417/350.2, and 4500-NH_3 (Ammonia as Nitrogen)

For EPA's sampling episodes, ammonia as nitrogen was determined by Method 350.2, an NPDES-approved method. Industry also supplied data determined by Methods 417/350.2 and 4500-NH_3.

Method 350.2 uses either colorimetric, titrimetric, or electrode procedures to measure ammonia. This method has a lower measurement range limit of 0.05 mg/L for the colorimetric and electrode procedures, and a lower measurement range limit of 1.0 mg/L for the titrimetric procedure. Rather than use different baseline values, EPA used 0.05 mg/L because it represented a value at which ammonia as N can be reliably measured by several determinative techniques in Method 350.2, as well as in other NPDES-approved methods.

One facility supplied concentration data and reported the method as '417/350.2.' Based on additional information received from the facility, the method utilized is equivalent to NPDES-approved Method 350.2; therefore, EPA included these data in its analyses.

Some facilities used the 4500-NH_3 procedure. In the listings of data, EPA has identified this procedure in four different ways: 4500-NH_3; 4500NH, BE; 4500NH_3-E; and 4500-NH_3F. With the exception of Method 4500-NH_3, which is a general method citation applicable to a group of specific methods, all these citations refer to NPDES-approved procedures for ammonia as nitrogen. 4500-NH_3-B refers to the primary distillation step performed prior to analysis. 4500-NH_3-E refers to the ammonia-selective electrode determinative technique, and 4500-NH_3-F refers to the spectrophotometric determination of ammonia by reaction with phenate.

EPA used the nominal quantitation limit of 0.05 mg/L derived from Method 350.2 as the baseline because this is the method associated with EPA's sampling episodes.

4.5.12 Methods 353.1, 353.2, and 353.3 (Nitrate/Nitrite)

Nitrate/nitrite can be determined by three NPDES-approved methods, each of which lists slightly different nominal quantitation limits that are expressed in the methods as the lower limit of the measurement range. Methods 353.1 and 353.2 are automated colorimetric procedures with quantitation limits of 0.01 and 0.05 mg/L, respectively. Method 353.3 is a cadmium reduction, spectrophotometric procedure with a nominal quantitation limit of 0.01 mg/L. In the pollutant of concern analyses, EPA established the baseline value as the Method 353.1 quantitation limit of 0.01 mg/L.

4.5.13 Methods 4500-CN M and D4374-98 (Thiocyanate)

EPA and industry used the 4500-CN M procedure in determining the concentrations of thiocyanate. In the listings of the data, EPA has identified this method in three ways: 4500-CN; 4500-CN M.; and 4500CN-M. EPA has confirmed that the associated data were all generated by Method 4500-CN M. The nominal quantitation limit for Method 4500-CN

M is cited in the method as the lower limit of the measurement range.[14] Because EPA used Method 4500-CN M, the Agency used its nominal quantitation limit of 0.1 mg/L as the baseline value for all thiocyanate results. None of the thiocyanate data had quantitated values or sample-specific quantitation limits lower than this baseline value.

Because there is no NPDES-approved method for thiocyanate, EPA proposed two consensus standards, Method 4500-CN M (Reference 4-3) and D4374-98 (Annual Book of ASTM Standards, Volume 11.02, 1999). Because EPA has not established any limitations for thiocyanate in today's rule, the D4374-98 consensus standard is not included in today's rule.

4.5.14 Methods 625 and 610 (Naphthalene)

In developing the limitations and standards for naphthalene, EPA included industry-supplied data from Method 625, an NPDES-approved GC/MS method for semivolatile organics. This method's nominal quantitation limit is expressed as the lower limit of the measurement range, typically the concentration of the lowest calibration standard. EPA selected 0.01 mg/L as the baseline value based on the ML for Method 1625 (see Section 4.5.1).

The industry-supplied naphthalene data from Method 1625 included quantitated values or sample-specific quantitation limits lower than the baseline value in developing the limitations and standards. EPA replaced these data with the value of the baseline value and assumed that the measurements were nonquantitated.

While none of today's data were determined by Method 610, it is an NPDES-approved method for naphthalene that is less susceptible to phenol interferences. In measuring for compliance with today's limitations and standards for naphthalene, if a facility has a problem with phenol in their wastewater, the laboratory can use the HPLC procedure in Method 610 to achieve the required sensitivity. Also, see Section 4.6.

4.5.15 Method 8270 (Benzo(a)pyrene)

Industry supplied benzo(a)pyrene data generated from Method 8270. Although Method 8270 is not NPDES-approved, EPA recognizes that a number of similarities exist between Method 8270 and NPDES-approved methods. The estimated quantitation limit of 10 μg/L for benzo(a)pyrene in Method 8270 is the same as Method 1625's ML which was used as the baseline value for this analyte. This is consistent with Method 625, which has an ML of 10 μg/L for benzo(a)pyrene. Many of the QC checks and procedures of Method 8270 are analogous to procedures utilized by NPDES-approved methods, Method 625 in particular. However, one major drawback for Method 8270 is that it only requires a subset of target analytes to be evaluated in the matrix spike, while Method 625 requires a full target analyte matrix spike. Furthermore, the calibration requirement in Method 8270 could be interpreted to mean that the calibration standard should be at or below the known or anticipated regulatory compliance level.

---

[14] The method lists this value as the lower limit under "application" in natural waters or wastewaters.

Because of these concerns, EPA contacted the facility for more information about its laboratory analyses. As explained in the proposal technical development document, EPA could only reconsider its decision to exclude these data pending a full review of the laboratory reports, including initial precision and recovery (IPR) analyses, instrument tunes, calibrations, blanks, laboratory control sample (LCS) analyses, matrix spikes, surrogates, and all sample data. However, this information was not provided to EPA. Because EPA has concerns about the quality of the benzo(a)pyrene data generated by Method 8270, EPA excluded them from developing the limitations and standards.

4.5.16 Methods 420.1 and 420.2 (Phenols (4AAP))

In EPA's database, the terms "total phenols" and "total recoverable phenolics" are used synonymously. The term "total recoverable phenolics" is used in the titles of EPA Methods 420.1 to 420.4. While "total recoverable phenolics" could be considered a more accurate term for what is measured in any of these related methods, both terms refer to an aggregate measure of compounds with a phenol-like or "phenolic" structure. The use of the adjective "recoverable" simply recognizes that there are some compounds that are not measured, as well as other related compounds in this class. Thus, the method reports what can be recovered from the sample under the conditions of the analysis. EPA uses the term phenols (4AAP) in today's rule.

The methods for the analysis of phenols (4AAP) employ the reagent 4-aminoantipyrine (4AAP), which reacts with phenolic compounds to produce a dark red product, an antipyrine dye. The concentration of the phenolic compounds is determined by measuring the absorbance of the sample at a wavelength of 460 to 520 nm, depending on the method. The methods are calibrated using a series of standards containing the single compound phenol. EPA Methods 420.1 and 420.2, the two NPDES-approved methods, provide several options for sample preparation and analysis, including a preliminary distillation designed to remove interferences and a chloroform extraction procedure in Method 420.1 that is designed to improve the sensitivity of the method. Both methods also provide information on the concentrations of the calibration standards that may be prepared for a given set of procedural options.

Each of these methods contains at least one set of options that will provide sufficient sensitivity to meet the effluent guideline limitation for phenols (4AAP). Therefore, as with any other compliance monitoring analysis, the permitted discharger is responsible for communicating the requirements of the analysis to the laboratory, including the sensitivity required to meet the regulatory limits associated with each analyte of interest. In turn, the laboratory is responsible for employing the appropriate set of method options and a calibration range in which the concentration of the lowest non-zero standard represents a sample concentration lower than the regulatory limit for each analyte.

The methods themselves do not contain a required calibration range. Each laboratory can, and does, establish a calibration range based on its use of the method. EPA used a baseline value of 0.05 mg/L because this was the most commonly reported sample-specific detection limit[15] in EPA's sampling episode data. (These data included more concentrated samples than effluent.)

4.6 Requirements for Laboratory Analysis for Compliance Monitoring

The permittee is responsible for communicating the requirements of the analysis to the laboratory, including the sensitivity necessary to meet the regulatory limits associated with each analyte of interest. In turn, the laboratory is responsible for employing the appropriate set of method options and a calibration range in which the concentration of the lowest non-zero standard represents a sample concentration lower than the regulatory limit for each analyte. For example, EPA Methods 420.1 and 420.2 provide several options for sample preparation and analysis, including a preliminary distillation designed to remove interferences and a chloroform extraction procedure (Method 420.1) designed to improve the sensitivity of the method. Both methods also provide information on the concentrations of the calibration standards that may be prepared for a given set of procedural options. Each of these methods contains at least one set of options that will provide sufficient sensitivity to meet the effluent guideline limitations for phenols (4AAP). Thus, it is the responsibility of the permittee to convey to the laboratory the required sensitivity to comply with the limitations. See Sierra Club v. Union Oil, 813 F.2d 1480, 1492 (9th Cir. 1987).

For organic compounds, such as 2,3,7,8-TCDF, naphthalene, and benzo(a)pyrene, it may be necessary for laboratories to overcome interferences using procedures such as those suggested in *Guidance on the Evaluation, Resolution, and Documentation of Analytical Problems Associated with Compliance Monitoring* (EPA 821-B-93-001). The Monitoring Guidance was developed in response to matrix interference problems encountered primarily in development of the final rule for the Organic Chemicals, Plastics and Synthetic Fibers (OCPSF) category promulgated at 40 CFR Part 414. EPA consulted several laboratories that used different strategies to analyze wastewaters (in-process, treated, untreated) from the OCPSF industry and other industries. Wastewaters in the OCPSF industry presented a considerably greater challenge than those in the iron and steel industry because of high loadings of inorganic substances, suspended solids, and especially of organic compounds including monomers, polymeric materials, intermediate chemicals, and manufactured products. As a result of the consultation with the laboratories testing these more complex matrices, EPA found that nearly all matrix interference problems could be eliminated. Therefore, EPA believes that laboratories and iron and steel mills following the Monitoring Guidance should be able to eliminate any residual matrix interference problems.

4.7 References

4-1 U.S. Environmental Protection Agency. Methods for Chemical Analysis of Water and Wastes. EPA 821-C-99-004. Washington, DC, June 1999.

---

[15] For more than one hundred samples, the laboratories reported a lower sample-specific detection limit of 0.005 mg/L using Method 420.1.

4-2 American Public Health Association, American Water Works Association, and Water Environment Federation. Standard Methods for the Examination by Water and Wastewater, 18th Edition. Washington, DC, 1992.

4-3 American Public Health Association, American Water Works Association, and Water Environment Federation. Standard Methods for the Examination by Water and Wastewater, 20th Edition. Washington, DC, 1998.

Table 4-1

Analytical Methods and Baseline Values

Analyte	Chemical Abstract Service (CAS) Number	Baseline Value (mg/L)	Samples Collected and Analyzed by	Method Used to Analyze Samples	Nominal Quantitation Value (mg/L) for Method
Ammonia as Nitrogen	7664-41-7	0.05	EPA, Industry	350.2	0.05
			Industry	417/350.2	0.05
				4500-NH$_3$	0.1(a)
				4500-NH$_3$F	0.1
				4500NH, BE	0.8
				4500NH$_3$-E	0.8
Fluoride	16984-48-8	0.1	EPA	340.2	0.1
Hexane Extractable Material (HEM)	C036	5	EPA	1664	5
Silica Gel Treated Hexane Extractable Material (SGT-HEM) (b)	C037	5	EPA	1664	5
Nitrate/Nitrite	C005	0.01	(c)	353.1	0.01
Thiocyanate	302-04-5	0.1	EPA	4500-CN	0.1
			EPA	4500-CN M	0.1
			Industry	4500CN-M	0.1
			Proposed	D4374-98	0.0001
Total Cyanide	57-12-5	0.02	EPA, Industry	335.2	0.02
			Industry	4500 CN E	0.005
				4500-CNC	0.005(d)
				4500-CNE	0.005
Total Suspended Solids (TSS)	C009	4	EPA, Industry	160.2	4
			Industry	160.2	4
				209C	4
				2540 D	4
Chromium	7440-47-3	0.01	EPA	1620	0.01
			Industry	200.7	0.01
				3120B	0.01
Hexavalent Chromium	18540-29-9	0.01	EPA, Industry	218.4	0.01
			Industry	3120B	NA

Table 4-1 (continued)

Analyte	Chemical Abstract Service (CAS) Number	Baseline Value (mg/L)	Samples Collected and Analyzed by	Method Used to Analyze Samples	Nominal Quantitation Value (mg/L) for Method
Lead	7439-92-1	0.05	EPA	1620	0.05
			Industry	200.7	0.05
				239.2	0.005
				3130B	NA
Mercury	7439-97-6	0.0002	EPA	1620	0.0002
			Industry	245.1	0.0002
Nickel	7440-02-0	0.04	EPA	1620	0.04
			Industry	200.7	0.04
Selenium	7782-49-2	0.005	EPA	1620	0.005
Zinc	7440-66-6	0.02	EPA	1620	0.02
			Industry	200.7	0.02
				3130B	NA
Benzo(a)pyrene	50-32-8	0.01	EPA	1625	0.01
			Industry	8270	0.01
Naphthalene	91-20-3	0.01	EPA	1625	0.01
			Industry	625	0.01
Phenols (4AAP)	C020	0.05	EPA, Industry	420.1	(c)
				420.2	(c)
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	51207-31-9	10 pg/L	EPA	1613B	10 pg/L

(a) For some of the industry-submitted data, “4500-NH_3" was cited as the method used. This reference is vague in that it potentially refers to seven different procedures. Consequently, EPA has listed the lowest of the measurement ranges cited in the methods.
(b) SGT-HEM measures nonpolar material (i.e., n-hexane extractable material that is not absorbed by silica gel), the portion of oil and grease that is similar to total petroleum hydrocarbons (TPH).
(c) The method does not have a required calibration range. The baseline value is based upon the most frequently reported sample-specific detection limit.
(d) Method 4500-CN-C is the distillation process by which to prepare samples for analysis by either 4500-CN-D or -E. Because EPA does not have complete information on which determinative technique industry used, the quantitation limit reflected in the citation for 4500-CN-C is the lower quantitation limit of the two procedures.
NA - Not available.

SECTION 5

DESCRIPTION OF THE INDUSTRY

This section describes the iron and steel industry in the United States. Unless otherwise noted, all estimates included in this section represent 1997 data collected in the U.S. EPA Collection of 1997 Iron and Steel Industry Data (EPA survey). EPA recognizes that the estimates provided in this section do not necessarily reflect the current status of the iron and steel industry in the United States; however, EPA does not have a more recent comprehensive set of data to use to describe the industry.

The United States is the third largest steel producer in the world, accounting for 12 percent of the international steel market. The iron and steel industry in the United States has an annual steel output of approximately 117 million tons per year, and employs nearly 145,000 people (Reference 5-1). Based on estimates from the EPA survey, there are approximately 254 iron and steel sites in the United States; the 254 sites are owned by 115 companies. The types of sites and the manufacturing operations conducted at these sites are described below.

5.1 Types of Sites

EPA classified manufacturing facilities in the iron and steel industry into the following three types on the basis of raw material consumption and manufacturing processes: integrated steel mills, non-integrated steel mills, and stand-alone facilities. This section provides a general description of the types of sites, these processes conducted, the number of facilities and locations, the types of steel processed, and the wastewater discharge practices for each type of site. Figure 5-1 is a schematic drawing of the steelmaking, refining, and casting operations that occur at iron and steel facilities. Figure 5-2 shows the various hot forming and finishing operations that steel may undergo to form semi-finished or finished products.

Integrated steel mills produce molten iron in blast furnaces using coke, limestone, beneficiated iron ore, and preheated air as the principal raw materials. Other raw materials used to produce molten iron may include sinter, other iron-bearing materials, oxygen, and alternate sources of carbon. These mills then charge the molten iron (or hot metal) and steel scrap to basic oxygen furnaces (BOFs) to produce molten steel. Depending on final product specifications, the molten steel then undergoes various refining steps prior to casting, hot forming, and finishing operations. Several integrated mills also have cokemaking and sintering plants that produce raw materials for blast furnace operations.

Non-integrated steel mills produce molten steel by melting steel scrap in electric arc furnaces (EAFs). Some non-integrated steel mills also use high-quality iron materials such as pig iron or direct-reduced iron along with scrap. As at integrated mills, the molten steel undergoes various refining, casting, hot forming, and finishing operations.

Stand-alone facilities do not produce molten steel and include certain raw material preparation facilities and steel forming and finishing mills. A number of stand-alone operations produce raw materials for ironmaking and steelmaking (e.g., by-product recovery and non-recovery coke plants, sinter plants, and direct-reduced ironmaking plants). Steel forming and finishing stand-alone mills conduct many of the same hot forming and steel finishing operations conducted at integrated and non-integrated steel mills. The major types of stand-alone facilities are described below:

- Coke plants and sinter plants manufacture feed materials for blast furnaces.
- Direct-reduced ironmaking plants manufacture feed materials for EAFs.
- Hot forming mills receive cast products from integrated and non-integrated steel mills. These facilities perform hot forming operations and, depending on the product, a limited number may perform steel finishing operations.
- Carbon steel finishing mills may perform acid pickling, cold forming and annealing, acid and alkaline cleaning, electroplating, and hot coating on carbon steel products received from other mills. Stand-alone stainless steel finishing mills typically perform acid pickling and descaling and cold forming and annealing operations on stainless steel products received from other mills.
- Pipe and tube mills include:
  - Facilities that manufacture butt-welded or seamless pipe and tube through hot forming operations,
  - Facilities that manufacture pipe and tube using cold forming operations, such as electric resistance welding, and
  - Facilities that receive pipe and tube and perform other operations, such as drawing.

  Only the stand-alone pipe and tube mills that manufacture butt-welded or seamless pipe and tube through hot forming operations, as opposed to those that perform cold forming and drawing operations on pipe and tube , were evaluated as part of the iron and steel industry for the purpose of developing effluent limitations and guidelines. Section 1 provides more detail on the applicability of the iron and steel category.

Table 5-1 presents EPA's national estimates of the numbers of iron and steel sites by type in the United States. There are 20 integrated steel mills that account for approximately 60 percent of domestic annual raw steel production. Approximately 94 non-integrated steel mills account for the remaining 40 percent of domestic annual raw steel production. There are approximately 138 stand-alone facilities. Non-integrated steel mills are the largest group and they outnumber integrated steel mills by more than four to one. Stand-alone finishing facilities form the second largest group, and stand-alone hot forming facilities form the third largest group. This reflects two trends in the industry over the past 25 years: (1) a shift of steel production from older, larger integrated steel mills to newer, smaller non-integrated steel mills, and (2) the emergence of specialized, stand-alone finishing facilities that process semi-finished sheet, strip, bars, and rods obtained from integrated or non-integrated facilities.

Integrated steel mills are located primarily east of the Mississippi River in Illinois, Indiana, Michigan, Ohio, Pennsylvania, West Virginia, Maryland, Kentucky, and Alabama; one integrated steel mill is located in Utah. Figure 5-3 shows the locations of integrated steel mills. Stand-alone coke plants and coke plants at integrated steel mills are located in Illinois, Indiana, Michigan, Ohio, New York, Pennsylvania, Virginia, Kentucky, Alabama, and Utah. Figure 5-4 shows the locations of stand-alone and colocated coke facilities. Non-integrated steel mills are located throughout the continental United States, as are stand-alone hot forming and finishing mills.

Steel produced at integrated and non-integrated steel mills can be classified as carbon steels, alloy steels, and stainless steels. Carbon steels owe their properties to varying concentrations of carbon, with relatively low concentrations of alloying elements (less than 1.65 percent manganese, 0.60 percent silicon, and 0.60 percent copper). Alloy steels contain concentrations of manganese, silicon, or copper greater than those for carbon steels, or other specified alloying elements added to impart unique properties to the steel. Stainless steels are corrosion resistant and heat resistant; the principal alloying elements for stainless steel are chromium, nickel, and silicon. Steel is typically considered stainless steel when the chromium content is 10 percent or greater.

Table 5-2 lists the types of steels manufactured or processed at integrated and non-integrated steel mills and stand-alone hot forming, finishing, and pipe and tube. All integrated steel mills produce carbon steels; some also produce alloy and stainless steels. EPA estimates that 72 non-integrated steel mills, 26 stand-alone hot forming mills, 45 stand-alone finishing mills, and 11 stand-alone pipe and tube mills produce or process carbon steels.

Steel mills discharge process wastewater directly to surface water (direct discharge), to publicly owned treatment works (POTWs) (indirect discharge), both directly and indirectly, or not at all (zero or alternative discharge). Zero and alternative dischargers include sites that do not discharge process wastewater and sites that are completely dry (i.e., do not use water in iron and steel operations). Table 5-3 shows the discharge status of integrated and non-integrated steel mills and stand-alone facilities. A single mill may discharge process wastewater from one operation directly to surface waters and from another operation indirectly to a POTW.

All but one integrated mill discharge directly; two discharge both directly and indirectly. EPA estimates that among the 94 non-integrated steel mills, 46 are direct dischargers, 32 are zero or alternative dischargers, and 19 are indirect dischargers. For the 70 stand-alone finishing mills, EPA estimates 34 indirect dischargers, 28 direct dischargers, and 11 zero or alternative dischargers.

5.2 Manufacturing Operations

The following subsections describe the types of manufacturing operations performed at integrated and non-integrated steel mills and stand-alone iron and steel facilities. Table 5-4 lists the various manufacturing operations and EPA's national estimates of the number of sites performing each operation, 1997 production, and 1997 production capacity.

5.2.1 Cokemaking

Cokemaking is the manufacture of metallurgical coke from coal. There are two types of coke plants operated in the United States. By-product recovery coke plants recover several chemical by-products from coke oven gas. Non-recovery or heat recovery coke plants do not recover chemical by-products from the coke oven gas; the only by-product is heat, which is used to generate steam and electric power. In 1997, there were 23 by-product recovery coke plants and one non-recovery coke plant located in the United States (one additional non-recovery coke plant started operation after 1997).

Coke is used to reduce iron oxide to metallic iron in both blast furnaces and foundries; coke used for blast furnace operations is called furnace coke, and coke used for foundry operations is called foundry coke. Presently, foundry coke is produced only by by-product coke plants, and furnace coke is produced by both by-product recovery and non-recovery coke plants. Of the 24 coke plants operating in 1997, 19 primarily produce blast furnace coke, 4 primarily produce foundry coke, and 1 routinely produces both. Merchant by-product cokemaking operations provide more than 50 percent of the coke produced to operations, industries, or processes other than ironmaking blast furnaces. Iron and steel by-product cokemaking operations are those other than merchant cokemaking operations.

By-Product Recovery Coke Plants

By-product recovery coke plants comprise coal handling and preparation facilities, one or more coke batteries (i.e., groups of 40 or more vertical, slot-type coke ovens located side by side) equipped with coal charging and coke pushing equipment, coke oven gas collection and cleaning facilities, by-product recovery systems, coke quenching stations, and associated air and water pollution control facilities and solid waste processing operations.

Blends of high-, medium-, and low-volatile coals and other carbonaceous materials are pulverized and screened to desired size and charged into the tops of coke ovens with charging machines called larry cars. Different blends of coals are used to produce foundry and furnace coke. The ovens are positive pressure ovens operated on a sequential batch basis. The coal charge is heated in the absence of air to drive off volatile materials and water to leave the carbonaceous residue called coke. The coking time is approximately 16 hours for furnace coke and approximately 28 to 30 hours for foundry coke. Coking temperatures in the ovens range from approximately 1,650 to 2,000°F (Reference 5-2).

When the coking cycle is completed, the oven doors are removed and the incandescent coke is pushed from the oven into a rail car called a coke quench car. Plants usually control air emissions from pushing operations with baghouses or wet scrubbers. The quench car is positioned under a quench station where large volumes of water quench the coke. All coke plants in the United States recycle and evaporate coke quench water, typically to extinction. The coke is then sized and stored for future use. Relatively fine coke particles collected in quench station sumps are called coke breeze. Coke breeze is reused as a charge material for production of foundry coke or for sinter plant operations, or sold for other uses.

Figure 5-5 presents a typical by-product cokemaking process diagram. Processed coke oven gas is ultimately used as a fuel for battery underfiring. Coke oven gas is scrubbed in gas collector mains, which are located on top of the coke battery, with a fluid called flushing liquor to condense tars and moisture derived from the coal. The flushing liquor is processed in tar decanter tanks to separate tar from the flushing liquor stream. Flushing liquor is recycled to the gas collector mains at a high rate. Primary gas coolers and electrostatic precipitators remove additional tar from coke oven gas. Exhausters pull the coke oven gas through the primary coolers and push the gas through the remainder of the by-product recovery plant. Final gas coolers lower the coke oven gas temperature further; the location of the final coolers depend on the types of by-products that are recovered at the plant.

Excess flushing liquor, also called waste ammonia liquor, is rejected from the flushing liquor circuit and is the principal process wastewater stream generated at by-product coke plants. Sludge collected at the bottom of the tar decanters is a listed hazardous waste and is typically mixed with coke breeze and other carbonaceous material and recycled to the coke ovens with the coal charge. The recovered tars are stored in tanks on site and sold as a by-product.

The by-product recovery cokemaking industry uses a variety of chemical processing technologies to recover additional products from coke oven gas and waste ammonia liquor, such as ammonia or ammonia compounds, sulfur and sulfur compounds, naphthalene, crude light oils, and phenols. The following technologies are used:

- *Recovery of ammonia and ammonia compounds*. Ammonia formed during by-product recovery cokemaking is recovered from both coke oven gas and waste ammonia liquor that is condensed from the gas (Reference 5-3). Ammonia is recovered from the waste ammonia liquor through distillation; overhead vapors from the distillation process are combined with the coke oven gas stream for further recovery of ammonia. Ammonia may be scrubbed directly from coke oven gas with sulfuric acid to produce ammonium sulfate crystals. Using the Phosam process, ammonia may also be scrubbed directly from coke oven gas with phosphoric acid and then stripped. The overhead vapor from the stripper is condensed to form an aqueous ammonia feed for a fractionator, where anhydrous ammonia is produced. Ammonia may also be scrubbed from coke oven gas using water; the ammonia-rich water stream is generally sent to an ammonia stripper to produce ammonia vapors. Vapors from the ammonia stripper are typically combined with coke oven gas and can be combusted or destructed, or can be used to generate ammonium sulfate crystals using sulfuric acid or liquid ammonia using the Phosam process.

- *Recovery of sulfur and sulfur compounds.* Desulfurization systems recover elemental sulfur or sulfur compounds from coke oven gas. Techniques to remove sulfur include iron oxide boxes using Fe_2O_3 on wood shavings, absorption and desorption with soda ash, Wilputte vacuum carbonate systems, and Claus sulfur recovery systems.

- *Recovery of naphthalene.* Crystals of naphthalene are condensed from the coke oven gas in the final cooler and recovered from the recirculating final cooler wastewater by skimming, filtration, or centrifugation. Naphthalene may be recovered by solidification at temperatures below 74°C (165°F).

- *Recovery of crude light oils.* Crude light oils are scrubbed from coke oven gas with a recirculated wash oil solution. Crude light oil is an unrefined oil rich in benzene, toluene, xylene, and solvent naphthas. The oil is recovered for resale, reused as a solvent to recover phenolic compounds from waste ammonia liquor, or further refined on or off site.

- *Recovery of phenols.* Liquid/liquid extraction with suitable solvents is a common method to remove and recover phenols from waste ammonia liquor. In liquid/liquid extraction, light oil or other suitable solvents extracts phenolic compounds from waste ammonia liquor. The phenolized solvent is separated and extracted with caustic to form sodium phenolate. Because there is not a strong economic incentive, phenol recovery is not commonly performed.

Non-Recovery Coke Plants

Non-recovery coke plants carbonize coal in large dome-shaped oven chambers. The single non-recovery coke plant that was in operation in 1997 operates Jewell-Thompson non-recovery coke batteries (Reference 5-4). Coal is charged to the ovens with a conveyor charging machine. Volatile by-products generated during the cokemaking process are contained in the ovens by negative pressure and are thermally destroyed, thus eliminating the need for a by-products recovery plant. Combustion of these volatile components also provides some of the heat for the cokemaking process. Air for combustion enters the ovens above the charge; the temperature in the ovens can be controlled by regulating the flow of air into the ovens. The volatile components are combusted in the sole flues beneath the cokemaking oven floors; additional air may be added to the sole flues to aid combustion. The gas is collected in a common waste heat tunnel above the ovens; the gas may then pass through an afterburner or a scrubber before being discharged to the atmosphere at a temperature of 1,600°F. Heat from the waste gases can be recovered to generate steam for electric power generation or for other uses.

Because non-recovery plants combust all materials evolved from the coal, there are no by-products recovered other than heat in the waste gases and coke breeze. The pushing and quenching operations are similar to those performed at by-product recovery coke plants. Non-recovery cokemaking operations do not generate process wastewater other than boiler blowdown and process storm water, which are typically disposed of by coke quenching.

5.2.2 Sintering

Sintering is a beneficiation process in which iron-bearing materials recovered from other iron and steel operations are mixed with iron ore, limestone, and finely divided fuel, such as coke breeze. During iron and steel production operations, blast furnaces, basic oxygen furnaces, continuous casters, and hot forming mills generate large quantities of particulate matter and other solids (e.g., fines, mill scale, flue dust, wastewater sludge). Sintering can recover a large percentage of these iron-rich materials, provided the oil content is low enough to prevent objectionable fumes. Sinter serves as a supplementary raw material for blast furnace operations.

Sinter plants consist of raw material handling facilities and raw material storage bins, a sinter strand (traveling grate combustion device), a mixing drum for each sinter strand, a windbox (draws air through the traveling grate), a discharge end, and a cooling bed for sintered product. The iron-rich materials are mixed in sinter machines and charged to the traveling grate at a depth of approximately one foot. The mixture is ignited, and air is drawn through the bed as it travels toward the discharge end to promote combustion and fusing of the iron-bearing materials. Sinter plants may operate either wet air pollution control systems or dry air pollution control systems. In 1997, seven sites reported that they used wet air pollution control systems to control air emissions from the sintering process, while two sites used dry air pollution control systems.

5.2.3 Briquetting

Briquetting is an agglomeration process used to recycle and reuse fine materials recovered from other iron and steel operations that otherwise could not be charged to blast furnaces or steelmaking furnaces. The operation forms materials into discrete shapes of sufficient size, strength, and weight for charging to a subsequent process (e.g., blast furnaces, BOFs). Materials are similar to those charged to sintering operations, although they are usually formed with the use of a binder and do not possess the strength of sintered products (Reference 5-5). Briquetting operations can be performed with or without heating the raw materials, and do not generate process wastewater. EPA estimates that four facilities perform briquetting or similar agglomeration processes.

5.2.4 Blast Furnace Ironmaking

Blast furnaces produce molten iron, which is charged to BOFs. The blast furnace has several zones: a crucible-shaped hearth (bottom of the furnace), an intermediate zone called a bosh (between the hearth and the stack), a vertical shaft called the stack (between the bosh and furnace top), and the furnace top, which contains the mechanism for charging the furnace. The hearth and bosh walls are lined with carbon-type refractory blocks, and the stack is lined with high-quality fireclay bricks. To protect these refractory materials from burning out, cooling water circulates through exterior plates, staves, or sprays. Blast furnaces range between 70 and 120 feet in height, with hearth diameters between 20 and 45 feet (Reference 5-6). The rated capacity of blast furnaces ranges from under one million tons per year to over four million tons per year. There are 20 integrated steel mills with blast furnace operations in the United States.

The raw materials charged to the top of the blast furnace include coke, limestone, beneficiated iron ores or iron pellets, scrap, and sinter. Iron pellets, the dominant burden material (material charged to the furnace) in North America, include acid pellets and fluxed pellets, which are typically produced at or near iron ore mine sites. A continuous feed of alternating layers of coke, iron-bearing materials, and limestone are charged to the top of the furnace. Hot blast (preheated air) at temperatures between 1,650 and 2,300°F and injected fuel (e.g., pulverized coal, oil, natural gas) are blown into the bottom of the furnace (top of the hearth) through a bustle pipe and tuyeres (orifices) located around the circumference of the furnace (Reference 5-6). The preheated air reacts with the coke to produce the reducing agent, carbon monoxide. The reducing gases ascend through the furnace to reduce the iron-bearing materials to produce the molten iron and slag. The following chemical equations present a simplified summary of the chemical reactions that occur in a blast furnace:

$3Fe_2O_3 + H_2 \text{-->} 2Fe_3O_4 + H_2O$
$3Fe_2O_3 + CO \text{-->} 2Fe_3O_4 + CO_2$

$Fe_3O_4 + H_2 \text{-->} 3FeO + H_2O$
$Fe_3O_4 + CO \text{-->} 3FeO + CO_2$

$FeO + H_2 \text{-->} Fe + H_2O$
$FeO + CO \text{-->} Fe + CO_2$

$3Fe + CO \text{-->} Fe_3C + H_2O$
$3Fe + 2CO \text{-->} Fe_3C + CO_2$

$CO_2 + C \text{-->} 2CO$
$H_2O + C \text{-->} CO + H_2$

$FeO + C \rightarrow Fe + CO$

$3Fe + C \rightarrow Fe_3C$

The molten iron, at approximately 2,800 to 3,000°F, accumulates in the hearth and is tapped at regular intervals into refractory-lined cars for transport to the steelmaking furnaces. Limestone is a fluxing agent that forms fluid slag to dissolve unwanted impurities in the ore. Molten slag, which floats on top of the molten iron, is also tapped and processed for sale as a by-product. Blast furnace slag uses include railroad ballast, aggregate in cement manufacturing, and other construction uses. Wastewater or plant service water is used for slag cooling or quenching. Nineteen of the 20 integrated facilities surveyed use water for slag cooling at blast furnace operations.

The hot blast exits the furnace top as blast furnace flue gas in enclosed piping. A combination of dry dust catchers and high-energy venturi scrubbers clean and cool the gas. Stoves combust the cleaned gas to preheat the incoming air or the cleaned gas is used as fuel elsewhere at integrated mills. Direct contact water is applied in the gas coolers and high-energy scrubbers. All sites operating blast furnaces use wet air gas cleaning systems.

5.2.5 Direct-Reduced Ironmaking

Another method of producing iron is through direct reduction. Direct reduction produces relatively pure iron in solid pellet form by reducing iron ore at a temperature below the melting point of the iron produced. Direct-reduced iron (DRI) is produced through the same chemical reactions presented in Section 5.2.4 for blast furnace ironmaking. DRI is used as a substitute for scrap steel in EAF steelmaking to minimize contaminant levels in the melted steel and to allow economic steel production when market prices for scrap steel are high. There were two direct-reduced ironmaking plants in the United States operating in 1997 (an additional direct-reduced ironmaking facility started operation after 1997).

DRI can be produced by several different types of processes (Reference 5-5). DRI may be produced in shaft furnaces or fluidized beds, with the reducing gases generated outside of the reduction furnace. DRI may also be produced in rotary kilns or shaft or hearth furnaces, with the reducing gases generated inside the reduction furnace. Facilities in the United States use the Midrex® process, which produces DRI in a shaft furnace with reducing gases produced outside of the reduction furnace. The Midrex® process is discussed in more detail below.

The Midrex® process equipment consists of three main components: a direct-reduction shaft furnace, a gas reformer, and a cooling-gas system. The direct-reduction shaft furnace is divided into three zones: a preheat zone, a reduction zone, and a cooling zone. Iron ore is charged into the top of the furnace and heated in the preheat zone with ascending gases from the reduction zone. Reformed gas consisting of hydrogen and carbon monoxide, which reduce the iron ore, flows into the reduction zone at a temperature of approximately 875° C; the hydrogen and carbon monoxide are produced in the gas reformers from natural gas and scrubbed reducing furnace top gas using a catalyst. The DRI formed in the reduction zone is cooled in the cooling zone using direct-contact cooling gas. The cooling gas is scrubbed and then recycled. DRI is continuously conveyed from the furnace through seal legs and screened to provide the final product. Direct-reduced ironmaking facilities have wet air pollution control systems to control furnace emissions and emissions from material handling and storage.

5.2.6 Steelmaking

Steelmaking in the United States is performed in either BOFs or EAFs. BOF and EAF processes are batch operations with tap-to-tap (batch cycle) times of about 45 minutes for BOFs and in the range of 1 hour to more than 1.5 hours for EAFs. BOFs typically produce high-tonnage carbon steels and EAFs produce low-tonnage carbon, alloy, and stainless steels.

Basic Oxygen Furnace (BOF)

The open hearth furnace process for steelmaking was replaced after World War II with the basic oxygen process (BOP). This process involves blowing oxygen through a lance into the top of a pear-shaped vessel. Lime addition to the charge removes phosphorus and sulfur impurities in the form of slag. Compared with the open hearth furnace, which had tap-to-tap times of 12 hours or more, steelmaking using BOP is a much quicker process. In addition, up to 35 percent of the charge could be steel scrap. After its invention, the BOP was modified. In addition to blowing oxygen directly onto the charge, the process involved also blowing burnt lime through the lance with the oxygen. This process allowed refining of pig iron smelted from high-phosphorus ores. Another process modification, developed in Canada and Germany in the mid-1960s, was the bottom-blown steelmaking process. This process used two concentric tuyeres, the outer with hydrocarbon gas and the inner with oxygen. This new process became know as Quelle-BOP (Q-BOP). Both the BOP and Q-BOP process are types of BOF steelmaking used today.

The BOF steelmaking process refines the product of the blast furnace (molten iron), which contains approximately 3.5 to 4.4 percent carbon, $\leq$0.05 percent sulfur, and $\leq$0.04 percent phosphorus. In steelmaking operations, the furnace charge consists of approximately two-thirds molten iron and one-third scrap steel. The furnace melts the charge and refines it by oxidizing silicon, carbon, manganese, phosphorus, and a portion of the iron in the molten bath. Various alloying elements are added to produce different grades of steel. Common alloying elements include aluminum, boron, chromium, copper, magnesium, molybdenum, niobium, nickel, silicon, and vanadium. The BOF allows close control of steel quality and the ability to process a wide range of raw materials.

Vessels used in the BOF process are generally vertical cylinders surmounted by a truncated cone. Typical heat sizes in BOFs range between under 100 tons per heat to over 300 tons per heat. Scrap and molten iron are first placed in the vessel. Oxygen is then injected into the molten bath either through the top of the furnace (top blown), bottom of the furnace (bottom blown), or both (combination blown). A violent reaction occurs immediately, bringing the molten metal and hot gases into intimate contact, causing impurities to burn off quickly. Management of furnace slag processes controls residual sulfur. The slag is separated and removed from the molten steel. Alloys are added to the bath or as the steel is tapped (poured) into ladles. Slag material is charged back to the blast furnace to recover iron or used as railroad ballast. Similar to blast furnaces, BOF manufacturing facilities may use wastewater or plant service water for slag cooling or quenching. Eighteen of the 20 integrated facilities surveyed use water instead of air for slag cooling in BOF operations.

Off-gases from BOFs exit the vessel at temperatures of approximately 3,000°F. This gas contains approximately 90 percent carbon monoxide, 10 percent carbon dioxide, and may also contain ferrous oxide dust. BOF off-gas control systems include three types: semi-wet, wet-open combustion, and wet-suppressed combustion. Semi-wet systems condition furnace off-gases with moisture prior to processing in the electrostatic precipitators or baghouses. Wet-open combustion systems admit excess air to the off-gas collection system, allowing carbon monoxide to combust prior to high-energy wet scrubbing for air pollution control. Wet-suppressed combustion systems do not admit excess air to the off-gas collection system prior to high-energy scrubbing for air pollution control. BOF facilities use water for air pollution control systems designed to treat furnace off-gases prior to release into the atmosphere (Reference 5-6).

Electric Arc Furnace (EAF)

The EAF is designed to produce specific grades of steel. The first EAFs developed in the late 1800s and early 1900s could melt approximately one ton per heat. Typical heat sizes in current EAFs range between under one ton per heat to over 350 tons per heat. EPA estimates that 96 sites operate EAFs.

An EAF is a cylindrical vessel with a dish-shaped refractory hearth and three electrodes that lower from the dome-shaped, removable roof. Shell diameters depend on the heat size and range from 8 feet for a 10-ton vessel to 30 feet for a 300-ton vessel. Tar-bonded magnesite bricks form the lining of the furnace. The walls typically contain water-cooled panels that are covered to minimize heat loss. The electrodes may also be equipped with water cooling systems (Reference 5-6).

EAF steelmaking consists of scrap charging, melting, refining, deslagging, and tapping. In addition to scrap steel, the charge may include pig iron, DRI, and alloying elements. As the steel scrap is melted, additional scrap may be added to the furnace. The EAF generates heat by passing an electric current between electrodes through the charge in the furnace. Lime-rich slag removes the steel impurities (e.g., silicon, sulfur, and phosphorus) from the molten steel. Oxygen may be added to the furnace to speed up the steelmaking process. At the end of a heat, the furnace tips forward and the molten steel is poured off. EAFs in the United States are equipped with dry or semi-wet air pollution controls, and none discharge process wastewater.

5.2.7 Vacuum Degassing

Vacuum degassing is a refining process in which gases are removed from molten steel prior to casting to produce steel of high metallurgical quality. Vacuum degassing is used to control composition and temperature, remove oxygen (deoxidation) and hydrogen (degassing), decarburize, and otherwise remove impurities from the steel. Vacuum degassers are common at integrated and non-integrated mills that produce carbon, stainless, and certain alloy steels. Vacuum degassers often operate as part of ladle metallurgy stations (discussed in Section 5.2.8), where additional steel refining is conducted. EPA estimates that 44 sites operate vacuum degassing systems.

Steam ejectors create the vacuum for most vacuum degassing units. Gases removed from the molten steel come in contact with the injected steam, thereby contaminating the condensate wastewater. While the molten steel is under vacuum, elements that have a relatively higher vapor pressure volatilize and are present in the gases.

5.2.8 Ladle Metallurgy and Secondary Steelmaking

Ladle metallurgy and secondary steelmaking are steel refining operations that molten steels undergo at atmospheric conditions (i.e., no vacuum is applied) prior to casting. The purpose of ladle metallurgy and secondary steelmaking may include controlling gases in the steel, adjusting concentrations of metallic or nonmetallic compounds (alloying), and adjusting physical properties (e.g., temperature).

Common types of ladle metallurgy include argon or nitrogen bubbling and stirring, argon-oxygen decarburization, lance injection, magnetic stirring, and other alloy addition operations. Common types of secondary steelmaking include electroslag refining and other alloy addition operations. None of sites that conduct ladle metallurgy and/or secondary steelmaking reported generating or discharging process wastewater from these operations. EPA estimates that 103 sites use ladle metallurgy and/or secondary steelmaking; some sites may operate more than one type of process. The following table lists the numbers of sites in 1997 performing various types of ladle metallurgy and secondary steelmaking.

1997 National Estimate for Types of Ladle Metallurgy and Secondary Steelmaking Processes

Type of Ladle Metallurgy or Secondary Steelmaking	Number of Sites
Argon bubbling	66
Argon-oxygen decarburization	16
Electroslag remelting	10
Lance injection	19

Type of Ladle Metallurgy or Secondary Steelmaking	Number of Sites
Other (a)	37

Source: U.S. EPA, U.S. EPA Collection of 1997 Iron and Steel Industry Data (Detailed and Short Surveys).
(a) Other types of ladle metallurgy include alloy addition, reheating, magnetic stirring, ladle stirring, and carbon addition/adjustment.

5.2.9 Casting

Casting converts molten steel into a semi-finished product or shape that is suitable for further processing. There are two main types of casting operations: continuous casting and ingot casting. Molten steel is tapped from the BOF or EAF into ladles large enough to hold an entire heat. The ladles are then processed in ladle metallurgy stations and/or vacuum degassers prior to teeming (pouring) the steel into ingot molds or direct casting it into semi-finished shapes using continuous casters. EPA estimates that 113 sites operate casters.

Continuous Casting

Continuous casting is the most efficient and most common method of casting performed at steel mills. In the continuous casting process, molten steel is poured from the ladle into a refractory-lined tundish. The molten metal from the tundish pours through nozzles into an oscillating water-cooled copper mold, where the metal partially solidifies. The copper molds oscillate to prevent the molten steel from sticking to their sides. Lubricants spray into the molds to keep the steel moving through the mold. After passing through the water-cooled molds, the partially solidified product passes into a secondary cooling zone, where sprays of contact water cool the semi-finished product enough to solidify. The product then passes into the cut-off zone where it is cut to the desired length.

Continuous casting machines are configured with either single or multiple strands, which mold molten steel into the desired shapes. The three main types of continuous casters are based on the shape of the cast product: billet, bloom, and slab. Billet casters form squares or rounds between 3 and 7 inches thick and are multiple-strand casters (Reference 5-6); billet casters also form steel for seamless tube production. Bloom casters form sections ranging between 7 by 7 inches and 14.6 by 23.6 inches and are usually three-strand. Slab casters form sections up to 12 inches thick and 100 inches wide, and are usually single- or twin-strands. In addition, casters may form beams that are fed directly to I-beam or H-beam rolling mills. The following table presents continuous casting products and the number of sites casting these products in 1997.

1997 National Estimate For Types of Continuous Casting Products

Type of Cast Product	Number of Sites
Slab	28
Thin slab	8
Round billet	6
Rectangular or square billet	47
Bloom	12
Other (a)	7

Source: U.S. EPA, U.S. EPA Collection of 1997 Iron and Steel Industry Data (Detailed and Short Surveys).
(a) Other types of cast products include beam blanks and near net-shape products.

Ingot Casting

Ingot casting involves teeming the molten steel into ingot molds, and then cooling and stripping the ingots out of the molds. The ingots are then heated and rolled into blooms, billets, or slabs during hot forming. Because continuous casting directly forms the molten steel into blooms, billets, or slabs, increasing productivity and conserving energy, continuous casting has replaced most ingot casting operations. Ingot casting is used typically for small, specialty batches and for certain applications for producing plate. Twenty-two sites reported performing ingot casting.

5.2.10 Hot Forming

Hot forming is a process in which preheated (typically in the range of 1,800°F), solidified steel is reshaped through a series of forming steps in which mechanical pressure is applied through work rolls (Reference 5-2). Hot formed products have numerous cross-sections, lengths, and tonnages. While several different types of hot forming mills are in operation today, they can be grouped into four types:

- Primary mills;
- Section mills;
- Flat mills (plate, hot strip, and sheet); and
- Pipe and tube mills (seamless and butt-weld).

In general, hot forming primary mills reduce ingots to slabs or blooms, or blooms to billets. Section mills reduce billets to form rod, bar products, structural shapes (e.g., channels, angles), or other forms. Flat mills reduce slabs to plates or strips. Pipe and tube mills form seamless products from round billets and butt-welded products from strips.

Hand chipping, machine chipping, manual scarfing, grinding, milling, and machine scarfing are methods used to remove surface defects from blooms, billets, and slabs prior to hot rolling. Scarfing removes a thin layer of the steel surface by localized melting and oxidation. The process may be done manually (continuously moving an oxyacetylene torch along the length of the product), or by a scarfing machine located near the entry of the hot forming mill.

Flat mills, specifically hot strip mills, are the most common type of hot forming mills at integrated steel mills. Hot rolled strip is formed from a slab, which is heated in one or more furnaces. Scale is removed from the heated slab in a two-high rolling mill with vertical rolls. The rolls loosen the scale, and high-pressure water jets remove the scale. The slab then rolls through four-high roughing stands until it reaches a thickness of approximately 1.2 inches. The slab then passes to the finishing train, where a crop-shear cuts both ends and high-pressure steam jets remove scale. Six or seven four-high finishing stands roll the strip to a thickness between 0.06 and 0.4 inches. Both the roughing and finishing stands are usually arranged in tandem.

Butt-welded pipes and tubes are made from hot rolled strips with square or slightly beveled edges called skelp. The width of skelp corresponds to the circumference of the pipe, while the gauge corresponds to the wall thickness. Skelp is preheated to welding temperature in a reheat furnace and drawn through a die or roll forming a cylindrical shape. The edges are pressed together forming a butt-weld. Seamless pipes and tubes are usually made by a piercing process. The process heats, pierces, and shapes a solid round bar or billet to the desired diameter and wall thickness.

Forging is another type of steel forming where steel shapes are produced by hammering or by processing in a press (Reference 5-7). Forging operations can be conducted on cold, warm, or hot steel. Typically, ingots are forged into billets, flats, or rounds. Types of forging include open die forging, impression die forging, ring rolling, and extrusion. Open die forging is conducted with dies that do not completely confine the steel that is being shaped, and is generally used to shape large parts, such as shafts, sleeves, and disks. Impression die forging is conducted in a die that completely encloses the steel shape that is being formed; impression die forging accounts for the majority of forging production. Ring rolling produces seamless rolled rings in a variety of dimensions. Extrusion is conducted by placing a steel shape in a container and compressing it until the steel travels through an opening to form an extruded product. Secondary forging processes and special techniques, such as drawing, ironing, bending, trimming, coining, and swaging, may also be conducted on steel shapes.

The following table presents the national estimate for types of hot forming operations and the number of sites performing these operations in 1997.

1997 National Estimate for Hot Forming Operations

Hot Forming Operation	Number of Sites
Rolling mill	122
Pipe and tube mill	6
Forging	14

Source: U.S. EPA, U.S. EPA Collection of 1997 Iron and Steel Industry Data (Detailed and Short Surveys).

The following table presents the national estimate for types of hot forming products and the number of sites producing these products in 1997.

1997 National Estimate for Hot Forming Products

Type of Hot Forming Product	Number of Sites
Bar	67
Beam (a)	8
Billet	25
Bloom (a)	7
Plate	21
Railroad rail (a)	4
Reinforcing bar	25
Rod	17
Sheet	11
Slab (a)	16
Small structural	23
Strip	25
Tube and pipe	21
Other (b)	44

Source: U.S. EPA, U.S. EPA Collection of 1997 Iron and Steel Industry Data (Detailed and Short Surveys).
(a) This estimate does not represent a national estimate of sites producing this product because it is based on data from only the detailed survey. Short surveys did not collect this level of detail on products.
(b) Other hot forming products include various miscellaneous product shapes.

Hot forming mills generally use water for scale breaking, flume flushing, and direct contact cooling. The water often recirculates in cooling water systems. Sites may have multiple hot forming contact water and/or rolling solution systems. Forging wastewater sources are very similar to those for hot forming.

5.2.11 Finishing

Steel finishing operations follow hot forming operations; therefore, integrated steel mills and those stand-alone steel finishing mills that receive steel from integrated steel mills are most likely to perform steel finishing operations. Integrated steel mills in the United States principally produce flat-rolled steel products that require finishing, such as hot rolled strip (hot bands), pickled and oiled strip, cold rolled and annealed strip and sheet, hot coated strip (principally zinc and zinc/aluminum), electroplated strip (principally chromium, tin, and zinc), and plates. Several non-integrated steel mills produce flat-rolled products, but most produce bar and bar products and small structural shapes. Non-integrated steel mills are more likely to ship hot rolled products without further surface treatments or finishing.

The type of steel finishing operation is closely related to the type of steel processed. For carbon steels, acid pickling with hydrochloric acid, cold forming and annealing, temper rolling, acid and/or alkaline cleaning, hot coating, and electroplating are performed. For stainless steels, descaling (molten salt bath and electrolytic sodium sulfate); sulfuric, nitric, nitric/hydrofluoric acid and sometimes hydrochloric acid pickling; cold forming and annealing; and temper rolling are likely to be performed. A number of steel finishing mills also perform surface coating of electrical steels.

Acid Pickling and Descaling

Acid pickling and descaling operations clean the steel surface prior to further processing (e.g., cold forming, application of protective and decorative coatings). The steel surface must also be cleaned at various production stages to ensure that oxides that form on the surface are not worked into the finished product, causing marring, staining, or other surface imperfections.

The acid pickling process chemically removes oxides and scale from the surface of the steel using water solutions of inorganic acids. While acid pickling is only one of several methods of removing undesirable surface oxides, it is most widely used because of comparatively low operating costs and ease of operation. Carbon steel is usually pickled with hydrochloric acid; stainless steels are pickled with sulfuric, hydrochloric, nitric, and/or hydrofluoric acids. The Agency estimates that 38 of the 69 acid pickling sites use hydrochloric acid, 33 use sulfuric acid, 28 use hydrofluoric acid, and 28 use nitric acid. The pickling process uses various organic chemicals that inhibit the acid from attacking the base metal while permitting it to attack the oxides. Wetting agents improve the effective contact of the acid solution with the metal surface. After the pickling bath, the steel passes through one or more rinse operations.

Finishing mills that conduct pickling operations may regenerate or recover the spent acid by removing the iron; acids can then be reused by the mill. Hydrochloric acid and sulfuric acid are the more commonly regenerated or recovered acids, although stainless steel finishing mills also recover nitric and mixed nitric/hydrofluoric acids.

Two common types of descaling operations are blast cleaning and salt bath descaling. Blast cleaning (mechanical descaling) uses abrasives such as sand, steel, iron grit, or shot to clean the steel surface. The abrasives come in contact with the steel using either a compressed air blast cleaning apparatus or by a rotary-type blasting cleaning machine. Salt bath descaling, a surface treatment operation, processes stainless or alloy steel products in molten salt solutions. This operation uses the physical and chemical properties of molten salt baths to loosen heavy scale from selected stainless and high-alloy steels; the scale is removed in subsequent water-quenching steps. Two processes, oxidizing and reducing, are commonly referred to by the names of proprietary molten salt descaling baths, Kolene® and Hydride®, respectively. Descaling may also be performed using an electrolytic solution of sodium sulfate.

Of the 69 sites operating acid pickling and descaling systems, 41 reported using wet air pollution control, and 14 reported using dry air pollution control. The remaining sites did not report the use of pollution control.

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. Cold rolling operations reduce the thickness of the steel much less than it is reduced in hot forming operations. Cold rolling imparts hardness to steel. The following table shows common products formed during cold forming.

1997 National Estimate for Type of Cold Forming Product

Type of Cold Forming Product	Number of Sites
Plate	5
Sheet	21
Strip	47

Source: U.S. EPA, U.S. EPA Collection of 1997 Iron and Steel Industry Data (Detailed and Short Surveys).

Common cold rolling mills in the iron and steel industry include tandem and temper mills. Tandem mills modify steel sheet properties, including strength, surface properties, and thickness. They are typically used in a series of three to five stands. Temper mills slightly improve the finish of steel sheet, such as shiny, dull, or grooved surfaces, and generally do not modify shape or thickness; they primarily improve flatness, alter mechanical properties, and minimize surface disturbances. Temper mills are typically used with only one or two stands (Reference 5-8).

Sendzimir cold rolling mills, commonly referred to as Z-mills, are another type of cold forming operation. Z-mills have various configurations, but generally steel passes through work rolls that are supported and driven by first- and second-intermediate rolls. The mill design allows for quick adjustments to vary the width, thickness, and hardness of the rolled steel. These mills typically use hydraulic fluid or oil emulsions rather than aqueous rolling solutions.

Cold rolling operations generate heat that is dissipated by flooded lubrication systems. These systems use palm oil or synthetic oils that are emulsified in water and directed in jets against the rolls and the steel surface during rolling.

Surface Treatment and Annealing Operations

Surface treatment and annealing operations include alkaline cleaning, annealing, hot coating, and electroplating. Facilities performing finishing operations often have a number of these operations on a single line.

Alkaline cleaning removes mineral and animal fats and oils from the steel surface. Caustic, soda ash, alkaline silicates, and phosphates are common alkaline cleaning agents. Passing the steel through alkaline solutions of specified compositions, concentrations, and temperatures is often enough to clean the product; however, for large-scale production or a cleaner product, sites may use electrolytic cleaning. Adding wetting agents to the cleaning bath also facilitates cleaning.

The annealing process heats steel to modify its bulk properties, which makes the steel easier to form and bend. Steel is heated and kept at a designated temperature and then cooled at a designated rate. Through the annealing process, the metal grain size increases, new bonds are formed at the higher temperature, and the steel becomes more ductile. Sites perform annealing through a batch or continuous process; they may follow annealing operations with a water quench to cool the steel for further processing.

Steel coating operations, such as hot coating and electroplating, improve resistance to corrosion or appearance. Hot coating operations involve immersing precleaned steel into molten baths of tin, zinc (hot galvanizing), combinations of lead and tin (terne coating), or combinations of aluminum and zinc (galvalume coating); any associated cleaning or fluxing (used to facilitate metal application) steps prior to immersion; and any post-immersion steps (e.g., chromium passivation). Based on survey responses, the metals used for hot coating operations include zinc, zinc/aluminum alloy, aluminum, chromium, lead, antimony, tin/lead alloy, and zinc/nickel alloy.

Electroplating uses electrodes to deposit a metal coating onto the steel. Historically, electroplating at steel mills was limited to tin and chromium electroplating for food and beverage markets and relatively low-tonnage production of zinc electroplated (electrogalvanized) steel for the automotive market. New coatings consisting of combinations of iron, nickel, and other metals have been developed. Based on survey responses, the metals used for electroplating operations include zinc, chromium, tin, nickel, brass, cobalt, copper, nickel/tin alloy, zinc/nickel alloy, and zinc/iron/aluminum alloy.

EPA estimates that, of the 98 sites performing surface treatment operations, 38 operate wet air pollution control systems and 16 operate dry systems.

5.3 References

5-1 American Iron and Steel Institute (AISI). Annual Statistical Report. Washington, DC, 1998.

5-2 U.S. Environmental Protection Agency. Preliminary Study of the Iron and Steel Category: 40 CFR Part 420 Effluent Limitations Guidelines and Standards. EPA 821-R-95-037, Washington, DC, September 1995.

5-3 Association of Iron and Steel Engineers. The Making, Shaping and Treating of Steel (10th edition). ISBN 0-930767-00-4, Pittsburgh, PA, 1985.

5-4 Knoerzer, Jeremy; Ellis, Charles E. The Design and Operation of Jewell's New Nonrecovery Coke Oven Batteries.

5-5 Association of Iron and Steel Engineers. The Making, Shaping and Treating of Steel (11th edition), Ironmaking Volume. Pittsburgh, PA, 1999.

5-6 Encyclopedia Britannica. Britannica.com. http:\\www.britannica.com, Chicago, IL.

5-7 The Forging Industry Association. The Forging Industry Association's How Are Forgings Produced?. http://www.forging.org/facts/wwhy6.htm, 2000.

5-8 American Iron and Steel Institute. AISI's Everything You Always Wanted to Know About Steel. . . A Glossary of Terms and Concepts. Courtesy of Michelle Applebaum, Managing Director (Summer 1998). Salomon Smith Barney Inc, http://www.steel.org/learning/glossary/, 2000.

Table 5-1

1997 National Estimate of Types of Iron and Steel Sites in the United States

Type of Site	Total Number of Sites Operating in 1997 (% of Industry Total)
Integrated steel mill with coke plant	9 (3.5%)
Integrated steel mill without coke plant	11 (4.5%)
Stand-alone coke plant	15 (6.0%)
Stand-alone sintering plant	2 (<1%)
Stand-alone direct-reduced ironmaking plant	1 (<1%)
Non-integrated steel mill	94 (37%)
Stand-alone hot forming mill	39 (15.5%)
Stand-alone finishing mill	70 (28%)
Stand-alone pipe and tube mill	11 (4.5%)
TOTAL (a)	**254**

Source: U.S. EPA, U.S. EPA Collection of 1997 Iron and Steel Industry Data (Detailed and Short Surveys).
(a) Columns do not sum to totals because of rounding each number and because two sites are counted as one integrated steel mill.

Table 5-2

1997 National Estimate of Sites Producing or Processing Carbon, Alloy, or Stainless Steel

Type of Site (a)	Total Number of Sites (a)	Number of Sites Producing Each Type of Steel		
		Carbon Steel	Stainless Steel	Alloy Steel
Integrated steel mill with coke plant	9	9	1	6
Integrated steel mill without coke plant	11	11	2	5
Non-integrated steel mill	94	72	20	58
Stand-alone hot forming mill	39	26	10	19
Stand-alone finishing mill	70	45	24	21
Stand-alone pipe and tube mill	11	11	0	6
TOTAL	**234**	**174**	**57**	**115**

Source: U.S. EPA, U.S. EPA Collection of 1997 Iron and Steel Industry Data (Detailed and Short Surveys).
(a) The sum of the numbers of sites producing each steel type may not equal the total number of sites. Sites may produce more than one steel type.

Table 5-3

1997 National Estimate of Direct, Indirect, and Zero or Alternative Discharging Sites

Type of Site	Total Number of Sites (a)	Number (%) of Direct Dischargers	Number (%) of Indirect Dischargers	Number (%) of Zero or Alternative Dischargers (b)
Integrated steel mill with coke plant	9	8 (89%)	3 (33%)	0 (c)
Integrated steel mill without coke plant	11	11 (100%)	0 (c)	0 (c)
Stand-alone coke plant	15	9 (60%)	5 (33%)	1 (7%)
Stand-alone sintering plant	2	1 (50%)	0 (c)	1 (50%)
Stand-alone direct-reduced ironmaking plant	1	0 (c)	1 (100%)	0 (c)
Non-integrated steel mill	94	46 (49%)	19 (20%)	32 (34%)
Stand-alone hot forming mill	39	22 (56%)	6 (15%)	12 (31%)
Stand-alone finishing mill	70	28 (40%)	34 (49%)	11 (16%)
Stand-alone pipe and tube mill	11	8 (72%)	3 (27%)	0 (c)
TOTAL (d)	**254**	**133 (53%)**	**70 (28%)**	**56 (22%)**

Source: U.S. EPA, U.S. EPA Collection of 1997 Iron and Steel Industry Data (Detailed and Short Surveys).
(a) The sum of direct dischargers, indirect dischargers, and zero dischargers may not equal the total number of sites. Sites may directly and indirectly discharge wastewater from their site.
(b) Zero dischargers include sites that do not discharge process wastewater and sites that are completely dry (i.e., do not use water in iron and steel operations).
(c) Cells with a zero (0) value indicate that none of the survey respondents have the characteristic.
(d) Columns do not sum to totals because of rounding each number and because two sites are counted as one integrated mill.

Table 5-4

1997 National Estimate of Actual Production and Rated Capacity by Manufacturing Operation

Manufacturing Operation	Total Number of Sites with this Operation	Total 1997 Production (million standard tons)	Total 1997 Rated Capacity (million standard tons)
Cokemaking	24	20.4	22.6
Sintering	9	12.4	17.9
Blast furnace ironmaking	20	54.5	68.6
BOF steelmaking	20	65.9	78.3
EAF steelmaking	96	50.8	75.8
Vacuum degassing	44	18.0	39.1
Ladle metallurgy	103	102	157
Casting	113	110	142
Hot forming	153	127	177 (a)
Acid pickling and descaling	69	48.3	67.9 (a)
Cold forming	103	72.8	105
Surface cleaning and coating	98	35.3	40.1
Briquetting and other agglomeration process	4	0.319	0.731
Direct-reduced ironmaking	2	0.581	1.56

Source: U.S. EPA, U.S. EPA Collection of 1997 Iron and Steel Industry Data (Detailed and Short Surveys).
(a) This estimate does not represent a national estimate of capacity because it is based on data only from the detailed survey. Production capacity was not requested in the short survey.

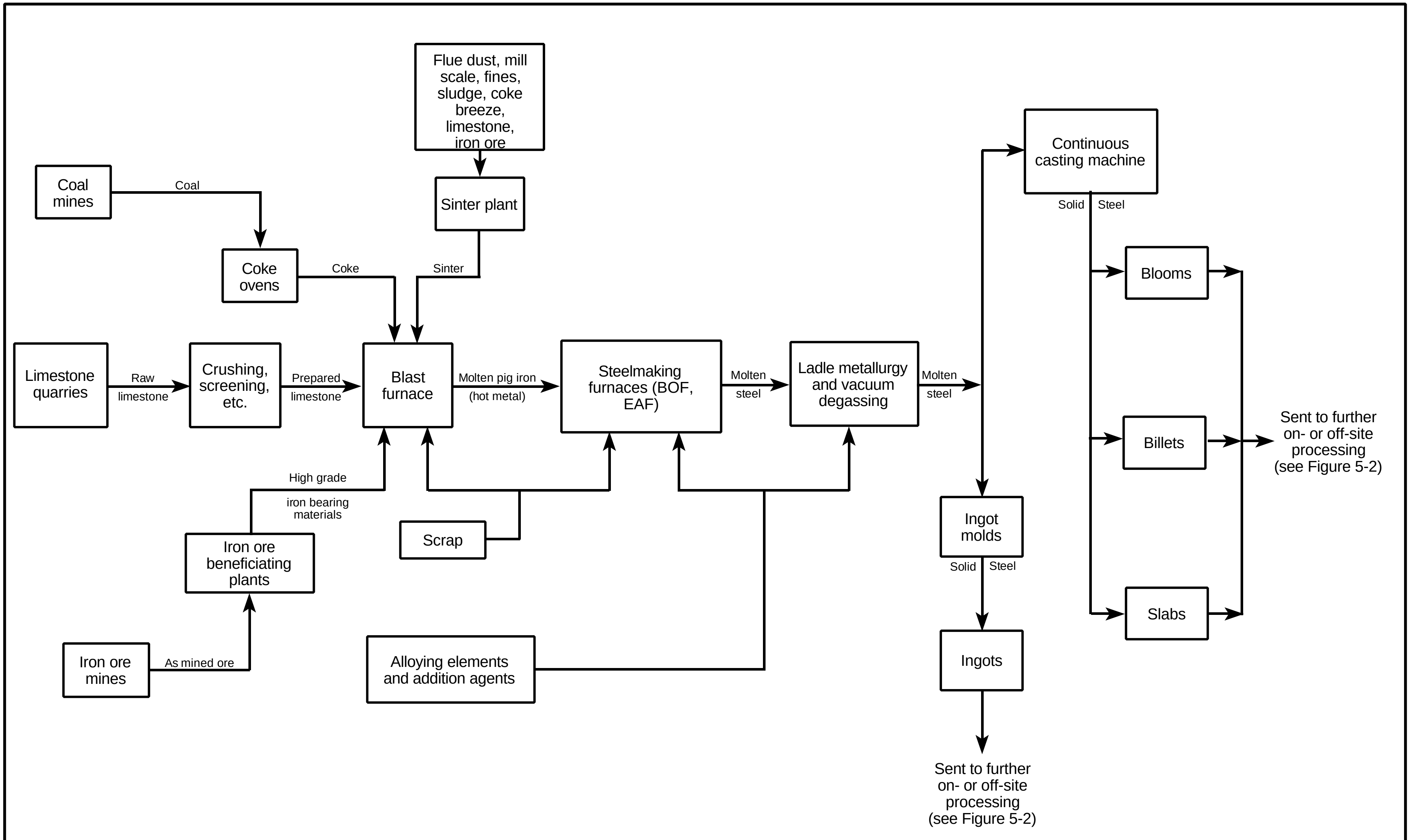


Figure 5-1. Iron and Steelmaking Operations

FIG5-1 4/30/02

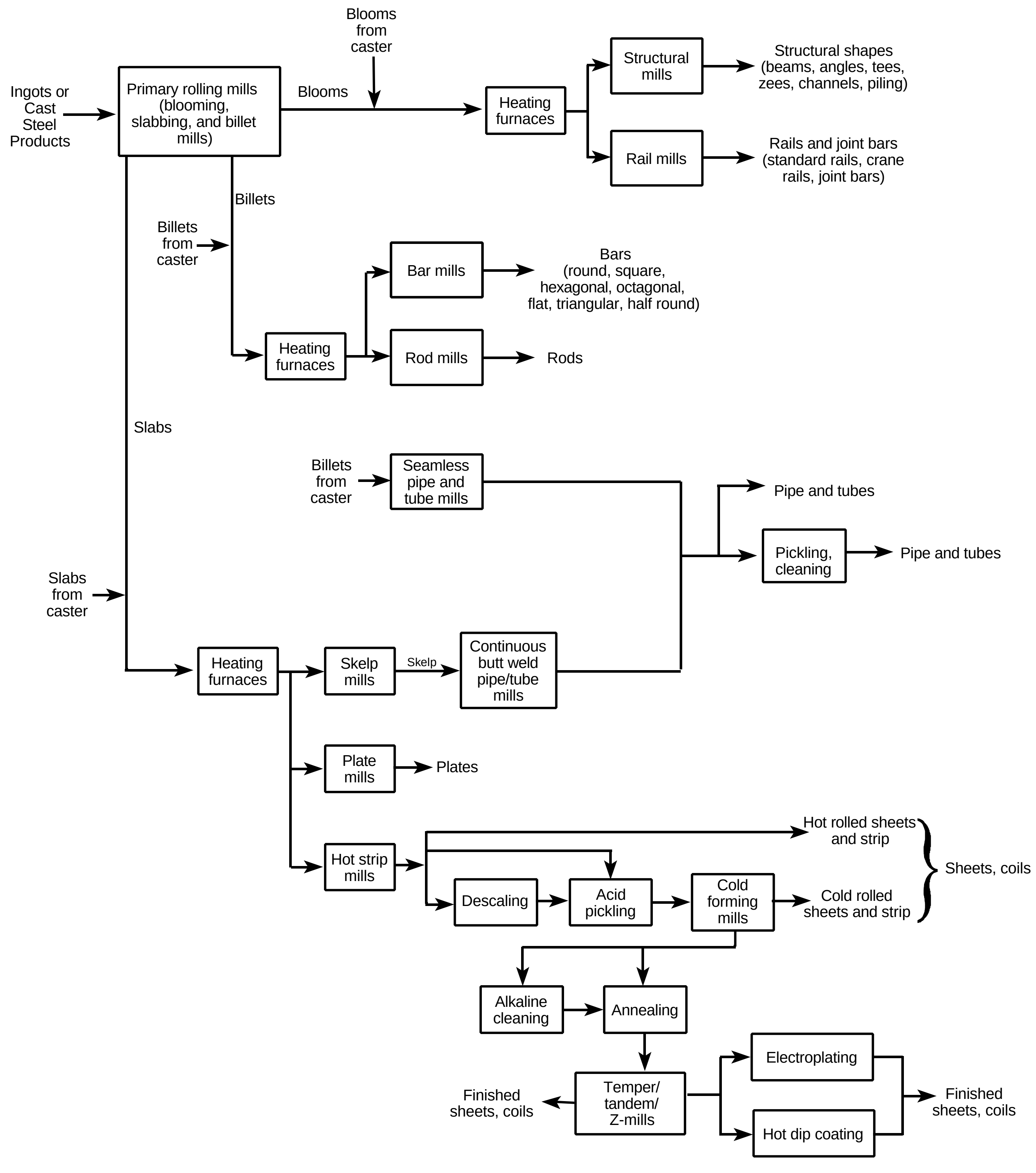
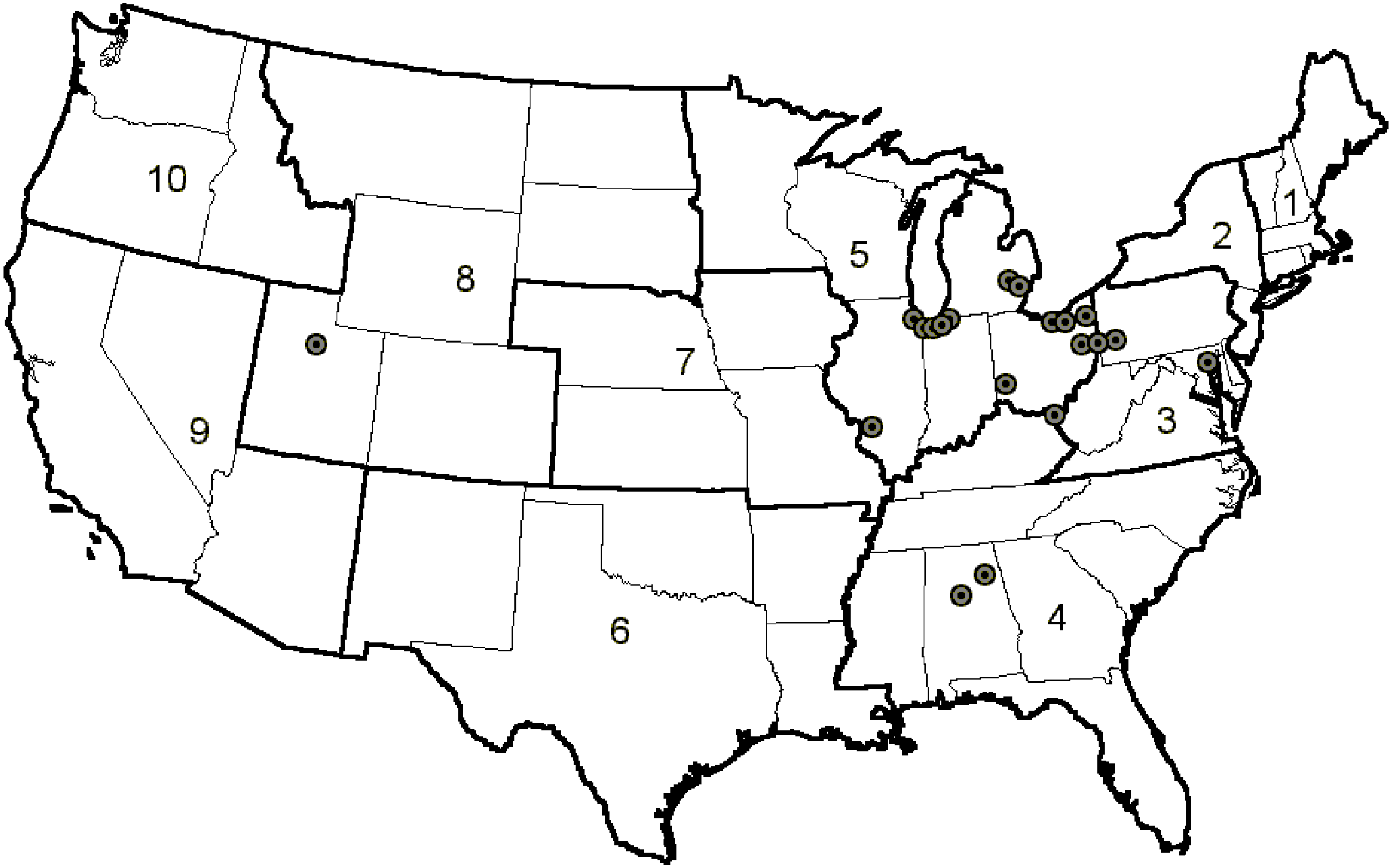


Figure 5-2. Forming and Finishing Operations

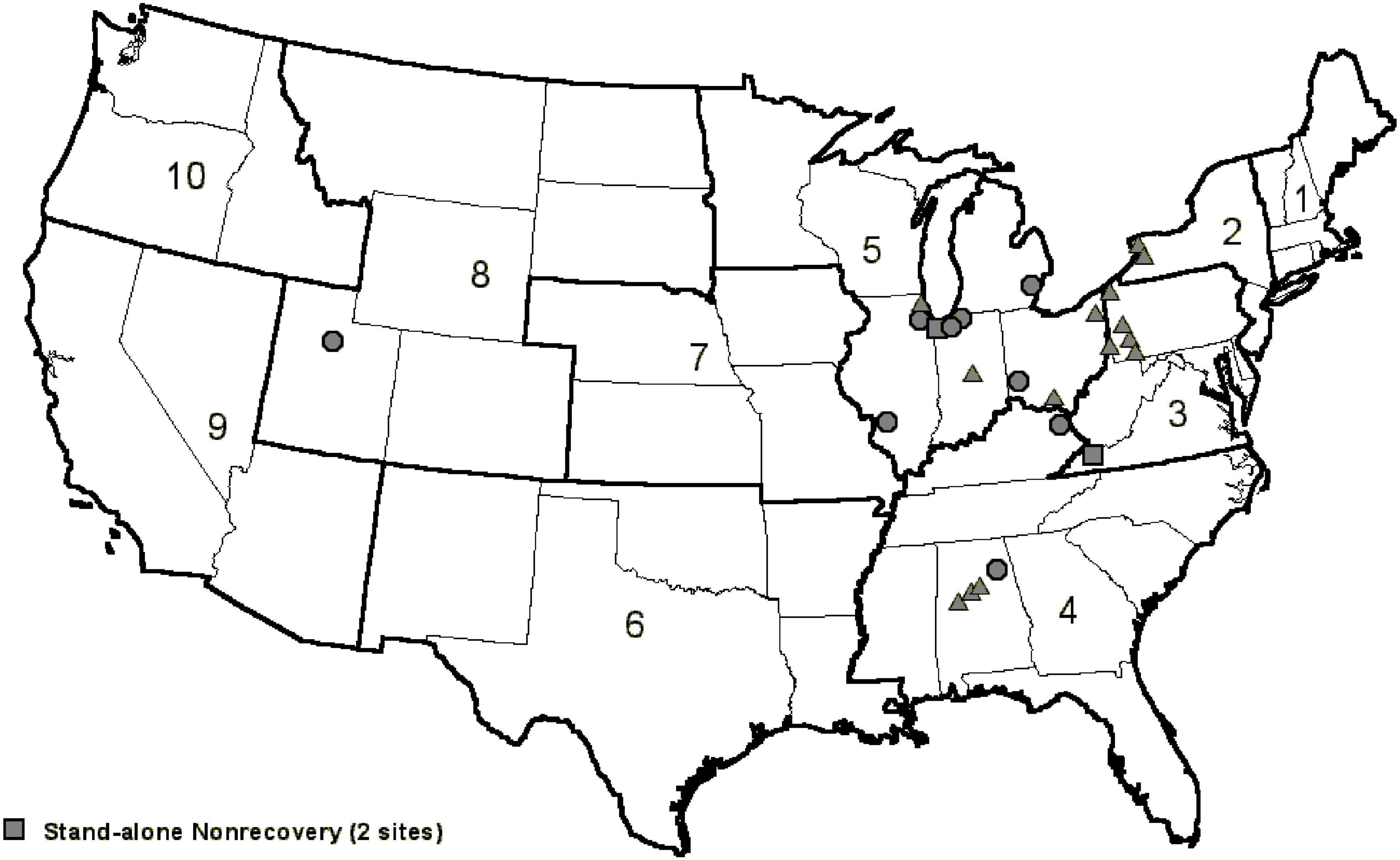
FIG5_2 | 4/30/02 | EPA

Figure 5-3.
Integrated Steel Manufacturing Sites



Smaller stand-alone forming and finishing facilities are generally located near steel manufacturing sites.

Figure 5-4.
Cokemaking Sites



■ Stand-alone Nonrecovery (2 sites)

● By-product Recovery Co-located at Integrated Steel Mills (9 sites)

▲ Stand-alone By-product Recovery (14 sites)

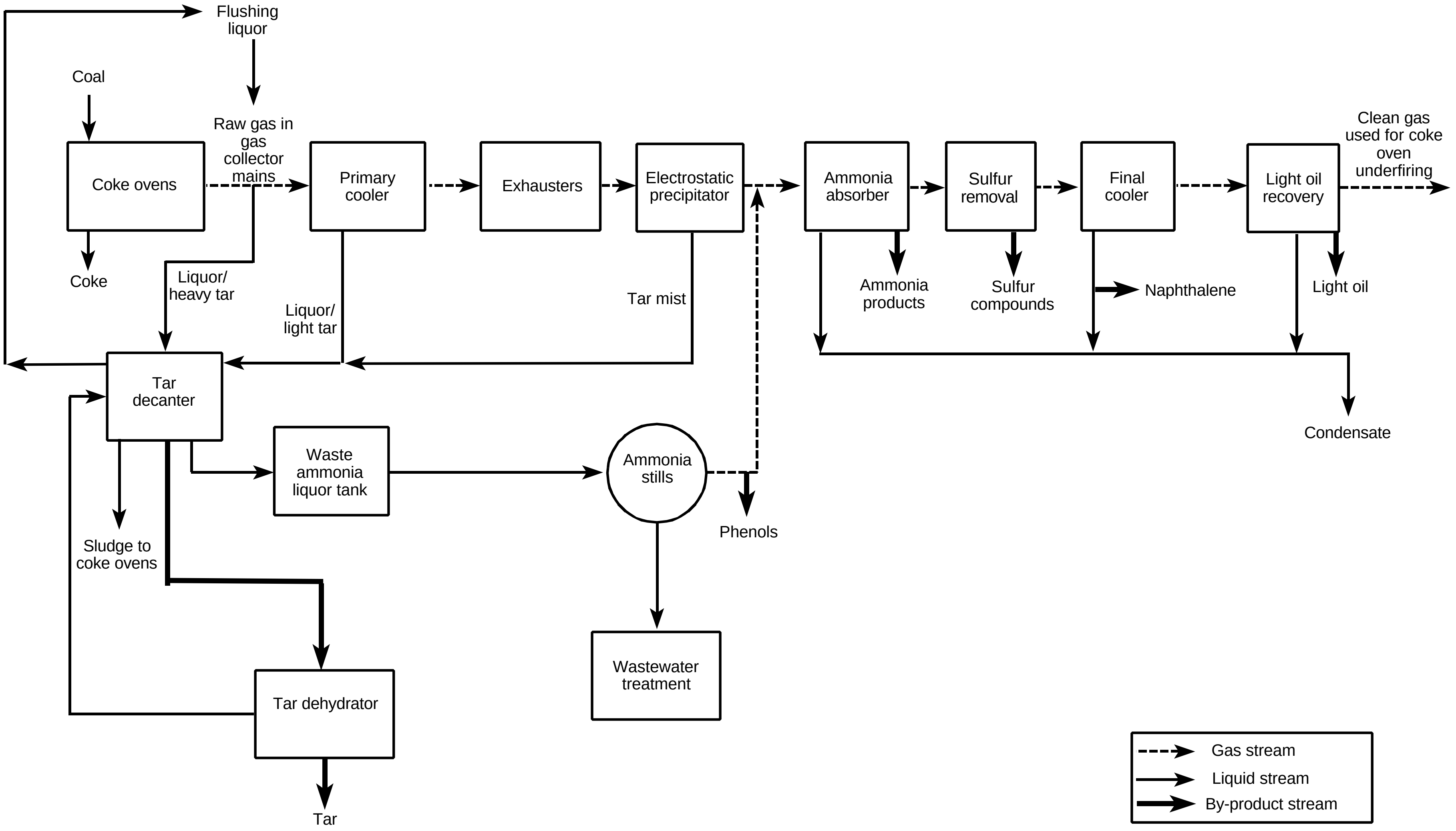


Figure 5-5. By-Product Recovery Cokemaking Process Diagram

FIG5-5 4/30/02 EPA