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Taconite Iron Ore NESHAP Economic Impact Analysis

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Taconite Iron Ore NESHAP Economic Impact Analysis

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EXECUTIVE SUMMARY

Under Section 112 of the Clean Air Act (the Act), the U.S. Environmental Protection Agency (EPA) is developing national emission standards for hazardous air pollutants (NESHAP) for the taconite processing source category. Taconite processing involves separating and concentrating iron ore as well as creating and indurating (hardening) pellets. Taconite production in the United States is concentrated in a few counties in Minnesota and Michigan.

To better control emissions of hazardous air pollutants (HAPs) during these processes, EPA expects that additional emission control equipment will be installed for indurating furnaces and other part of the operation, such as onsite crushing and handling and pellet handling. Table ES-1 provides detail on the estimated total costs. Incorporating comments from industry, the Agency has estimated the total capital costs of complying with the rule to be approximately $57 million, and the total annualized cost (including the costs of new capital equipment and new operation, maintenance, monitoring, record keeping, and reporting [MRR] activities) to be $8.61 million. The controls will increase the cost of producing taconite pellets and the iron and steel made from those pellets. For this reason, the Agency examined the economic impacts on the industry using an integrated mathematical model that simulates the market response of taconite and iron and steel producers to the estimated costs of compliance. The model predicts that the price of taconite will increase by approximately $0.10 per metric ton (0.18 percent of the current price), while domestic taconite production is projected to decline by 70,000 metric tons (0.14 percent of the total production). Additional results are presented in Table ES-2.

Further, the Agency conducted a regional impact analysis using IMPLAN (an input-output model) recognizing the fact that taconite production facilities are highly geographically concentrated in Minnesota and Michigan. However, these incremental regional impacts are projected to be very small. The IMPLAN results reported in Table ES-3 indicate that the $0.4 million of direct costs that are imposed on the region cause the regional economy another $0.2 million loss via indirect and induced effects. Overall, EPA estimates that the rule may lead to approximately seven layoffs.

Table ES-1. Estimated Total Costs of the Taconite NESHAP (10^6 \$2002)

Cost Component	Total Capital Cost (\$$10^6$)	Annualized Capital Cost (10^6 \$/yr)	O&M Cost (10^6 \$/yr)	MRR Labor Cost (10^6 \$/yr)	Total Annualized Cost (10^6 \$/yr)
Emission Control Cost	52.8	4.53	3.16		7.7
Monitoring, Record keeping and Recording Cost	4.58	0.39	0.12	0.4	0.91
Total Cost	57.4	4.93	3.28	0.4	8.61

Table ES-2. Social Costs: (10^6 \$2002)

	Value (\$$10^6$)
Consumer Surplus Loss (–)/Gain (+)	–\$2.86
Producer Surplus Loss (–)/Gain (+)	–\$5.73
Merchant Taconite Producers	–\$3.59
Integrated Iron and Steel Plants	–\$4.51
Nonintegrated Steel Plants	\$1.09
Foreign Producers	\$1.27
Total Social Costs	–\$8.60

This economic impact analysis (EIA) is organized as follows. Section 1 provides an introduction to the analysis. Section 2 describes the taconite industry and affected production processes. Section 3 reports the estimated national control costs. Section 4 presents the analytical methods used and the estimated economic impacts of the rule. Appendix A resents the data used in the economic model and the equations within the model. Appendix B provides a sensitivity analysis by varying elasticities of demand and supply.

Table ES-3. Estimated Total Impacts of the Taconite NESHAP on Value of Output (10^3 $2002)[a]

	Minnesota	Michigan
Direct effect	–847	492
Indirect effect	–222	143
Induced effect	–168	69
Total Impact	–1,236	704

[a] All amounts were inflated using the consumer price index available from the Bureau of Labor Statistics (<http://data.bls.gov/cgi-bin/surveymost>).

Source: Minnesota IMPLAN Group (MIG). 2001. IMPLAN county data for Minnesota and Michigan. IMPLAN impact report of output.

SECTION 1

INTRODUCTION

Under Section 112 of the Clean Air Act (the Act), the U.S. Environmental Protection Agency (EPA) is developing national emission standards for hazardous air pollutants (NESHAP) for the taconite processing source category. Taconite mining and processing fall under the North American Industry Classification System (NAICS) 21221 Iron Ore Mining. According to the 1997 Economic Census of Manufacturing, in 1997, 32 establishments owned by 26 companies produced products that are categorized in NAICS 21221 (U.S. Department of Commerce, Bureau of the Census, 2000). In 1997, these firms employed 7,920 workers and shipped products valued at $1.9 billion (U.S. Department of Commerce, Bureau of the Census, 2000).

Since 1997, however, the number of companies, plants, and employees in the industry and the value of product shipments from the industry have declined. Demand for domestic iron ore is entirely dependent on the steel industry. Because of massive imports of foreign semifinished steel and iron ore, as well as the adverse effect of the 1997 Asian financial crisis, approximately 20 domestic steel companies have filed for bankruptcy since 1997 (Skillings Mining Review, 2000; Kirk, 2000a; Kirk, 2000b). Concurrently, the domestic iron ore industry has experienced major structural changes through company mergers and acquisitions. As reported in the 2003 U.S. Geological Survey Mineral Commodity Summaries, in 2002, 11 iron ore companies owned 11 mining operations, eight concentration plants, and eight pelletizing plants. During the same period, these firms employed approximately 5,000 workers and shipped products valued at $1.2 billion (Kirk, 2003).

Taconite, the principal iron ore mined in the United States, has a low (20 percent to 30 percent) iron (Fe) content and is found in hard, fine-grained, banded iron formations. The main taconite iron ore deposits are located near Lake Superior in Minnesota (Mesabi Iron Range) and Michigan (Marquette Iron Range). The taconite mining operations in Michigan and Minnesota accounted for virtually all domestic iron ore production (Kirk, 2003). The following taconite ore production processes will be covered by the rule (EPA, 2001):

- liberation of the iron ore by wet or dry crushing and grinding in gyratory crushers, cone crushers, rod mills, and ball mills;

- concentrating of the iron ore by magnetic separation or flotation;
- pelletization by wet tumbling with a balling drum or balling disc; and
- indurating using a vertical shaft furnace, straight grate, or grate/kiln, and material handling (transfer, pellet cooling) of the indurated pellets.

Better control of HAP emissions from these processes will lead to increases in their operating costs. This in turn will increase the cost of producing taconite pellets and the iron and steel made from those pellets, affecting prices and quantities in both the market for taconite and the markets for steel and iron products that taconite is used to produce. Therefore, this economic impact analysis (EIA) analyzes the economic impacts of the compliance costs on the industry, based on a conventional economic framework. Because the economies of the states and localities where taconite is mined are so dependent on taconite, we also analyze the local and regional impacts of the rule. The report is organized as follows:

- Section 2 provides background information on the taconite industry and describes the affected production processes in great detail.
- Section 3 reports the estimated national control costs based on different emissions control equipments for indurating furnaces, onsite crushing and handling facilities, and pellet handling operations.
- Section 4 presents an integrated mathematical economic model that simulates the market response of taconite and iron and steel producers to the estimated costs of compliance. Section 4 also presents the estimated impacts on the markets for taconite and steel, companies in the taconite industry, and the regions where taconite production is concentrated.
- Appendix A provides details about data and methodology, and Appendix B presents the results of a sensitivity analysis of estimated demand and supply elasticities.

SECTION 2

INDUSTRY PROFILE

This industry profile provides information to support the economic impact analysis (EIA) of a National Emission Standard for Hazardous Air Pollutants (NESHAP) regarding taconite iron ore processing. Taconite mining and processing fall under the North American Industry Classification System (NAICS) 21221 Iron Ore Mining. Using the NAICS definition, this industry comprises establishments primarily engaged in (1) developing mine sites, mining, and/or beneficiating (i.e., preparing) iron ores and manganiferous ores valued chiefly for their iron content and/or (2) producing sinter iron ore (except iron ore produced in iron and steel mills) and other iron ore agglomerates (U.S. Department of Commerce, Bureau of the Census, 2001).

Taconite, the principal iron ore mined in the United States, has a low (20 percent to 30 percent) iron (Fe) content and is found in hard, fine-grained, banded iron formations. The main taconite iron ore deposits are located near Lake Superior in Minnesota and Michigan. According to the Economic Census of Manufacturing, in 1997, 32 establishments owned by 26 iron ore companies produced products that are categorized in NAICS 21221 (U.S. Department of Commerce, Bureau of the Census, 2001). In 1997, these firms employed 7,920 workers and shipped products valued at $1.9 billion (U.S. Department of Commerce, Bureau of the Census, 2001). Since 1997, however, the number of companies, plants, and employees in the industry has declined. Demand for domestic iron ore is entirely dependent on the steel industry. Due to massive imports of foreign semifinished steel and iron ore, as well as the adverse effect of the 1997 Asian financial crisis, 35 domestic steel companies have filed for bankruptcy since 1997 (United Steelworkers of America, 2002). Concurrently, the domestic iron ore industry has experienced major structural changes through company mergers and acquisitions.

As reported in the 2003 U.S. Geological Survey Mineral Commodity Summaries, in 2002, 11 iron ore companies owned 11 mining operations, 8 concentration plants, and 8 pelletizing plants. During the same period, these firms employed approximately 5,000 workers and shipped products valued at $1.2 billion (Kirk, 2003). Of the 11 mining operations, 6 were taconite facilities on the Mesabi Iron Range in Northern Minnesota and 2 were on the Marquette

Iron Range in the Upper Peninsula of Michigan. Virtually all domestic iron ore production was from the 8 taconite mining operations in Minnesota and Michigan that were operated by 5 companies (Kirk, 2003).

The following taconite ore production processes will be covered by the rule (EPA, 2001):

- liberation of the iron ore by wet or dry crushing and grinding in gyratory crushers, cone crushers, rod mills, and ball mills;
- concentrating of the iron ore by magnetic separation or flotation;
- pelletization by wet tumbling with a balling drum or balling disc; and
- indurating using a vertical shaft furnace, straight grate, or grate/kiln, and material handling (transfer, pellet cooling) of the indurated pellets.

The economic effects of the rule are conditional on the technology for producing taconite iron ore and their costs of production, the value of the taconite products to end users, and the organization of the industries engaged in iron ore production and use. Due to the present condition of the iron ore industry, some tables of information from government sources that present data for prior years (e.g., 1997) may not reflect the current situation of the industry. To the extent possible, we update ownership and operating characteristics to the year 2002. Overall, this profile provides background information on these topics organized within a conventional economic framework:

- Section 2.1 includes a detailed description of the production process for the taconite mining industry, with a brief discussion of the inputs to the production process and costs of production.
- Section 2.2 describes the characteristics, uses, and consumers of iron ore pellets as well as substitution possibilities.
- Section 2.3 discusses the organization of the industry and provides facility- and company-level data. Usually, small businesses are reported separately for use in evaluating the impact on small businesses to meet the requirements of the Regulatory Flexibility Act (RFA) as amended in 1996 by the Small Business Regulatory Enforcement and Fairness Act (SBREFA). Because the iron ore industry has no small businesses, we do not address any issues associated with them.
- Section 2.4 contains market-level data on prices and quantities and discusses trends and projections for the industry.

2.1 The Supply Side

Domestic iron ore supply (production minus exports) satisfied 60 percent of domestic demand in 2001 (Kirk, 2001b). Taconite ores mined in Minnesota and Michigan accounted for virtually all the domestic useable ore production. Minnesota produced 73 percent of the national output of useable ore while Michigan accounted for about 27 percent (Kirk, 2001b). The production process typically involves four stages, and taconite iron ore is the primary input. The production process, product characteristics, and associated costs of production are described in detail in the following subsections.

2.1.1 Taconite Pellet Production Processes, Inputs and Outputs

Low-grade taconite ore in Minnesota and Michigan is the primary source of iron for the iron and steel industry in the United States. Taconite iron ore processes are illustrated in Figure 2-1. Figure 2-1 also demonstrates the emission points from taconite ore production. Three types of hazardous air pollutants (HAPs) are released from the processes: acidic gases (hydrochloric and hydrofluoric acid), metallic particulate matter, and products of incomplete combustion (PICs) (EPA, 2001).

2.1.1.1 Mining of Crude Ore

Iron ore is a mineral substance that, when heated in the presence of a reductant, yields metallic iron (Fe). It almost always consists of iron oxides, the primary forms of which are magnetite (Fe_3O_4—iron content 72.4 percent), hematite (Fe_2O_3—iron content 69.9 percent), and goethite ($Fe_2O_3H_2O$—iron content 62.9 percent) (McKetta, 1988). Table 2-1 shows that domestic taconite iron ore is generally mined and processed on the Mesabi Iron Range of northern Minnesota and the Marquette Iron Range of the Upper Peninsula of Michigan. Domestic ore is mined from open pits because most commercial ore bodies lie close to the surface and their lateral dimensions are large. Mining activities involve overburden removal, drilling, blasting, and removal of waste rock and crude taconite from the open-pit (EPA, 2001).

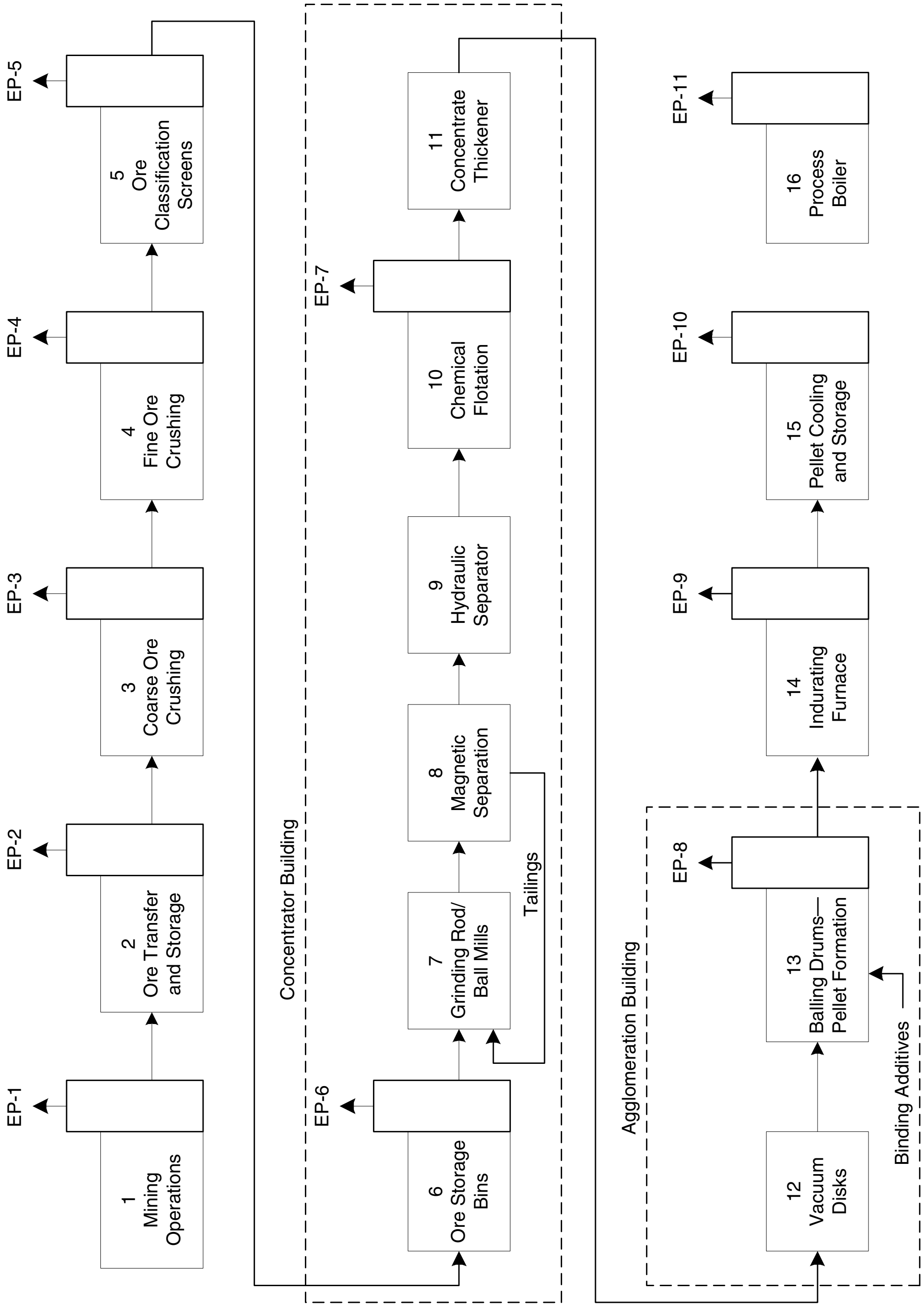

Figure 2-1. Process Flow Diagram for Taconite Iron Ore Processing

Table 2-1. Iron Ore Mined and Pelletized in the United States, 2001 (10^3 metric tons)

District and State	Number of Mines [a]	Crude Ore	Usable Ore
Lake Superior			
Minnesota	6	117,000	33,800
Michigan	2	36,800	12,300
Other States	3	78	83
Total	11	154,000	46,200

[a] Status in 2003.
Data are rounded and may not add to total.
Source: Kirk, W.S. 2001b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-2001. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/feormyb01.pdf>.
Kirk, W.S. 2003. "Iron Ore." U.S. Geological Survey Mineral Commodity Summaries. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340303.pdf>.

Mining in open pits is mostly done with large powerful shovels and trucks. Shovels at taconite mines are used to dig surface overburden as well as iron ore and waste rock. Rotary drills with 12- to 17 ½-inch bits are used to create holes about 16 inches in diameter to a depth of 45 to 55 feet into the taconite ore for explosives to be placed for blasting activities. The commonly used blasting agent is a mixture of ammonium nitrate fertilizer and fuel oil (called ANFO), which is pumped into the holes. The quantity of taconite broken by individual blasts usually ranges from about 0.4 to 1.5 million tons. Trucks then transport the crude iron ore to the primary or coarse crushers. In some mining operations, trains are used to haul ore to the crushers (EPA, 2001; EPA, 1994; McKetta, 1988).

2.1.1.2 Beneficiation

The mined taconite is beneficiated to increase its iron content, reduce the content of impurities, and improve its physical structure, according to the needs of consumers. Beneficiation processes typically involve milling (crushing and grinding); screening; washing; and processes that separate ore minerals from gangue (sand, rock, and other impurities surrounding the iron) by differences in physical or chemical properties. Figure 2-2 illustrates the general beneficiation processes. Table 2-2 presents the crushing stages operating at the taconite facilities located in Minnesota and Michigan (EPA, 2001).

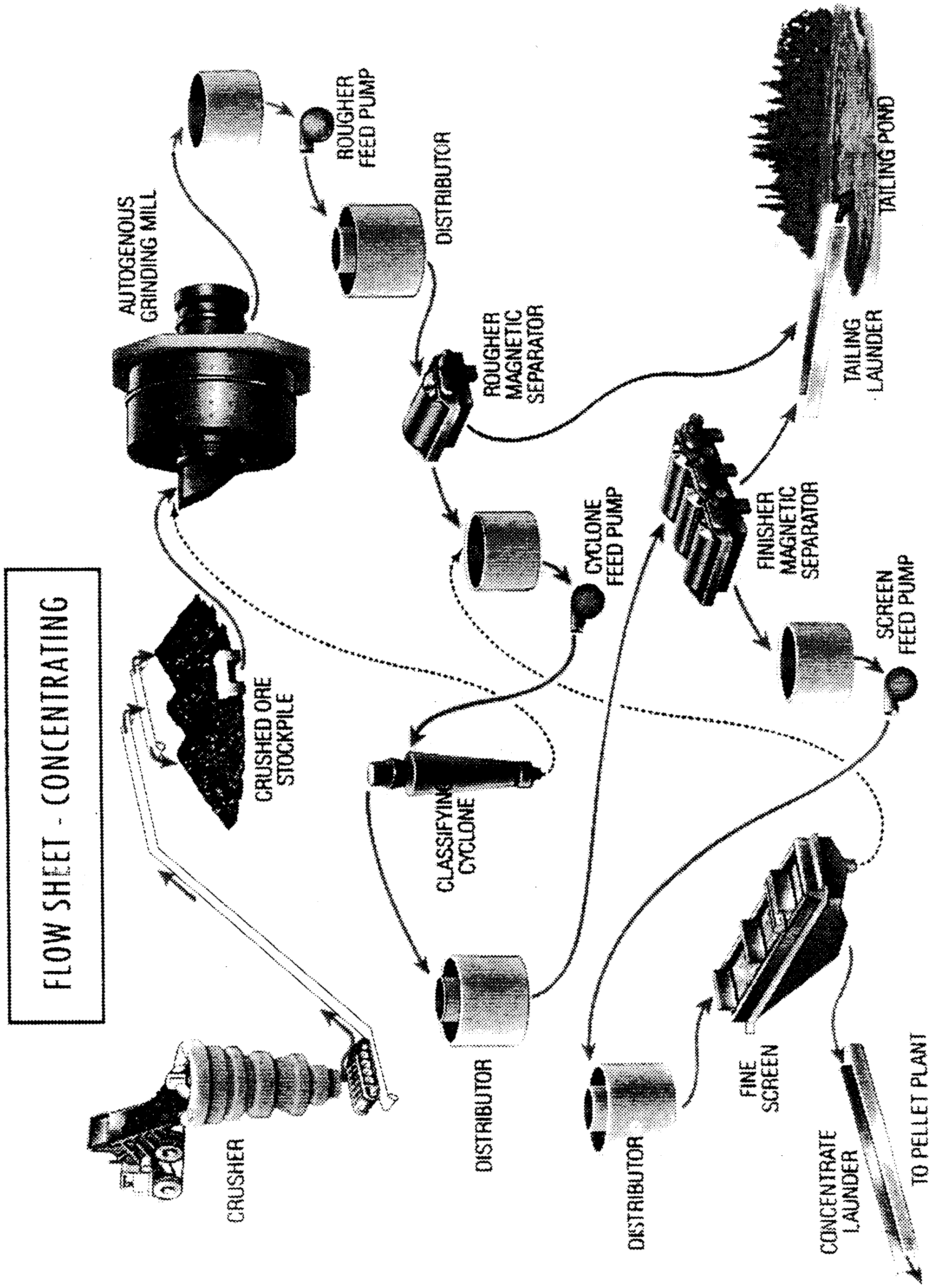

Figure 2-2. Flow Sheet: Concentrating

Table 2-2. Crushing Stages Operated at Eight Taconite Facilities in Michigan and Minnesota, 2000

State	Company	Mine	Pelletizing Plant	Stages of Crushing	Number of Indurating Furnaces
Michigan	Empire Iron Mining Partnership	Palmer[a]	Palmer	Single	2
	Tilden Mining Co., LC	Ishpeming[a]	Ishpeming	Single	1
Minnesota	EVTAC Mining, LLC	Eveleth[b]	Forbes[b]	Four	2
	Hibbing Taconite Co.	Hibbings[b]	Hibbing	Single	2
	Ispat-Inland Steel Mining Co.	Virginia[b]	Virginia	Three	2
	National Steel Pellet Co.	Keewatin[c]	Keewatin	Single	2
	Northshore Mining Co.	Babbitt[b]	Silver Bay[d]	Three	2
	U.S. Steel LLC (Minntac)	Mountain Iron[b]	Mountain Iron	Three	3

[a] Located in Marquette County
[b] Located in Saint Louis County
[c] Located in Itasca County
[d] Located in Lake County

Source: U.S. Environmental Protection Agency (EPA). 2001. *National Emissions Standard for Hazardous Air Pollutants (NESHAPs) for Taconite Iron Ore Processing Plants—Background Information for Proposed Standards*. Washington, DC: U.S. Environmental Protection Agency.

After crushing, the ore is sent to rod mills for fine grinding, then sent to either ball or pebble mills (McKetta, 1988). The taconite ore slurry discharged from the rod/ball mills is passed through multiple stages of magnetic separation (EPA, 2001). Magnetic separation involves three stages: cobbing, cleaning/roughing, and finishing. Each stage works on finer particles as a result of removing oversized particles in earlier separations. Ore material not picked up by magnetic separators is rejected as nonmagnetic gangue or tailings, which are re-ground to extract as much iron as possible. Cleaners and finishers then work on ore particles in the range of 48 mesh and less than 100 mesh, respectively (EPA, 2001; EPA, 1994).

The iron-bearing slurry flows into a hydraulic concentrator where excess water is removed through gravity separation. Sediment collected at the bottom of the concentrator is passed on to the chemical flotation unit (see EPA Technical Resource Document, 1994, for details of these processes,). In the flotation process, three types of additives are used to upgrade the iron ore concentrates by removing residual gangue (silica) from the iron-bearing slurry:

frothers, collectors/amines, and anifoams. Then the iron-rich concentrates become the raw materials for producing taconite pellets in the agglomerating process (EPA, 1994).

2.1.1.3 Agglomeration

After beneficiation activities, agglomeration is used to combine the iron-rich concentrates into pellets, sinter, briquettes, or nodules. This section focuses only on the pelletizing (indurating) processes because pellets account for more than 95 percent of domestic iron ore production. Figure 2-3 illustrates the typical pelletizing procedures. In the pelletizing processes, the iron-rich concentrates are mixed with water and a binder, normally bentonite (clay), hydrated lime, or organic material (peridor). Then the concentrate is rolled into marble-sized balls (3/8 to 5/8 inch [9-15 mm] in diameter) inside large rotating cylinders. These green (moist and unfired) balls are then dried and heated to 2,354 to 2,552°F. The induration or heating of the green balls can be done in a vertical shaft furnace on a travel grate or straight grate or by a combination of a travel grate and a rotary kiln, or grate-kiln (see EPA Taconite MACT draft report for technical details; EPA, 2001). The finished product is taconite pellets. As Table 2-3 shows, the travel grate and grate-kiln are the most commonly used types of indurating furnaces in the pelletizing processes in the United States (EPA, 2001; EPA, 1994).

2.1.2 Types of Products

Ninety-nine percent of domestic iron ore production was pelletized before shipment (Kirk, 2001b). Standard (acid) pellets and fluxed pellets (pellets with a basicity ratio of 0.6 or greater [American Iron Ore Association, 2000]) are the two major types of pellet products. In addition to iron, standard pellets can include silica, alumina, magnesia, manganese, phosphorus, and sulfur. Fluxed pellets contain a certain amount of limestone (calcium carbonate, $CaCO_3$) and/or dolomite, in addition to all the constituents of standard pellets. Sometimes fluxed pellets are characterized by basicity ratio, which is a mass ratio of the sum of calcium oxide and magnesium oxide divided by the sum of silicon oxide and aluminum oxide:

$$\text{Basicity ratio} = [(CaO + MgO)/(SiO_2 + Al_2O_3)]$$

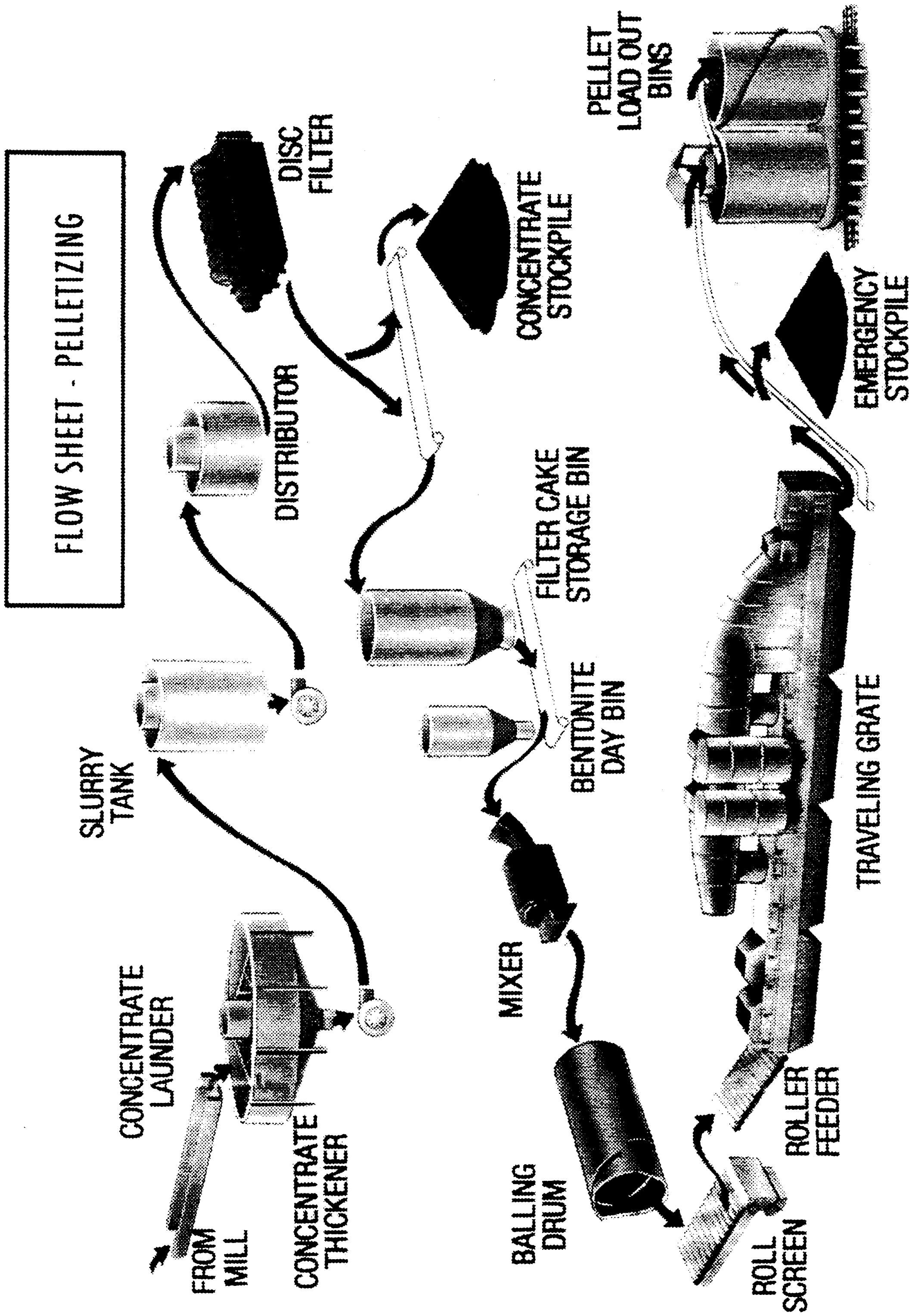

Figure 2-3. Flow Sheet: Pelletizing

Table 2-3. Types of Indurating Furnaces Used at Eight Taconite Facilities, 2000

State	Company	Mine	Pelletizing Plant	Type of Indurating Furnaces	Number of Indurating Furnaces
Michigan	Empire Iron Mining Partnership	Palmer[a]	Palmer	Grate-kiln	4
	Tilden Mining Co., LC	Ishpeming[a]	Ishpeming	Grate-kiln	2
Minnesota	EVTAC Mining, LLC	Eveleth[b]	Forbes[b]	Grate-kiln	2
	Hibbing Taconite Co.	Hibbing[b]	Hibbing	Travel grate	3
	Ispat-Inland Steel Mining Co.	Virginia[b]	Virginia	Travel grate	1
	National Steel Pellet Co.	Keewatin[c]	Keewatin	Grate-kiln	1
	Northshore Mining Co.	Babbitt[b]	Silver Bay[d]	Travel grate	4
	U.S. Steel LLC (Minntac)	Mountain Iron[b]	Mountain Iron	Grate-kiln	5

[a] Located in Marguette County
[b] Located in Saint Louis County
[c] Located in Itasca County
[d] Located in Lake County

Source: U.S. Environmental Protection Agency (EPA). 2000. *Economic Impact Analysis of Proposed Integrated Iron and Steel*. Washington, DC: U.S. Environmental Protection Agency.

Fluxed pellets of at least 1.0 basicity ratio are called fully fluxed pellets. Fluxed pellets accounted for 66 percent of total pellet production in 2001, which was 45.8 million tons (Kirk, 2001b).

2.1.3 Major By-Products, Co-Products, and Input Substitution Possibilities

Manganese, phosphorus (apatite), cobalt, copper, vanadium, and small quantities of silver and gold are the by-products or co-products of domestic iron ores. Manganese has a close association with iron so that the oxides of both metals are usually smelted together. Cobalt was an important by-product of iron ore mined in Pennsylvania until 1972. Both vanadium and cobalt are not economically recoverable (McKetta, 1988).

Iron ore is the only source of primary iron. Magnetite (taconite), hematite (jaspilite), goethite (limonite), siderite, ilmenite, and pyrite are the major types of iron ores mined around the world. In the United States, magnetite, hematite and goethite are the most common ore types. Minnesota and Michigan mostly produce magnetite and hematite with a small amount of goethite. Other minor iron ore deposits located in Missouri and Utah are the possible substitutes for taconite. Besides domestic iron ores, imported iron ore products (e.g., iron-rich concentrates, fine ores and pellets) are used as substitutes for taconite ore.

2.1.4 Costs of Production and Worker Productivity

This section examines the costs of production as reported in the 1997 Economic Census of Mining for the iron ore industry, historical costs for the industry, and worker productivity for various plant sizes. These data, from 1997, represent the most recent Economic Census data available for the industry. These figures are reported for NAICS 21221, Iron Ore Mining.

2.1.4.1 Costs of Production

The three primary types of production costs for the iron ore industry are capital expenditures, labor expenses, and cost of inputs used.   Each of these cost categories is discussed below for the iron ore industry. Overall, labor and machinery accounted for the majority of production costs in 1997 (U.S. Department of Commerce, Bureau of the Census, 1999).

- As shown in Table 2-4, capital costs in 1997 for the iron ore industry totaled approximately $91 million, or 5 percent of total production costs. Buildings and other structures accounted for $81 million (about 90 percent of capital costs), while $9 million (10 percent of these costs) can be attributed to mineral exploration and development. The expenditures for mineral land and rights, which depend on whether the land contains sufficient quantity and grade of taconite ore to be economic for further development (see the Minnesota Mining Tax Guide for more detail; Minnesota Department of Revenue, 2002) amounted to $0.1 million.
- The iron ore industry spent approximately $542 million in 1997 on labor for a total of 32 percent of total production costs. Twenty-seven percent of labor costs were spent on fringe benefits, and the remaining expenditures (about $394 million) went toward the annual payroll.
- Cost of inputs used for the iron ore industry totaled $1 billion (62 percent of total production costs) in 1997. Supplies used, minerals received, and purchased machinery installation costs accounted for the most significant portion of this cost (approximately 58 percent). Other material costs included $117 million for fuel expenditures and about $259 million for purchased electricity.

Table 2-4. Production Costs for NAICS 21221—Iron Ore Mining, 1997

	1997 ($\$10^3$)	Percentage of Total Cost of Production
Total Cost of Production	$1,677,400	100.0%
Total Capital Expenditures	$90,963	5.4%
Buildings and other structures	$81,437	4.9%
Mineral exploration and development	$9,420	0.6%
Mineral land and rights	$106	0.0%
Total Labor Expenditures	$541,771	32.3%
Annual payroll	$393,921	23.5%
Fringe benefits	$147,850	8.8%
Total Cost of Supplies	$1,044,666	62.3%
Supplies used, minerals received, and purchased machinery installed	$603,797	36.0%
Resales	NA	NA
Fuels	$117,001	7.0%
Purchased electricity	$258,971	15.4%
Contract work	NA	NA

NA = Not available.
Source: U.S. Department of Commerce, Bureau of the Census. 1999. *1997 Economic Census of Mining, Industry Series—Mining*. Washington, DC: Government Printing Office.

2.1.4.2 Variations in Worker Productivity by Establishment Size

Table 2-5 provides information from the most recent Economic Census (1997) on variations in the productivity of workers (measured by value added per production worker) for facilities of varying size. Data are not provided for establishments with more than 20 employees, but value added per production worker is lower for the industry as a whole than it is for the smaller establishments. Thus, there appears to be no efficiency advantage to larger establishments.

Table 2-5. Worker Productivity by Plant Size for Facilities in NAICS 21221—Iron Ore Mining, 1997

Employees	Establishments	Value Added by Manufacturer ($\$10^3$)	Number of Production Worker Hours (10^3)	Value Added/ Production Worker Hour
0 to 4 employees	9	1,382	17	$81.29
5 to 9 employees	3	1,930	22	$87.73
10 to 19 employees	8	8,313	124	$67.04
20 to 49 employees	1	NA	NA	NA
50 to 99 employees	1	NA	NA	NA
100 to 249 employees	2	NA	NA	NA
250 to 499 employees	2	NA	NA	NA
500 to 999 employees	3	NA	NA	NA
1,000 to 2,499 employees	3	NA	NA	NA
Total	32	983,940	15,326	$64.20

NA = Not available.
Source: U.S. Department of Commerce, Bureau of the Census. 1999. *1997 Economic Census of Mining, Industry Series—Mining*. Washington, DC: Government Printing Office.

2.2 The Demand Side

In addition to the supply side, estimating the economic impacts of the regulation on the taconite iron ore manufacturing industry requires characterizing various aspects of the demand for taconite pellets. This section describes the product characteristics desired by end users and possible substitutes for taconite pellets.

2.2.1 Uses and Consumers

2.2.1.1 Uses

Taconite pellets are primarily consumed by iron and steel producers. As Table 2-6 illustrates, almost all (98.8 percent) of the iron ore produced in the United States was used for manufacturing iron and steel in 2001. Data are incomplete for 2002, but data show that

Table 2-6. U.S. Consumption of Iron Ore by End Use, 1997-2001 (10^3 metric tons)

End Use/Year	2002	2001	2000	1999	1998	1997
Integrated Iron and Steel Plants	58,800	61,900	70,700	67,800	70,000	71,800
Blast furnaces	52,900	57,300	64,400	62,100	63,500	64,900
Steel furnaces	300	35	49	57	101	86
Sintering plants	5,620	4,560	6,190	5,840	6,330	6,660
Miscellaneous	2	0	0	2	48	146
Direct-reduced iron for steelmaking	NA	1,800	2,340	2,420	2,400	752
Nonsteel End Uses	NA	756	1,150	1,290	1,280	1,280
Total	NA	64,400	74,100	71,500	73,600	73,800

Note: Because of rounding, numbers may not add up to the total.

Source: Kirk, W.S. 1997b. “Iron Ore.” U.S. Geological Survey Minerals Yearbook-1997. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340497.pdf>.
Kirk, W.S. 1998b. “Iron Ore.” U.S. Geological Survey Minerals Yearbook-1998. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340498.pdf>.
Kirk, W.S. 1999b. “Iron Ore.” U.S. Geological Survey Minerals Yearbook-1999. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340499.pdf>.
Kirk, W.S. 2000b. “Iron Ore.” U.S. Geological Survey Minerals Yearbook-2000. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/iomyb00.pdf>.
Kirk, W.S. 2001b. “Iron Ore.” U.S. Geological Survey Minerals Yearbook-2001. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/feormyb01.pdf>.
Kirk, W.S. 2003b. “Iron Ore in January 2003.” U.S. Geological Survey Mineral Industry Survey. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/iomis0103.pdf>

integrated iron and steel plants consumed 90 percent of domestic iron ore production in 2002. Table 2-6 also shows that the use of iron ore in integrated iron and steel mills has been steadily decreasing since 1997 due to the increasing market share of electric arc furnaces (more than 50 percent of domestic production in 2002) and their use of direct reduced iron (DRI) (Kirk, 2001b). Integrated steelmakers used small amounts of DRI in blast furnaces as a process coolant. On the other hand, EAF minimills and specialty mills consumed greater quantities of DRI to improve their steel quality (Fenton, 2000). Because EAFs represent a growing share of the steel industry, use of iron ore to produce DRI increased significantly during the 1990s. In addition to the taconite pellets consumed in the iron and steel industry, the remaining 2 percent of taconite ore production is used in manufacturing other commodities such as cement, heavy-medium materials, ballast, iron oxide pigments, high-density concrete, ferrites, specialty chemicals, and additives to animal feed (McKetta, 1988).

2.2.1.2 Consumer Characteristics

In 2001, 78 percent of domestic taconite ore (36 metric tons) was produced for captive use (Kirk, 2001b), which was not traded on the market. In other words, taconite ore is mined, processed into pellets, and used in company-owned blast furnaces to make iron and steel; the plants performing different steps in the process are owned by a single company or by related companies. For example, Ispat-Inland International N.V., USX Corporation, and NKK Steel have ownership interests in mines to ensure secure sources of iron ore for their integrated steel mills. Other steel mills acquire iron ore pellets based on long-term contractual agreements with pellet producers. For instance, Geneva Steel Company purchases iron ore pellets from USX Corporation under a long-term pellet supply contract.

In 2001, 13 companies owned 19 operating integrated iron and steel facilities (Fenton, 2001). All facilities have iron making, steel making, and casting operations. Table 2-7 lists the companies and their iron making operations. Five facilities are located in Ohio; four are in Indiana; two each are in Illinois, Alabama, and Michigan; and one each is in Kentucky, Maryland, Utah, Pennsylvania, and West Virginia. USX Corporation has the most production capacity for iron making, while Acme Metals Incorporated has the least capacity of all companies owning integrated facilities.

2.2.2 Product Characteristics

Pellets are usually the most desirable form of iron ore because they contribute the most to the productivity of the blast furnace. Pellets usually measure from 3/8 to 5/8 inch (9.55 to 16.0 millimeters) in diameter and contain 60 to 66 percent iron. Besides iron, standard pellets can include silica, alumina, magnesia, manganese, phosphorus, sulfur, and moisture. Fluxed pellets contain a certain amount of limestone (calcium carbonate, $CaCO_3$), dolomite and/or lime (CaO), in addition to all the constituents of standard pellets.

2.2.3 Substitution Possibilities in Consumption

Domestic iron ore production has been steady since 1990 although the steel demand has risen from 96 million metric tons in 1990 to 133 million metric tons in 1999 (a 39 percent increase). The need for domestic iron ore production in iron and steel making may decrease because of the growth of minimills and imports of iron ore substitutes. Imported iron ore substitutes for both integrated mills and minimills include steel mill products, scrap, pig iron, and direct reduced iron (DRI). Steel mill products are semifinished steel, such as blooms, billets, slabs, sheets, bars and plates (Fenton, 2001). In 2002, 10 million tons of semifinished foreign

Table 2-7. Iron Making Capacity and Facility Location of U.S. Integrated Iron and Steel Companies (10^3 metric tons per year)

Company Name	Iron-Making Capacity	Facility Locations
Acme Metals Incorporated	907	Riverdale, IL
AK Steel Holdings Corporation	3,901	Ashland, KY; Middletown, OH
Bethlehem Steel Corporation	7,312	Burns Harbor, IN; Sparrows Pt., MD
Geneva Steel Company	2,384	Orem, UT
Ispat-Inland International N.V.	NA	East Chicago, IN
LTV Corporation	6,886	Cleveland, OH; East Chicago, IN
National Steel Corporation	5,384	Granite City, IL; Ecorse, MI
Renco Group Incorporated	1,325	Warren, OH
Rouge Industries Incorporated	2,662	Dearborn, MI
Republic International LLC	2,029	Lorain, OH
USX Corporation	10,641	Braddock, PA; Fairfield, AL; Gary, IN
Weirton Steel Corporation	2,449	Weirton, WV
WHX Corporation	1,953	Mingo Junction, OH
Total	48,831	

NA = Not available.

Source: U.S. Environmental Protection Agency (EPA). 2000. *Economic Impact Analysis of Proposed Integrated Iron and Steel*. Washington, DC: U.S. Environmental Protection Agency.
Association of Iron and Steel Engineers (AISE). 1998. *1998 Directory Iron and Steel Plants.* Pittsburgh, PA: AISE.
U.S. Environmental Protection Agency (EPA). 1998. Update of Integrated Iron and Steel Industry Responses to Information Collection Request (ICR) Survey. Database prepared for EPA's Office of Air Quality Planning and Standards. Research Triangle Park, NC: U.S. Environmental Protection Agency.

steel were imported. This would potentially decrease the need for iron ore pellets from Minnesota and Michigan. However, the recent U.S. government's quotas and tariffs on imported steel slabs and finished steel would reduce imports and strengthen domestic iron ore production (Skillings Mining Review, 2003). Pig iron is the product of blast furnaces and is used by integrated mills and to some extent by minimills. DRI is a product obtained by reducing iron ore to iron metal at temperatures below the melting point of iron. DRI is used as a scrap substitute in EAF steel making at minimills and specialty mills (Kirk, 2000b). About 2.2 million tons of DRI were used domestically in 2001 as a substitute for iron and steel scrap (Fenton, 2002).

2.3 Industry Organization

This section identifies the characteristics of the taconite industry in the United States. The issues affecting this industry's organization are addressed at both the company and facility levels.

2.3.1 Taconite Manufacturing Facility Characteristics

Table 2-8 lists the eight taconite mining and pelletizing plants in the United States as of 2001. Six of these operations were on the Mesabi Iron Range in northeastern Minnesota: EVTAC Mining LLC, Hibbing Taconite Company, Inland Steel Mining Company, National Steel Pellet Company, Northshore Mining Company, and the U.S. Steel LLC (Minntac). The other two operations, located on the Marquette Iron Range in the Upper Peninsula of Michigan, were the Empire and Tilden Mines (Skillings Mining Review, 2003). Figure 2-4 illustrates the locations of taconite facilities.

Besides the plant locations, Table 2-8 also provides information on plant annual capacity, year 2002 production, and employment. The total domestic pellet production in 2002 was 51 million metric tons and the workforce totaled 5,516 employees. The facilities operated by Cleveland-Cliffs produced a total of about 24 million metric tons, which was 46 percent of the total domestic pellet production. Except for EVTAC Mining LLC and Inland Steel Mining Company, all the plants employed more than 500 people. Employment at these facilities ranged from 355 employees at Ispat-Inland Steel Mining Company to 1,570 employees at US Steel's Minntac operations. Data on plant locations and employment were obtained from the EPA (2001), Skillings Mining Review (2003), and Kirk (2001b).

2.3.2 Firm Characteristics

Facilities comprise a site of land with a plant and equipment that combine inputs (taconite iron ore) to produce output (taconite pellets). Companies owning these facilities are legal business entities that have the capacity to conduct transactions and make business decisions that affect that facility. The terms establishment, facility, and plant are synonymous in this study and refer to the physical location where products are manufactured. Likewise, the terms company and firm are synonymous and refer to the legal business entity that owns one or more facilities. This section presents information on the parent companies that own the taconite mining and pelletizing plants identified in the previous section.

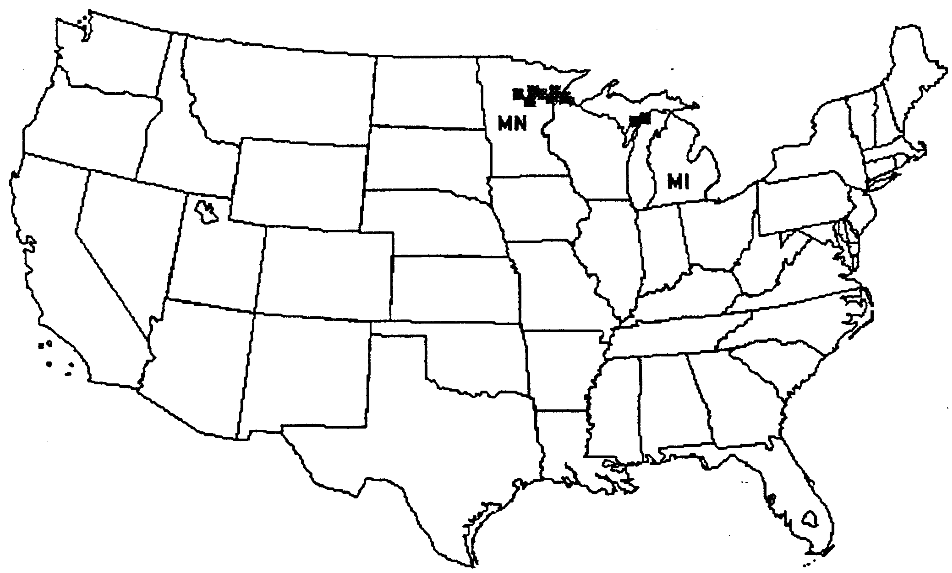

Figure 2-4. Locations of Taconite Iron Ore Processing Facilities

2.3.2.1 Ownership

As discussed in Section 2.3.1, 5 companies operated 8 mining and pelletizing facilities in 2002. Table 2-9 lists companies that own and/or operate these facilities. With four facilities, Cleveland-Cliffs operates more plants that produce taconite pellets than any other domestic manufacturer.

As Table 2-9 and Figure 2-5 show, most iron ore mines are wholly owned subsidiaries of one or more steel-producing companies. Some of the pellets are also produced for commercial purposes. In 2001, 78 percent of domestic ore was produced for captive use and not sold on the market (Kirk, 2001b), because the ownership structure of taconite differs from other industries. In many cases, a mine is owned by multiple parent companies. The ore may be produced for these parent companies, and thus does not reach the open market. For example, Ispat-Inland Steel Mining Company obtains iron ore pellets directly from the Empire Mine in Michigan and Minorca Mine in Minnesota, in which it has ownership interests. Stelco Incorporated has

Table 2-8. Taconite Iron Ore Facility Capacity and Production, 2002

State	Company	Operator	Mine	Pelletizing Plant	Annual Capacity (million metric tons)	2002 Production (million metric tons)	Employment
Minnesota	EVTAC Mining, LLC	Independent	Eveleth[a]	Forbes[a]	4.47	4.25	428
	Hibbing Taconite Co.	Cleveland-Cliffs	Hibbing[a]	Hibbing	8.53	7.82	740
	Ispat-Inland Steel Mining Co.	Ispat Inland, Inc.	Virginia[a]	Virginia	2.64	2.86	355
	National Steel Pellet Co.	National Steel Corp.	Keewatin[b]	Keewatin	5.54	5.56	504
	Northshore Mining Co.	Cleveland Cliffs	Babbitt[a]	Silver Bay[c]	4.88	4.17	500
	U.S. Steel LLC (Minntac)[e]	U.S. Steel	Mountain Iron[a]	Mountain Iron	16.05	14.88	1,570
Michigan	Empire Iron Mining Partnership	Cleveland Cliffs	Palmerd	Palmer	6.26	3.70	635
	Tilden Mining Co., LC	Cleveland Cliffs	Ishpeming[d]	Ishpeming	7.92	7.99	784
Total United States[f]					56.30	51.22	5,516

[a] Located in Saint Louis County
[b] Located in Itasca County
[c] Located in Lake County
[d] Located in Marguette County
[e] U.S. Steel Corp. is an independent company from USX Corp. as/of the end of 2001.
[f] Because of rounding, numbers may not add up to the total

Source: U.S. Environmental Protection Agency (EPA). 2001. *National Emissions Standard for Hazardous Air Pollutants (NESHAPs) for Taconite Iron Ore Processing Plants—Background Information for Proposed Standards*. Washington, DC: U.S. Environmental Protection Agency.
Skillings Mining Review. "US/Canadian Iron Ore Production 2002." July 20, 2002. pp. 17-30.
Skillings Mining Review. "US/Canadian Iron Ore Production 2001." July 28, 2001. pp. 19-32.
Skillings Mining Review. "US/Canadian Iron Ore Production 2000." July 29, 2000. pp. 21-36.
Kirk, W.S. 2001b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-2001. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/feormyb01.pdf>.

Table 2-9. Taconite Iron Ore Facility Operator and Ownership, 2002

State	Company	Operator	Ownership	Share (%)
Minnesota	EVTAC Mining, LLC	Independent	Eveleth Taconite Co.[a]	45
			Virginia Horn Taconite Co.[b]	40
			Ontario Eveleth Taconite Co.[c]	15
	Hibbing Taconite Co.	Cleveland-Cliffs	Cleveland-Cliffs	23
			Bethlehem Steel Corp.	62
			Stelco Inc.	15
	Ispat-Inland Steel Mining Co.	Ispat Inland, Inc.	Ispat International N.V.	100
	National Steel Pellet Co.	National Steel Corp.	National Steel Corp.	32
			NKK Steel	68
	Northshore Mining Co.	Cleveland Cliffs	Cleveland-Cliffs	100
	U.S. Steel LLC (Minntac)[d]	U.S. Steel LLC	U.S. Steel LLC	100
Michigan	Empire Iron Mining Partnership	Cleveland Cliffs	Cleveland-Cliffs	79
			Ispat International N.V.	21
	Tilden Mining Co., LC	Cleveland Cliffs	Cleveland-Cliffs	85
			Stelco Inc.	15

[a] Owned by Rouge Steel Company
[b] Owned by AK Steel Holding Corporation
[c] Owned by Stelco Incorporated
[d] U.S. Steel Corp. is an independent company from USX Corp as of the end of 2001.
NA = Not available.

Source: U.S. Environmental Protection Agency (EPA). 2001. *National Emissions Standard for Hazardous Air Pollutants (NESHAPs) for Taconite Iron Ore Processing Plants—Background Information for Proposed Standards*. Washington, DC: U.S. Environmental Protection Agency.
"Hibbing Taconite Resumes Operations." *Skillings Minings Review* August 4, 2001. pp. 7.
"US/Canadian Iron Ore Production 2002." *Skillings Mining Review* July 20, 2002. pp. 17-30.
"US/Canadian Iron Ore Production 2001." *Skillings Mining Review* July 28, 2001. pp. 19-32.
"US/Canadian Iron Ore Production 2000." *Skillings Mining Review* July 29, 2000. pp. 21-36.
Kirk, W.S. 2001b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-2001. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/feormyb01.pdf>.
U.S. Securities and Exchange Commission. Electronic Data Gathering, Analysis, and Retrieval (EDGAR) System.
Hoover's Online. Electronic database. <http://www.hoovers.com/>. Obtained on August 28, 2001.

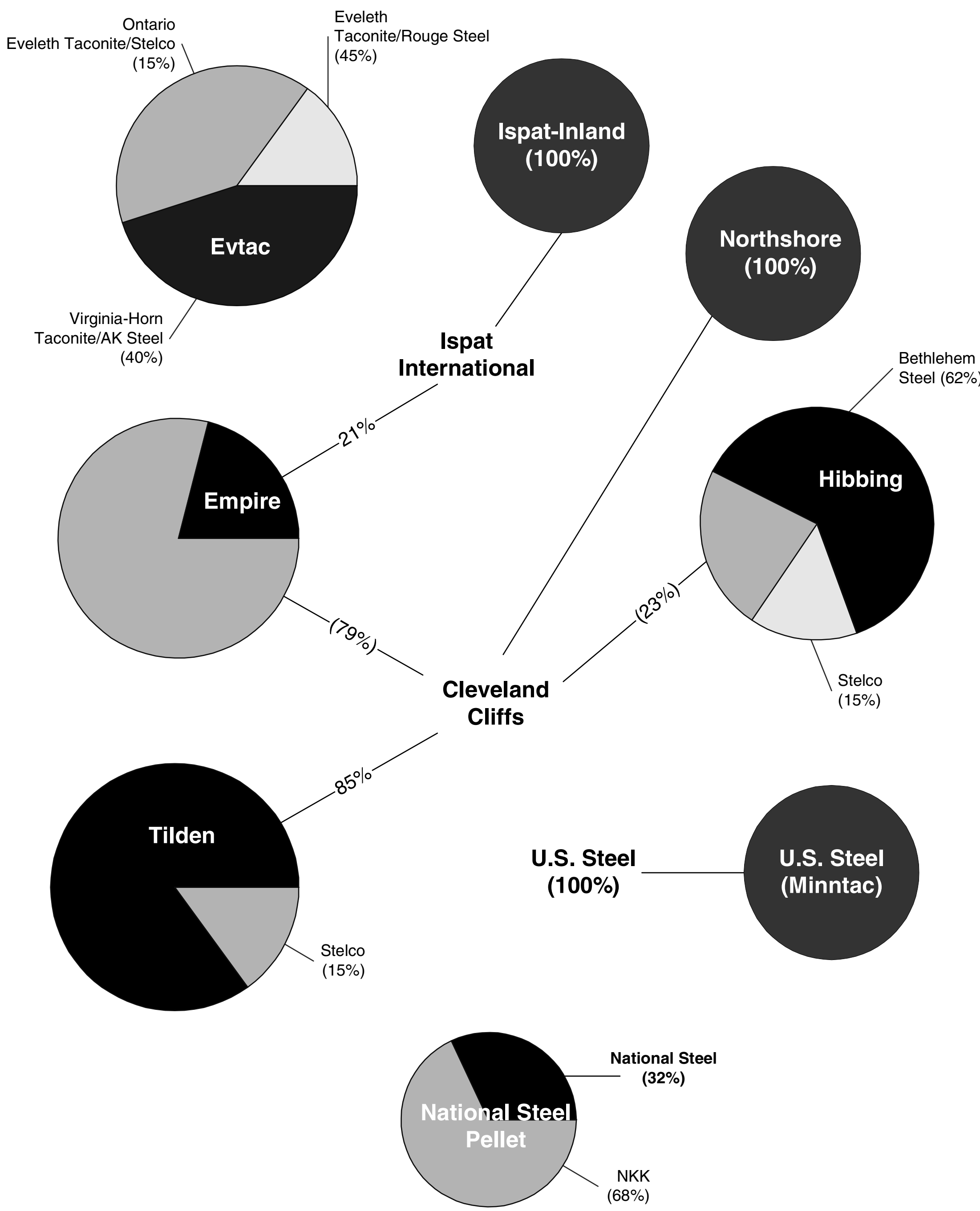

Figure 2-5. Taconite Iron Ore Facility Operator and Ownership, 2002

ownership interests in EVTAC Mining Company, Hibbing Taconite Company, and Tilden Mine to ensure secure sources of iron ore for its integrated steel companies. Other steel mills acquire iron ore pellets based on long-term contractual agreements with pellet producers. For instance, Geneva Steel Company purchases iron ore pellets from USX Corporation under a long-term pellet supply contract.

2.3.2.2 Size Distribution

Company sales and employment ranges are reported in Table 2-10. Most companies are large, publicly owned integrated steel companies, such as AK Steel Corporation, Bethlehem Steel Corporation, Ispat International N.V., LTV Corporation, and USX Corporation. Two companies have sales volumes less than $1 billion, six between $1 and $5 billion, and two with more than $5 billion. Five companies have fewer than 10,000 employees and the other five companies employ 10,000 or more people. Sales and employment data were collected from Hoover's Online (2001) and complemented with information from InfoUSA (2001).

2.3.2.3 Horizontal and Vertical Integration

Whether a firm in this industry is vertically or horizontally integrated, or not integrated, depends on the nature of the primary business activity that the parent company does and on the businesses the various facilities owned by the parent company engage in. Vertically integrated firms may produce the inputs used in their production process or use the product as an input into other production processes. These firms may own several plants and/or operate many subsidiaries, each of which handles a different stage of production or directly or indirectly produces an input or product. In the taconite industry, captive iron ore producers are parts of vertically integrated iron and steel operations. Most of the companies in Table 2-9 are vertically integrated. For example, Ispat-Inland Steel Mining Company, National Steel Corporation, and USX Corporation use taconite pellets produced by taconite operations they own in their integrated steel operations to produce iron and steel. However, USX Corporation spun off its integrated steel operation (now called United States Steel Corporation) at the end of 2001 (U.S. Steel, 2002).

Companies that are not integrated either horizontally or vertically produce only one type of product or set of closely related products. The smaller companies involved in manufacturing taconite ore products are, for the most part, not integrated; they produce a sole product without having forward or backward corporate linkages. These companies purchase inputs from outside

Table 2-10. Taconite Iron Ore Facility Owner Company Sales and Employment, 2002

Owner Company	Legal Form of Organization	Sales ($\$10^6$)	Employment
Bethlehem Steel Corp.	Public	3,572	11,500
Cleveland-Cliffs	Public	599	3,858
Eveleth Taconite Co.[a]	Public	1,127	2,705
Ispat International N.V.	Public	4,889	15,400
National Steel Corp.	Public subsidiary	2,609	8,342
Stelco Inc.	Public	2,009	9,749
US Steel Corp.[b]	Public	7,054	20,351
Virginia Horn Taconite Co.[c]	Public	4,289	11,300

[a] Owned by Rouge Steel Company
[b] Previously owned by USX Corporation
[b] Owned by AK Steel Holding Corporation

NA = Not available.
Source: U.S. Environmental Protection Agency (EPA). 2001. *National Emissions Standard for Hazardous Air Pollutants (NESHAPs) for Taconite Iron Ore Processing Plants—Background Information for Proposed Standards*. Washington, DC: U.S. Environmental Protection Agency.
Skillings Mining Review. "US/Canadian Iron Ore Production 2002." July 20, 2002. pp. 17-30.
Skillings Mining Review. "US/Canadian Iron Ore Production 2001." July 28, 2001. pp. 19-32.
Stelco Inc. website. <http://www.stelco.com/>. Obtained on August 28, 2001.
Hoover's Online. Electronic database. <http://www.hoovers.com/>. Obtained on August 28, 2001.
InfoUSA Incorporated. 2001. ReferenceUSA electronic database.

suppliers, not of their corporate tree. Then they manufacture the product and sell it either directly to consumers or through wholesalers.

2.3.3 Small Businesses in the Taconite Industry

To determine the possible impacts of the NESHAP on small businesses, businesses producing taconite are categorized as small or large using the Small Business Administration's (SBA's) general size standards definitions. For NAICS 21221, these guidelines indicate a small business employs 500 or fewer workers (U.S. Small Business Administration, 2000). Based on the SBA definition and the company employment shown in Table 2-10, this industry has no small businesses.

2.3.4 Market Structure

Market structure is of interest because it affects the behavior of producers and consumers in the industry. If an industry is perfectly competitive, then individual producers are not able to influence the price of the outputs they sell or the inputs they purchase. This condition is most likely to hold if the industry has a large number of firms, the products sold are undifferentiated, and entry and exit of firms are unrestricted. Product differentiation can occur both from differences in product attributes and quality and from brand name recognition of products. Entry and exit of firms are unrestricted for most industries except, for example, in cases when government regulates who is able to produce, when one firm holds a patent on a product, when one firm owns the entire stock of a critical input, or when a single firm is able to supply the entire market.

When compared across industries, firms in industries with fewer firms, more product differentiation, and restricted entry are more likely to be able to influence the price they receive for a product by reducing output below perfectly competitive levels. This ability to influence price is referred to as exerting market power. At the extreme, a single monopolistic firm may supply the entire market and hence set the price of the output.

2.3.4.1 Measures of Industry Concentration

To assess the competitiveness of a market, economists often estimate concentration ratios and the Herfindahl-Hirschmann Indexes (HHI) for the subject market or industry. Firms in less-concentrated industries are more likely to be price takers, while firms in more-concentrated industries are more likely to be able to influence market prices. Tables 2-8 and 2-9 provide data on the market share that each company holds in terms of pellet production and company ownership share. With fewer than a dozen owner companies, many of them vertically integrated, and with significant barriers to entry, the taconite industry is likely to be fairly concentrated. However, there are no publicly available market concentration statistics available for the taconite industry.

2.3.4.2 Geographic Concentration

As Table 2-8 and Figure 2-4 illustrate, the taconite mining and processing facilities are located in either Minnesota or Michigan. In Minnesota, all of the iron ore production occurs in the Mesabi Range, located in Cook (2000 population: 5,168), Itasca (43,992), Lake (11,058), and Saint Louis (200,528) counties. In Michigan, the production is from the Empire and Tilden Mines in Marquette County (2000 population: 64,634). The geographic location of the 8 taconite facilities indicates that the potential impact of the rule will be concentrated in the five counties mentioned above. Based on the information from Cleveland-Cliffs, the Empire and Tilden Mines have a local economic impact of $390 million per year. The Hibbing Taconite and Northshore Mining Companies have an economic impact of more than $400 million per year on the local economy (Cleveland-Cliffs, 2001).

2.4 Markets

This section examines the historical market statistics and future trends and projections for the taconite pellet industry. Historical data for this industry are provided for domestic production and consumption, domestic prices, and foreign trade in iron ore pellets. The future trends section focuses on projected demand and employment for the taconite pellet industry.

2.4.1 Historical Market Data

This section provides data on historical quantities of iron ore produced and consumed in the United States, the quantities imported and exported, and prices.

2.4.1.1 Domestic Production

Table 2-11 presents the data on the quantities of iron ore production from 1990 to 2001, including crude ore, usable ore, and pellet productions. The domestic production of crude ore ranged from a low of 154 million metric tons in 2001 to a high of 213 million in 1998. On average, 30 percent of the crude ore mined could be processed into usable ore. The domestic useable ore production in 2001, at 46.2 million metric tons, reached its lowest level since 1990. The domestic production of pellets in 2001, at 45.8 million metric tons, also reached its record low.

2.4.1.2 Domestic Consumption

Table 2-11 also shows the domestic consumption of iron ore products, including iron ore and agglomerates (pellets and sinter). The domestic consumption of iron ore ranged from a low of 66.4 million metric tons in 1991 to a high of 83.1 million metric tons in 1995. In 2001, domestic consumption was 67.3 million metric tons, reached its second lowest level since 1990. During the same year, the integrated iron and steel producers consumed about 62 million metric tons of iron ore products. Of the ore consumed, 83 percent was of domestic origin, 7 percent was imported from Canada, and 10 percent came from other countries (Kirk, 2001b).

Table 2-11. Domestic Production and Consumption of Iron Ore, 1990-2001 (10^3 metric tons)

Year	Crude Ore	Usable Ore	Pellet Production	Consumption[a]
1990	181,431	56,405	54,817	76,900
1991	183,774	56,758	54,777	66,400
1992	184,600	55,589	54,196	75,100
1993	180,896	55,657	54,497	76,800
1994	191,989	58,378	57,579	80,200
1995	209,988	62,485	61,397	83,100
1996	207,988	62,069	61,096	79,600
1997	208,743	62,968	62,075	79,500
1998	213,357	62,927	62,128	78,200
1999	192,481	57,747	57,512	75,100
2000	208,055	63,100	62,400	76,500
2001	154,000	46,200	45,800	67,300

[a] Includes iron ore and agglomerates (pellets and sinter)

NA = Not available.

Source: American Iron Ore Association. 2000. *Iron Ore: 1999 Statistical Report*. Cleveland: American Iron Ore Association.
Skillings Mining Review. "US/Canadian Iron Ore Production 2000." July 29, 2000. pp. 21-36.
Kirk, W.S. 1994. "Iron Ore." U.S. Geological Survey Minerals Yearbook-1994. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340494.pdf>.
Kirk, W.S. 1995. "Iron Ore." U.S. Geological Survey Minerals Yearbook-1995. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340495.pdf>.
Kirk, W.S. 1996b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-1996. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340496.pdf>.
Kirk, W.S. 1997b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-1997. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340497.pdf>.
Kirk, W.S. 1998b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-1998. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340498.pdf>.
Kirk, W.S. 1999b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-1999. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340499.pdf>.
Kirk, W.S. 2000b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-2000. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/iomyb00.pdf.>
Kirk, W.S. 2001b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-2001. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/feormyb01.pdf.>

2.4.1.3 Domestic Prices

One of the major structural changes in the domestic iron ore industry occurred in 1982 with the development of a U.S. spot market for pellets, which led to the beginning of price competition. As a result of the spot market for pellets, domestic iron ore producers lowered prices to make domestic ore competitive with imported material and also reduced production costs by improving labor productivity, reducing wages, negotiating lower-cost power contracts and royalty agreements, pressing suppliers to reduce prices for materials, lobbying legislators for tax breaks, and paying off debt (Kirk, 1998b).

The domestic prices of iron ore products (e.g., direct-shipping ore, concentrates, agglomerates, and byproduct ore) from 1990 through 2001 are presented in both current and 2002 dollars in Table 2-12. Note that the iron ore prices presented in Table 2-12 were the values of the useable ore at mines, which did not include mine-to-market transportation costs. Also most spot sales are individually negotiated one-time contacts made directly between buyer and seller (Kirk, 2001b). Thus, the prices presented in Table 2-12 would only be a representation of a small proportion of the entire domestic iron ore production. As shown in Table 2-12, adjusted prices in 2002 dollars for iron ore products range from a low of \$23.66 per metric ton in 2001 to a high of \$31.72 per metric ton in 1992. Between 1993 and 1997, the adjusted price never went above \$30 per metric ton. In addition to vertically integrated production and the spot market, long-term contracts (mentioned above) affect prices. The prices at which iron ore products change hands under long-term contracts are frequently tied to movement in the spot market price or the world price. The low spot market prices in both 1999 and 2000 coincided with increased imports of pig iron, DRI, and semifinished steel, reducing the demand for domestic iron ore. Steel producers increased their use of imports because it allowed them to increase steel production in response to cyclical increases in steel demand without having to increase their blast furnace production, reopen idled blast furnaces, and hire new personnel.

2.4.1.4 Foreign Trade

Table 2-13 provides data on the quantities and dollar values of imported iron ore products from 1990 through 2002. The average volume of imported iron ore products during that period was slightly more than 15 million metric tons per year. The average dollar value of iron ore imports between 1990 and 2002 was slightly more than \$450 million per year in constant 2002 dollars. In 2002, the value of imported iron ore products per metric ton was \$25.10. As of 2001, about 43 percent of the imports were from Canada, followed by 40 percent

Table 2-12. Historical Prices of Usable Iron Ore at Mines [a], 1990-2001

Year	Shipments (10^3 metric tons)	Value of Shipments ($\$10^3$)	Average Value per Metric Ton [b]	
			Current $	2002 $
1990	57,000	1,570,000	27.54	31.56
1991	56,800	1,530,000	26.94	30.68
1992	55,600	1,550,000	27.88	31.72
1993	56,300	1,380,000	24.51	28.12
1994	57,600	1,410,000	24.48	28.09
1995	61,100	1,700,000	27.82	28.80
1996	62,200	1,750,000	28.14	27.69
1997	62,800	1,860,000	29.62	29.28
1998	63,200	1,970,000	31.17	31.07
1999	58,500	1,550,000	26.50	26.55
2000	61,000	1,560,000	25.57	25.66
2001	50,600	1,210,000	23.91	23.66

[a] Usable iron ore includes direct-shipping ore, concentrates, agglomerates, and byproduct ore.
[b] Average value per metric ton = value of shipments/shipments

Source: Kirk, W.S. 1994. "Iron Ore." U.S. Geological Survey Minerals Yearbook-1994. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340494.pdf>.
Kirk, W.S. 1995. "Iron Ore." U.S. Geological Survey Minerals Yearbook-1995. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340495.pdf>.
Kirk, W.S. 1996b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-1996. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340496.pdf>.
Kirk, W.S. 1997b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-1997. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340497.pdf>.
Kirk, W.S. 1998b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-1998. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340498.pdf>.
Kirk, W.S. 1999b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-1999. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/340499.pdf>.
Kirk, W.S. 2000b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-2000. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/iomyb00.pdf.>
Kirk, W.S. 2001b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-2001. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/feormyb01.pdf.>
Bureau of Labor Statistics. "Producer Price Index Revision—Current Series: PCU1011#, Iron Ores: 1990-2003." <http://www.146.142.4.24/servlet/surveyoutputservlet?output?>.

Table 2-13. U.S. Imports for Consumption and Value of Imports of Iron Ore Products, 1990-2002 ($\$10^3$)

Year	Imports (10^3 metric tons)	Value of Imports		Value of Imports per Metric Ton[a]	
		Current $	2002 $	Current $	2002 $
1990	18,082	559,534	641,218	30.94	35.46
1991	13,331	436,607	497,320	32.75	37.31
1992	12,501	395,618	450,087	31.65	36.01
1993	13,981	415,063	476,236	29.69	34.06
1994	17,552	509,887	585,034	29.05	33.33
1995	17,509	485,846	502,931	27.75	28.72
1996	18,382	555,953	547,239	30.24	29.77
1997	18,599	551,035	544,674	29.63	29.29
1998	17,009	527,059	525,386	30.99	30.89
1999	14,244	398,527	399,375	27.98	28.04
2000	15,677	420,046	421,388	26.79	26.88
2001	10,645	292,744	289,669	27.50	27.21
2002	12,453	312,555	312,555	25.10	25.10

Source: U.S. International Trade Commission. "SIC-1011: FAS Value by FAS Value for All Countries." <http://dataweb.usitc.gov>. As obtained June 4, 2003a.
U.S. International Trade Commission. "SIC-1011: Customs Value by Customs Value for All Countries." <http://dataweb.usitc.gov>. As obtained June 4, 2003b.
Bureau of Labor Statistics. "Producer Price Index Revision—Current Series: PCU1011#, Iron Ores: 1990-2003." <http://www.146.142.4.24/servlet/surveyoutputservlet?output?>.

from Brazil (see Table 2-14). Pellets and fine ores were the two major types of imported products, as shown in Table 2-15.

Overall, the volume of exported iron ore products is much lower than the volume of imported iron ore products, and the price per metric ton is higher. As Table 2-16 presents, the average volume of exported iron ore products between 1990 and 2002 was slightly more than 5 million metric tons per year. The average dollar value of iron ore exports during that period was slightly more than $200 million dollars per year in constant 2002 dollar terms. Table 2-14 indicates that in 2001, most exported iron ore products went to Canada (99 percent). The major exported product was pellets (see Table 2-15).

Table 2-14. Value of Imports for Consumption and Exports of Iron Ore by Country, 2001 ($\$10^3$)

	Value ($)	Share (%)
Imports from:		
Australia	4,840	1.7
Brazil	104,000	35.5
Canada	133,000	45.4
Chile	17,400	5.9
Peru	1,030	0.4
Sweden	2,570	0.9
Venezuela	6,500	2.2
Others	23,300	8.0
Total	292,640	100.0
Exports to:		
Canada	227,000	99.2
Others	1,840	0.8
Total	228,840	100.0

Source: Kirk, W.S. 2001b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-2001. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/feormyb01.pdf.>

2.4.2 Trends and Projections

In 2002, iron ore was produced in about 50 countries. The seven largest of these producing countries—China, Brazil, Australia, Russia, India, Ukraine, and the United States—accounted for more than 80 percent of the world total (1.1 billion metric tons), and no other country had as much as a 5 percent share (Kirk, 2003). U.S. iron ore production in 2002 totaled 50 metric tons or 4.5 percent of the world total. Domestic steel making accounted for about 98 percent of domestic iron ore consumption (Kirk, 2001a). From 1992 to 1997, the domestic production of usable iron ore trended upward from 56 million metric tons to about 63 million metric tons, an average growth rate of 2.6 percent (Kirk, 1999b). In 2000, domestic iron ore production reached its highest level (63 metric tons) since 1981, and domestic iron ore consumption has declined since 1995 by an average of 2.5 percent per year (Kirk, 2000b; Kirk, 1999b).

Table 2-15. Quantity of Imports and Exports of Iron Ore by Type of Product, 2001 (10^3 metric tons)

Type of Product	Imports	Exports
Concentrates	598	74
Coarse ores	28	1
Fine ores	4,050	22
Pellets	5,500	5,490
Briquettes	0	<0.5
Other agglomerates	462	21
Roasted pyrites	7	1
Total	10,700	5,610

Source: Kirk, W.S. 2001b. "Iron Ore." U.S. Geological Survey Minerals Yearbook-2001. <http://minerals.usgs.gov/minerals/pubs/commodity/iron_ore/feormyb01.pdf.>

The majority of U.S. iron ore trade involves Canada. Since 1990, about 50 percent of U.S. imports were from Canada, and 99 percent of U.S. exports were shipped there. The iron ore mines and most of the integrated steel industry are close to the Great Lakes, which offers low-cost transportation and helps U.S. ore producers have a competitive advantage. However, each iron ore producer is aware that it must reduce costs substantially to compete with foreign producers (Kirk, 2000b).

The domestic pellet industry is experiencing a serious decline in demand for its products and is projecting a tonnage decrease of at least 10 to 15 percent from the 2000 levels (Skillings Mining Review, 2001). Due to the massive imports of cheap steel into the U.S. market, coupled with world-wide overcapacity in steel production (Hufbauer and Goodrich, 2002), the U.S. steel industry has undergone a downsizing, which has accelerated since 1998 when the Asian economic crisis weakened global demand for steel. For instance, in early 2001, the LTV Steel Mining Company (LTVSMC) closed its taconite mining operation in Hoyt Lakes, which was later sold to Cleveland-Cliffs. (Cleveland-Cliffs, Inc., 2001). Then the LTV Corporation decided to sell its Cleveland Works East and Indiana Harbor Works integrated steel assets under an Asset Protection Plan (APP) issued by the U.S. Bankruptcy Court (LTV Corporation, 2002). Domestic steelmakers are now experiencing structural changes in their markets that have the potential to affect the domestic iron ore industry. For example, some of the integrated steel makers use imported iron ore as feedstock to produce direct reduced iron. Further, the

Table 2-16. U.S. Domestic Exports and Value of Exports of Iron Ore Products, 1990-2002 ($$10^3$)

Year	Exports (10^3 metric tons)	Value of Exports		Value of Exports per Metric Ton[a]	
		Current $	2002 $	Current $	2002 $
1990	3,181	123,236	141,226	38.75	44.40
1991	4,045	156,197	177,917	38.62	43.99
1992	5,055	186,814	212,535	36.95	42.04
1993	5,060	166,805	191,289	32.97	37.83
1994	4,972	162,468	186,412	32.67	37.49
1995	5,267	184,459	190,946	35.02	36.25
1996	6,256	231,701	228,069	37.04	36.46
1997	6,336	234,894	232,183	37.07	36.64
1998	5,994	244,473	243,697	40.79	40.66
1999	6,120	242,962	243,479	39.70	39.79
2000	6,146	245,953	246,739	40.02	40.14
2001	5,605	229,241	226,833	40.90	40.47
2002	6,753	248,810	248,810	36.85	36.85

Source: U.S. International Trade Commission. "SIC-1011: FAS Value by FAS Value for All Countries." <http://dataweb.usitc.gov>. As obtained June 4, 2003a.
U.S. International Trade Commission. "SIC-1011: Customs Value by Customs Value for All Countries." <http://dataweb.usitc.gov>. As obtained June 4, 2003b.
Bureau of Labor Statistics. "Producer Price Index Revision—Current Series: PCU1011#, Iron Ores: 1990-2003." <http://www.146.142.4.24/servlet/surveyoutputservlet?output?>.

minimills' share of the steel market has increased steadily, rising from 15 percent in 1970 to about 50 percent in 2000. Minimills use iron and steel scrap and direct reduced iron as feedstock, rather than iron ore pellets made from taconite. This trend is expected to continue and will affect the domestic iron ore industry negatively (McGraw-Hill, 2000).

Given the severe economic environment, domestic steel producers asked the International Trade Commission (ITC) to impose substantial tariffs of up to 40 percent on all imported steel products, and the ITC has found that there was injury from imports in most steel markets. In June 2001, the Bush Administration requested a Section 201 investigation to determine if the steel industry has been injured from imports. After the investigation, the U.S. International Trade Commission found the imports were a substantial cause of serious injury or threat of injury and recommended a four-year program of tariffs and tariff-rate quotas to the President. In response, President Bush decided to impose tariffs on several key steel products for a period of three years (Bush, 2002). Meanwhile, leading U.S. steelmakers are trying to develop consolidation plans to protect their iron and steel interests in North America as well as to prevent further bankruptcies. For example, the U.S. Steel Corporation has begun talks to acquire National Steel of Japan, NKK, and has also considered merging with other steel companies, including Bethlehem Steel and Wheeling-Pittsburgh Steel (BBC News, 2001). As to iron ore supply, Cleveland-Cliffs, Inc. has taken several actions to consolidate its position as the largest supplier of iron ore to the North American steel industry. In a recent press release, Cleveland-Cliffs stated that it plans to increase its ownership of the Tilden Mine from 40 percent to 85 percent by acquiring 45 percent share from Algoma Steel, Inc., to reduce pellet production and employment at the Empire Mine operation, and to invest (along with Kobe Steel, Steel Dynamics, Inc., the Iron Range Resources and Rehabilitation Agency, and the State of Minnesota) in the Mesabi Nuggets Project. Phase II of this project involves construction of a pilot plant that applies Kobe Steel's ITmk3 iron-making technology for converting iron ore into nearly pure iron nuggets that are substitutes for pig iron (Cleveland-Cliffs, Inc., 2002).

SECTION 3

ENGINEERING COST ESTIMATES

This chapter presents the estimated regulatory compliance costs resulting from the control of HAP emissions under the standards. EPA estimated the emission control, MRR costs necessary to bring each facility into compliance with the standards. Section 3.1 provides a description of the emissions controls for taconite facilities; Section 3.2 provides a summary of the overall costs anticipated to be incurred by the industry; and Section 3.3 provides more detailed information about the costs.

3.1 Description of Emissions Controls

EPA identified several operations at taconite facilities that produce HAP emissions, including ore crushing and handling operations (OCH), indurating furnaces, finished pellet handling (PH), and ore dryers. Three types of HAPs are released from the processes: acidic gases (hydrochloric and hydrofluoric acid), metallic particulate matters, and PICs (EPA, 2001). Using data on baseline emissions and emissions control performance of existing taconite facilities, EPA defined Maximum Achievable Control Technology (MACT) emissions standards for each type of unit, as shown in Table 3-1.

Table 3-1. MACT Standards for Existing Affected Sources

Affected Source	MACT limit (gr/dscf)
Ore crushing, and handling	1.1
Finished pellet handling	0.1
Indurating furnaces	368.6
Total	369.8

Source: U.S. Environmental Protection Agency (EPA). 2003. *National Emissions Standard for Hazardous Air Pollutants (NESHAPs) for Taconite Iron Ore Processing Plants—Background Information for Proposed Standards*. Washington, DC: U.S. Environmental Protection Agency.

EPA estimated emission control costs based on replacement of existing non-compliant emission control equipment with new wet scrubber control equipment capable of meeting the

MACT standards. As a result of discussions with the industry during the public comment process, EPA revised the costs of installing new wet scrubbers. To ensure that costs were accurate, EPA asked each plant to provide an estimate and incorporated this information into its estimates; the data underlying these estimates can be found in the docket. EPA's final estimate is slightly higher than its estimate at proposal and slightly lower than industry's estimates, largely because it is based on a smaller number of affected emission units requiring replacement of control equipment. Public comments on the proposal indicated that emissions controls at one furnace no longer need to be replaced, resulting in a reduction in the estimated costs for that source. MRR costs have been updated to reflect changes in performance testing, monitoring, and compliance schedule requirements to address public comments. Finally, EPA has updated its base year for the cost estimates from 1999 to 2002.

3.2 Summary of Costs

The incremental costs of complying with the rule include the costs of purchasing and installing capital equipment to control emissions from various units and to monitor the emissions from various units. EPA then annualizes the capital costs over the life of the equipment (25 years) using a 7 percent interest rate. The annualized capital costs are combined with the operating and maintenance costs to estimate the total annualized costs of the rule. These costs include not only the costs of controlling emissions, but also the costs of conducting MRR activities. Each of the affected facilities already has some emissions control equipment in place and thus has some baseline level of operating and maintenance costs. Therefore, EPA estimates the incremental costs of the rule as the difference between costs currently incurred and the costs that would be incurred to comply with the rule. Table 3-2 provides a summary of the emission control costs and the MRR costs for the taconite industry. EPA estimates that, for existing sources, the total capital cost of the rule will be $57.4 million and total annualized costs, including MRR costs, will be $8.6 million per year. Approximately 74 percent of the total annualized costs are associated with the emission control upgrades for the indurating furnaces. EPA developed the cost estimates based on information gathered from industry representatives and vendors of industry-specific control equipment, and using procedures in the EPA's *Air Pollution Control Cost Manual*. All costs are presented in 2002 dollars.

3.3 Plant-Specific Costs

Table 3-3 shows the emission control costs and the MRR costs for each of the eight taconite plants. Total annualized costs, including both emissions control costs and MRR costs, range from approximately $122,000 to more than $2.8 million. EPA estimates that six indurating furnaces at four taconite plants (Minntac, EVTAC, Hibbing, and National) will incur

Table 3-2. Summary of the Industry Cost (10^6 \$2002)

Cost Component	Total Capital Cost (\$$10^6$)	Annualized Capital Cost (10^6 \$/yr)	O&M Cost (10^6 \$/yr)	MRR Labor Cost (10^6 \$/yr)	Total Annualized Cost (10^6 \$/yr)
Emission Control Cost	52.8	4.53	3.16		7.7
Monitoring, Record keeping and Recording Cost	4.58	0.39	0.12	0.4	0.91
Total Cost	57.4	4.93	3.57	0.4	8.61

Source: Alpha-Gamma Technologies, Inc. 2003. "Revised Taconite Ore Processing NESHAP Cost Impacts" Memorandum Chris Sarsony, Alpha-Gamma to Conrad Chin, U.S. Environmental Protection Agency. July, 2003.

emission control costs. Existing emissions control equipment at indurating furnaces at the remaining four plants is estimated to achieve MACT standards, so these plants do not incur incremental emissions control costs. Similarly, EPA estimates that three plants (National, Northshore, and Hibbing) will incur emissions control costs for their pellet handling operations, while the remaining plants do not incur incremental emission control costs. Over 90 percent of the costs are incurred by four taconite plants: Minntac, EVTAC, Northshore, and Tilden. One taconite plant is not projected to incur any incremental emission control costs, although it does incur MRR costs. EPA estimates that this plant is achieving MACT emissions control levels at baseline.

Table 3-3. Plant-Specific Costs (10^6 \$2000)

Facility	Process	Emission Control Costs: A Total Capital Costs	B Annual-ized Capital Costs	C O&M Costs	D Total Annual Emission Control Costs (B+C)	E Total Capital Costs ($)	Monitoring, Record keeping, and Recording Costs [c]: F Annual-ized Capital Costs ($/YR)	G Equipment O&M Costs ($/YR)	H MRR Labor Costs ($/YR) [a]	I Total Annual MRR Costs (F+G+H)	J Total Annual Costs (D+I)
MINNTAC	Indurating	$20,000,000[b]	$1,716,210	$1,126,704	$2,842,914	$0[c]	$0	$0			
	OCH	$0[b]	$0	$0	$0	$0[c]	$0	$1,600			
	PH	$0[b]	$0	$0	$0	$0[c]	$0	$0			
	Total	$20,000,000	$1,716,210	$1,126,704	$2,842,914	$0	$0	$1,600	$50,550	$52,151	$2,895,065
National	Indurating	$18,000,000[d]	$1,544,589	$1,205,833	$2,750,422	$50,000[e]	$4,291	$0			
	OCH	$0[d]	$0	$0	$0	$375,000[e]	$32,179	$0			
	PH	$0[d]	$0	$0	$0	$150,000[e]	$12,872	$0			
	Total	$18,000,000	$1,544,589	$1,205,833	$2,750,422	$575,000	$49,341	$0	$50,550	$99,891	$2,850,314
EVTAC	Indurating	$500,000[f]	$42,905	$20,000	$62,905	$40,000[g]	$3,432	$0			
	OCH	$1,410,000[f]	$120,993	$100,978	$221,971	$430,000[g]	$36,899	$5,334			
	PH	$200,000[f]	$17,162	$9,455	$26,617	$45,000[g]	$3,861	$0			
	Total	$2,110,000	$181,060	$130,434	$311,494	$515,000	$44,192	$5,334	$50,550	$100,077	$411,571
Northshore	Indurating	$0[h]	$0	$0	$0	$400,000[i]	$34,324	$51,205			
	OCH	$5,550,000[h]	$476,248	$351,450	$827,699	$110,955[i]	$9,521	$16,002			
	PH	$1,050,000[h]	$90,101	$77,472	$167,573	$100,000[i]	$8,581	$533			
	Total	$6,600,000	$566,349	$428,922	$995,272	$610,955	$52,426	$67,740	$50,550	$170,717	$1,165,988
Inland	Indurating	$0[j]	$0	$0	$0	$100,000[k]	$8,581	$0			
	OCH	$0[j]	$0	$0	$0	$300,000[k]	$25,743	$3,200			
	PH	$150,000[j]	$12,872	$9,703	$22,575	$125,000[k]	$10,726	$533			
	Total	$150,000	$12,872	$9,703	$22,575	$525,000	$45,051	$3,734	$50,550	$99,335	$121,909

(continued)

Table 3-3. Plant-Specific Costs (10^6 \$2000) (continued)

		Emission Control Costs					Monitoring, Record keeping, and Recording Costs [c]				
Facility	Process	A Total Capital Costs	B Annual-ized Capital Costs	C O&M Costs	D Total Annual Emission Control Costs (B+C)	E Total Capital Costs ($)	F Annual-ized Capital Costs ($/YR)	G Equipment O&M Costs ($/YR)	H MRR Labor Costs ($/YR) [a]	I Total Annual MRR Costs (F+G+H)	J Total Annual Costs (D+I)
Tilden	Indurating	$5,356,750[l]	$459,665	$214,270	$673,935	$450,000[m]	$38,615	$19,202			
	OCH	$0[l]	$0	$0	$0	$552,000[m]	$47,367	$6,934			
	PH	$0[l]	$0	$0	$0	$224,000[m]	$19,222	$0			
	Ore Dryers	$0[l]	$0	$0	$0	$150,000[m]	$12,872	$0			
	Total	$5,356,750	$459,665	$214,270	$673,935	$1,376,000	$118,075	$26,136	$50,550	$194,762	$868,697
Hibbing	Indurating	$0[n]	$0	$0	$0	$0[o]	$0	$0			
	OCH	$0[n]	$0	$0	$0	$0[o]	$0	$0			
	PH	$610,000[n]	$52,344	$48,156	$100,500	$0[o]	$0	$0			
	Total	$610,000	$52,344	$48,156	$100,500	$0	$0	$0	$50,550	$50,550	$151,051
Empire	Indurating	$0[p]	$0	$0	$0	$100,000[p]	$8,581	$12,801			
	OCH	$0[p]	$0	$0	$0	$475,000[p]	$40,760	$0			
	PH	$0[p]	$0	$0	$0	$400,000[p]	$34,324	$0			
	Total	$0	$0	$0	$0	$975,000	$83,665	$12,801	$50,550	$147,017	$147,017
Total	Indurating	$43,856,750	$3,763,370	$2,566,807	$6,330,178	$1,140,000	$97,824	$83,208			
	OCH	$6,960,000	$597,241	$452,429	$1,049,670	$2,242,955	$192,469	$33,070			
	PH	$2,010,000	$172,479	$144,786	$317,266	$1,044,000	$89,586	$1,067			
	Ore Dryers	$0	$0	$0	$0	$150,000	$12,872	$0			
Grand Total		$52,826,750	$4,533,091	$3,164,022	$7,697,113	$4,576,955	$392,751	$117,345	$404,403	$914,499	$8,611,612

(continued)

Table 3-3. Plant-Specific Costs (10^6 \$2000) (continued)

Source: Alpha-Gamma Technologies, Inc. 2003. "Revised Taconite Ore Processing NESHAP Cost Impacts" Memorandum Chris Sarsony, Alpha-Gamma to Conrad Chin, U.S. Environmental Protection Agency. July, 2003.

Notes:

[a] The MRR labor cost is from the supporting statement. The total labor burden was divided by 8 to obtain the per facility cost. A worksheet showing the initial performance testing burden calculation is contained in the worksheet titled "Initial Perf. Testing Costs."
[b] L. Salmela, MINNTAC, April 8, 2003.
[c] L. Salmela, MINNTAC, April 8, 2003. $60,000 in capital MRR costs were estimated for OCH bag leak detection systems, but these costs are included in the indurating capital costs.
[d] L. Gietzen, National Steel, April 3, 2003.
[e] L. Gietzen, National Steel, March 26, 2003.
[f] B. Anderson, EVTAC, April 4, 2003 and June 5, 2003.
[g] B. Anderson, EVTAC, April 4, 2003.
[h] D. Skolasinski, Cleveland-Cliffs, April 7, 2003.
[i] D. Skolasinski, Cleveland-Cliffs, April 7, 2003. The capital MRR costs for SV32 to SV 53 are included in the capital emission control costs.
[j] D. Skolasinski, Cleveland-Cliffs, April 5, 2002.
[k] D. Skolasinski, Cleveland-Cliffs, April 5, 2002.
[l] E. Maki, Tilden, March 25, 2002 and L. Parker, Tilden, June 9, 2003.
[m] E. Maki, Tilden, March 25, 2002.
[n] A. Hayden, Hibbing: March 26, 2002; May 15, 2002; April 3, 2003; June 11, 2003.
[o] A. Hayden, Hibbing, April 3, 2003.
[p] D. Ahola, Empire, April 4, 2003.

SECTION 4

ECONOMIC IMPACT ANALYSIS: METHODS AND RESULTS

The underlying objective of the EIA is to evaluate the effect of the regulation on the welfare of affected stakeholders and society in general. The engineering cost analysis presented in Section 3 represents an estimate of the resources required to comply with the rule under baseline economic conditions. This section augments the cost analysis with an evaluation of how producers and consumers may react and respond to regulatory costs. For instance, producers may elect to reduce production in response to increased costs, thereby reducing market supply. Moreover, the control costs may be passed along to consumers through price increases. The primary purpose of this section is to develop and apply an analytical structure for measuring and tracking these effects as they are distributed across the stakeholders tied together through economic linkages. The conceptual approach to this analysis is described in detail in Section 4.1, followed by the economic impact results based on the operational model in Section 4.2. In addition to a market-based model, Section 4.3 presents the regional economic impact analysis of the rule recognizing the fact that all affected taconite facilities are concentrated in Minnesota and Michigan.

4.1 Conceptual Approach

To evaluate the impact on the iron ore and steel mill products markets, the Agency developed two national competitive partial equilibrium models (taconite and steel mill products) to estimate the economic impacts on society resulting from the regulation. We assume that, within each industry, the commodities of interest are homogeneous (e.g., perfectly substitutable) and that the number of buyers and sellers is large enough that no individual buyer or seller has market power (i.e., influence on market prices). As a result of these conditions, producers and consumers take the market price as a given when making their production and consumption choices.

4.1.1 Baseline and With-Regulation Market Equilibrium

A graphical representation of the competitive model of price formation, as shown in Figure 4-1(a), posits that market prices and quantities are determined by the intersection of the market supply and demand curves. Under the baseline scenario, a market price and quantity

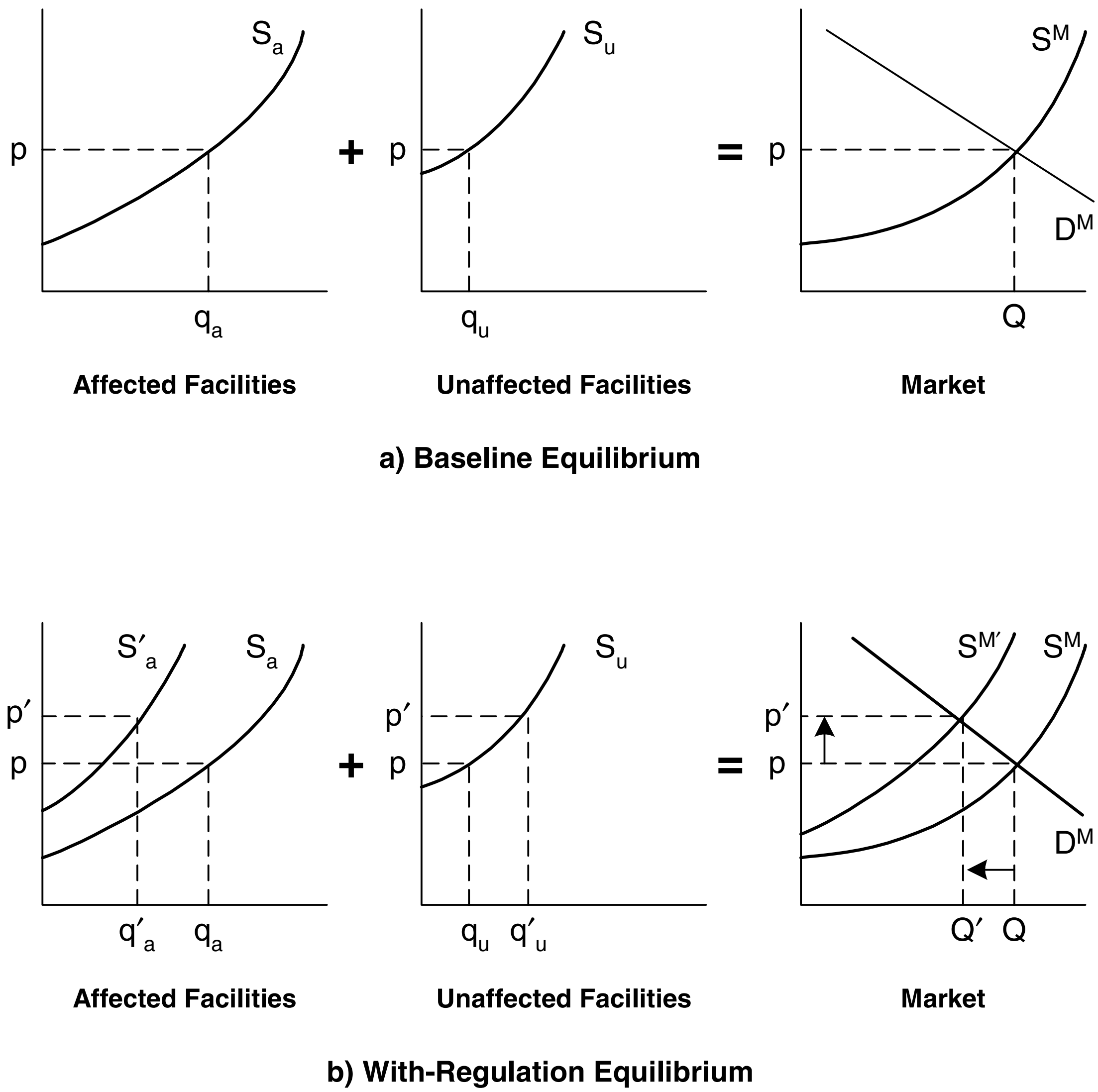

Figure 4-1. Market Equilibrium without and with Regulation

(p,Q) are determined by the downward-sloping market demand curve (D) and the upward-sloping market supply curve (S) that reflects the sum of the (affected) domestic and (unaffected) domestic and import supply curves.

With the regulation, the costs of production increase for affected domestic suppliers. The imposition of these regulatory control costs is represented as an upward shift in the supply curve for domestic supply. As a result of the upward shift in this supply curve, the market supply curve for affected products will also shift upward as shown in Figure 4-1(b) to reflect the increased costs of production for domestic supply.

In baseline without the standards, the industry produces total output, Q, at price, p, with affected producers supplying the amount q_a and unaffected domestic production and imports accounting for Q minus q_a, or q_u. With the regulation, the market price increases from p to p′, and market output (as determined from the market demand curve, D) declines from Q to Q′. This reduction in market output is the net result of reductions in affected domestic supply and increases from unaffected supply. In this case, unaffected supply includes both unaffected domestic producers and foreign producers. While the vast majority of the iron ore produced in this country is affected, a few iron ore producers are not part of the taconite industry. In the steel industry, the growing sector of the industry that uses EAF technology is expected to be less affected or unaffected by the rule, compared to integrated iron and steel producers.

4.1.2 Approach for Modeling Impacts on Affected Markets

The Agency modeled the impacts of increased control costs using two standard partial equilibrium models—one for iron ore sold on the market (i.e., merchant iron ore) and one for the steel mill product market. The compliance costs are introduced into each model as follows:

- Iron ore—control cost-induced shifts affect the merchant mine supply curves for iron ore sold in the market.
- Steel mill products—control costs affecting captive mines increase the costs of the steel plants owning the mines, resulting in an upward shift in the supply curve for steel mill products.

Conceptually, we have linked these two standard partial equilibrium models by specifying the interactions between supply and demand for products and then solving for changes in prices and quantities across both markets simultaneously. For example, changes in the market price for iron ore would result in higher production costs for steel plants. Thus, these compliance costs would also indirectly affect the steel market. The Agency explicitly modeled these interactions to better characterize the distribution of impacts on downstream iron and steel producers in the steel mill product markets. The following section discusses how the Agency characterized market supply and demand for each market..

4.1.3 Supply

After critical review, the Agency characterized supply at the mine/facility level. The model incorporates some fixed factors of production on producers (e.g., plant and equipment) that are augmented with variable factors inputs (e.g., materials, labor) to produce iron ore and steel mill products. These fixed factors are the source of diminishing marginal returns, hence, increasing marginal costs. Therefore, each producer's decision can be characterized by an upward-sloping supply curve.

An important measure of the magnitude of supply response is the price elasticity, computed as the percentage change in quantity supplied divided by the percentage change in price. Domestic supply elasticity was computed as the slope of a log-log regression of quantity produced on per-unit production cost. The computed domestic supply elasticity is 1.08. From the literature, we identified empirical estimates of foreign supply (ABARE, 1995). We used a value of 0.66,[1] which is consistent with research indicating that import supply may be more responsive than domestic supply. For the second model of the steel mill product market, EPA used midpoint values for flat-rolled products reported by the U.S. International Trade Commission (USITC, 2002). The domestic supply elasticity value used in this analysis is 3.5 and foreign supply elasticity is 15.

4.1.4 Demand

Consumption choices are a function of the price of the commodity, income, prices of related goods, tastes, and expectations about the future. In this analysis, EPA considered how these choices change in response to higher prices resulting from regulation, holding other variables constant. The economic model includes both domestic and foreign demand and assumes that the law of demand holds (i.e., the quantity demanded falls when price rises).

For the domestic demand elasticity in the iron ore market, the Agency estimated the elasticity using a method based on studies by J.R. Hicks (1961, 1966) and R.G.D. Allen (1938) on the elasticity of derived demand for intermediate goods. This method produced an estimated value of –0.14., which means a 1 percent increase in price would lead to a 0.14 percent decline in quantity demanded. In contrast, literature estimates for export demand indicate foreign consumers are more responsive to changes in the market price. Ho and Jorgenson (1998) report an export demand elasticity for metal mining of –0.92.

For the domestic demand elasticity in the steel mill product market, the Agency used an econometric estimate (–0.59) computed for the Integrated Iron and Steel NESHAP economic

[1] The United States primarily imports iron ore from Canada and Brazil. Overall, the North American import supply elasticity of iron ore is 0.04 while the Brazilian import supply elasticity is 0.66. EPA selected the highest of the two elasticity estimates reported by ABARE.

impact analysis (EPA, 2000). Ho and Jorgenson (1998) report export demand elasticities for fabricated metal ranging from –1.1 to –1.9. We used an average value of –1.25.

4.2 Economic Impact Results

To develop quantitative estimates of these impacts, we developed a computer model using the conceptual approach described above.[2] Using this model, EPA characterized supply and demand of two affected commodities for the baseline year, 2000; introduced a policy "shock" into the model by using control cost-induced shifts in the affected domestic supply functions of these markets; and used the market model to determine a new with-regulation equilibrium in each market. Although most of the data collected are 2000, we have incorporated up to date financial information from several publicly available sources to better characterize the whole industry. In the following sections, we present the market, industry, and societal impacts projected by the model.

4.2.1 Market-Level Impacts

The increased cost of production due to the regulation is expected to slightly increase the price of iron ore and steel mill products and reduce production/consumption from baseline levels. As shown in Table 4-1, the price of iron ore increases 0.10 percent. Domestic production of merchant iron ore declines by 70,000 metric tons (Mt), or 0.14 percent. Imports increase by 24,000 Mt, or 0.19 percent, resulting in a net decline of 46,000 Mt (0.073 percent). This means that producers will not be able to recoup much of their compliance costs through a price increase. The market as a whole (internationally) is minimally affected with only slight movements in price and output.

The price of steel mill products increases minimally by 0.004 percent. Domestic production declines by 22,000 metric tons (Mt), or 0.025 percent. This is the net result of declines of 30,000 Mt (0.07 percent) from integrated steel mills that use iron ore and increases in production from unaffected EAFs of 7,000 Mt (about 0.02 percent). Imports increase by 20,000 Mt, or 0.07 percent, resulting in a net decline in the market quantity

[2]Appendix A includes a description of the model's baseline data set and specification.

Table 4-1. Market-Level Impacts of the Taconite NESHAP, 2002

Main Scenario	Baseline	With Regulations	Change Absolute	Relative
Taconite				
Price ($/metric ton)	$55.31	$55.40	$0.10	0.177%
Quantity (10^6 metric tons)	63.671	63.325	–0.046	–0.073%
Domestic	51.239	51.149	–0.070	–0.137%
Imports	12.453	12.477	0.024	0.190%
Steel Mill Products				
Price ($/metric ton)	$532.00	$532.02	$0.02	0.004%
Quantity (10^6 metric tons)	119.636	119.633	–0.003	–0.002%
Domestic	89.984	89.961	–0.022	–0.025%
Basic Oxygen Process	44.350	44.321	–0.030	–0.067%
Electric	45.633	45.641	0.007	0.016%
Imports	29.652	29.672	0.020	0.067%

of steel mill products of only 3,000 Mt (0.002 percent). Domestic integrated steel producers are projected to absorb nearly all compliance costs as prices rise only minimally. Competition from EAFs and foreign producers is likely the reason; their increased production is projected to replace almost all domestic production lost. However, lost domestic production of integrated steel mills is a very small portion of their total output: 0.07 percent. Thus, the market as a whole (internationally) shows almost no change resulting from this regulatory cost.

4.2.2 Industry-Level Impacts

Revenue, costs, and profitability of the domestic industry also change as prices and production levels adjust to increased costs associated with compliance. For domestic producers, operating profits are projected to decrease by $7.0 million (see Table 4-2). These losses are the net result of three effects:

- Decreased revenue ($6.2 million)—revenue decreases from output declines are slightly mitigated by small increases in the prices of iron ore and steel mill products.

Table 4-2. Industry-Level Impacts of the Taconite NESHAP, 2000

	Change
Merchant Taconite	
Revenue ($\$10^6$)	\$3.66
Costs ($\$10^6$)	\$7.25
Production	–\$1.33
Compliance	\$8.58
Operating Profits	–\$3.59
Steel Mill Products	
Revenue ($\$10^6$)	–\$9.82
Costs ($\$10^6$)	–\$6.40
Production	–\$6.40
Compliance	\$0.00
Operating Profits	–\$3.42
Total Domestic	
Revenue ($\$10^6$)	–\$6.15
Costs ($\$10^6$)	\$0.85
Production	–\$7.73
Compliance	\$8.58
Operating Profits	–\$7.00

- Reductions in production costs as output declines ($7.7 million)—variable production costs fall as firms reduce their output.
- Increased emissions control costs ($8.6 million)—for plants/mines included in the market model, we have assumed total annual compliance costs vary with the level of output. Therefore, the compliance costs being incurred with regulation are slightly smaller than the engineering compliance costs input into the model because output declines due to regulatory costs.

4.2.3 Impacts at the Company Level

This section examines the impact of reduced production and increased costs on companies that own taconite facilities. One of the most sensitive issues to consider in the EIA is the possibility that the regulation may induce a producer to shut down operations rather than comply with the regulation. After critical review, the Agency determined the availability and quality of plant-level data and the size of the compliance costs did not support formal modeling of a plant closure decision within the market model.[3] However, the Agency did examine the closure issue using empirical literature and also examined other company impact issues using financial statements.

4.2.3.1 Review of Empirical Literature on Closure

To our knowledge, no empirical work examines the conditions that contribute to capacity reductions and closures of taconite mines. In contrast, the steel industry has been the focus of several empirical papers regarding this question. Given that the rule will likely increase the costs associated with iron ore, we first identified literature that reported the impacts of rising inputs costs on a firm's decision to close. Beeson and Giarratani (1998) found the changes in iron ore costs did not have a statistically significant impact on either capacity or plant closures. In addition, we reviewed findings regarding impacts of pollution abatement costs on the probability of steel plant closure. Deily (1988) claims that little or no new investment occurs in plants that will eventually be closed. She finds that firms' real investment per ton of capacity declined with increases in pollution control costs during 1971–1981. Beeson and Giarratani report that pollution control costs have a small but statistically significant impact on the probability of steel plant closures. They estimate a 10 percent change in pollution abatement costs increases the probability of closure by 1.79 percent. However, Deily and Gray (1991) find that total compliance costs have a negative and marginally significant effect on the probability of closure. They qualify their conclusion suggesting that the use of total rather than incremental costs, data quality, or technological coincidence may explain this unexpected result. Based on the data collected and the size of the annual compliance costs, the Agency concludes this regulation *alone* is unlikely to lead to mine closures or integrated steel plant closures. As mentioned in Section 4.2.1, integrated steel producers are projected to reduce output by 0.02 percent. Consequently, these reductions in output are expected to be too small to result in any plant closure. The rule may, however, add to existing financial stresses in the industry.

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[3]A detailed description of the economic model is included in Appendix A.

4.2.3.2 With-Regulation Company Operating Income

To evaluate if the regulation will add to current financial stresses in the industry, the Agency obtained 2000 financial data for seven affected domestic companies from publicly available financial statements. Although three of these firms (National Steel, U.S. Steel Group, and Ispat Inland, Inc.) are owned by another parent company, we used 10-K data for these companies to focus on impacts on the most directly-affected companies or parts of companies. A review of these data shows that the affected firms are all large, with substantial resources at their disposal. However, only four of these companies reported positive operating income[4] for 2000. The remaining firms are currently experiencing serious financial difficulties, and are vulnerable to mergers and acquisitions as has been the trend in recent years in this industry. In fact, two of them (Bethlehem Steel and National Steel) have filed voluntary petitions for relief under Chapter 11 of the U.S. Bankruptcy Code since December 2000. Although these filings do not necessarily imply closure, another firm (LTV) that had filed for Chapter 11 protection was recently authorized to shut down and sell all integrated steel assets.

EPA used two methods to gauge the impacts of the regulation for these eight firms. First, we compared annualized compliance costs to baseline operating income. Without accounting for market adjustments, this computation approximates the change in the companies' operating income due to the rule. The results are as follows:

- Four firms with positive operating income—Three of these firms are projected to experience declines in operating income ranging from 0.2 to 2 percent. The fourth is projected to experience a more substantial reduction in operating income, approximately 19%.
- Three firms with negative operating incomes—Operating losses are projected to increase by less than one percent.

4.2.3.3 Company Ability to Make Compliance Capital Investments

Although the economic model assumes firms can make capital investments associated with the rule, the ability to make these investments depends on a company's short-run financial strength. The Agency acknowledges that changes in financial conditions since 2000 may present significant obstacles to making capital investments (for example, two filed voluntary petitions for relief under Chapter 11 of the U.S. Bankruptcy Code). Therefore, EPA examined each firm's

[4]This measure equals sales less cost of goods sold, depreciation, and sales and administrative expenses. In the short run, a plant would be presumed to continue to operate as long as variable profits are positive. The Agency considered the owning company's operating margin as a reasonable approximation of plant-level variable profit rate.

financial statement more closely, computing the Altman Z-scores to gauge their financial condition.[5] We found that all the domestic firms had Z-scores that suggest the companies may face potential bankruptcy (i.e., had Z-scores lower than 1.8). This also implies that companies in the industry may have difficulty financing capital expenditures.

EPA also considered financial strength using the current ratio. The current ratio is the ratio of current assets to current liabilities and provides a measure of liquidity. Based on industry data for 1997, the median current ratio for the iron and steel industry was 1.9 (D&B, 1998). Data for 2000 show only two of the eight firms had current ratios exceeding this value. However, we found that five firms still made environmental compliance capital investments comparable in size to the costs of the rule in 2002. In spite of their financial difficulties, iron and steel companies are apparently able to make environmental investments. Therefore, giving consideration to this evidence, we conclude that it is possible that one or more steel firms may close or sell some or all of their operations when the costs of this rule are added to their current financial stresses.

4.2.4 Employment Impacts

Reduction in domestic production leads to changes in industry employment. These changes were estimated by multiplying the change in domestic production by census data on industry employment:

$$\Delta E_1 = [\Delta Q/Q]\ E_0 \tag{4.1}$$

Domestic employment at taconite facilities is projected to decline by only four employees (full-time equivalents [FTEs]) as a result of the rule based on lost domestic production of taconite.[6] Taconite mining is known to be a highly capital intensive industry, as opposed to labor intensive. Due to the nature of the industry, lost domestic production is not expected to lead to substantial layoffs.

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[5]The Altman Z-Score model is used as a predictive model for corporate bankruptcy. For this analysis, EPA has not used this model as a predictive model but has used it to consider the short-run financial strength of the affected firms.

[6]The direct reduction in employment at taconite facilities resulting from the rule may generate additional job losses through induced or indirect impacts on the economy of the taconite region, as laid-off workers spend less. These regional impacts are examined in Section 4.3.

4.2.5 Social Costs

The value of a regulatory action is traditionally measured by the change in economic welfare that it generates. The regulation's welfare impacts, or the social costs required to achieve environmental improvements, will extend to consumers and producers alike. Consumers experience welfare impacts due to changes in market prices and consumption levels associated with the rule. Producers experience welfare impacts resulting from changes in profits corresponding with the changes in production levels and market prices. However, it is important to emphasize that this measure does not include benefits that occur outside the market, that is, the value of reduced levels of air pollution with the regulation.

The economic analysis accounts for behavioral responses by producers and consumers to the regulation (i.e., shifting costs to other economic agents). This approach provides insights on how the regulatory burden is distributed across stakeholders. As shown in Table 4-3, the economic model estimates the total social cost of the rule at $8.60 million. As a result of higher prices and lower consumption levels, consumers (domestic and foreign) are projected to lose $2.86 million, or 33 percent of the total social costs or the rule. Producer surplus declines by $5.73 million, or 67 percent of the total social costs. This value consists of affected integrated plants and merchant iron ore mines experience losses of $8.09 million, and unaffected domestic supply and foreign producers who gain $2.36 million in producer surplus as a result of the regulation, because they experience price increases and unchanged costs.

4.2.6 Sensitivity Analysis

EPA is confident that the elasticity estimates used in the model reflect the best estimates available from the literature. However, EPA also conducted sensitivity analysis to explore the effect of different elasticity values. EPA increased or decreased the elasticities of demand and supply by 25 percent and re-evaluated the economic impacts. The results of this sensitivity analysis are presented in Appendix B. Compared to the main scenario reported here, Simulation 1 (increase demand elasticities by 25 percent) and Simulation 4 (decrease supply elasticity by 25 percent) result in larger price adjustments and a greater share of the burden being borne by consumers of taconite and steel. Conversely, Simulation 2 (decrease demand elasticities by 25 percent) and Simulation 3 (increase supply elasticities by 25 percent) result in smaller price adjustments and a greater share of the burden being borne by the producers of taconite and steel. Overall, changes are very small, variations of a few percentage points in price and quantity, and variations of less than 3 percent in the shares of the social costs borne by producers and consumers. See Appendix B for the details.

Table 4-3. Social Costs of the Taconite NESHAP, 2000

	Value ($\$10^6$)
Consumer Surplus Loss (–)/Gain (+)	–$2.86
Producer Surplus Loss (–)/Gain (+)	–$5.73
Merchant Taconite Producers	–$3.59
Integrated Iron and Steel Plants	–$4.51
Nonintegrated Steel Plants	$1.09
Foreign Producers	$1.27
Total Social Costs	–$8.60

4.3 Regional Economic Impacts

As mentioned in Section 2, the taconite industry affected by this rule is concentrated in one county in Michigan and four counties in Minnesota. As a result, the Agency decided to conduct an analysis of the rule's impact on this region. Although the rule is national in scope, affecting a product that is used throughout the nation and internationally, we expect that the economic impacts of the rule on producers of taconite ore may be concentrated geographically in this relatively small region. This section focuses on determining the compliance burden for these regions in Minnesota and Michigan, and to what extent the regulation imposes significant impacts on the regional economies beyond those imposed by the current condition of the taconite industry. Section 4.3.1 provides a general discussion of IMPLAN, the economic model chosen for this regional economic impact analysis. Section 4.3.2 provides general background information on the most affected counties in Minnesota and Michigan. Section 4.3.3 describes the estimated economic impacts of the rule on the identified counties.

4.3.1 IMPLAN Application in Regional Economic Impact Analysis

Regional economic impact analysis is commonly used to investigate how a change in economic activity in one part of the economy will affect economic activity in another part. This type of analysis has been used to evaluate the effects of changes in policies and regulations that affect local businesses either directly or indirectly, such as stricter local air pollution standards, changes in local taxes, or increased government spending on infrastructure. Regional economic impact analysis has also been used to measure the impacts of many different activities, such as government projects; plant closings or downsizing; military base conversions; and recreation activities (the presence of fishing, boating, and hunting in a particular area) that draw in visitors from outside the region. A regional economic impact analysis generally attempts to address the following basic questions concerning an activity of interest:

- How much spending does this activity bring to the region?
- How much income does this activity generate for local households and businesses?
- How many jobs does this activity support?
- How much tax revenue is generated by this activity?
- What portion of sales by local businesses is due to this activity?

Regional economic impact analyses are also frequently used to compare the impact expected from alternative policies under consideration in many State and local government agencies.

IMPLAN is a relatively standard type of input-output (I-O) model used for regional impact analysis. I-O models are mathematical models that quantify the supply and demand relationships between sectors in a region's economy. For example, tax revenues from an industry in the region may account for ten percent of a region's or county's total income. IMPLAN models a change in that industry to also impact the tax revenue based on the relationship, or factor, associated with that industry. A one percent drop in industry revenues would thus be associated with a 0.1 percent drop in tax revenues (10%•1%). I-O models are tools that can be used to estimate changes in production, income, employment, and local government expenditures and revenues resulting from a change in economic activity. Unlike the partial equilibrium market model used earlier in this section, I-O models do not estimate behavioral responses such as changes in relative prices of inputs or outputs. Whereas the partial equilibrium model used in Section 4.2 carefully estimates market responses in the most affected sectors, use of I-O models permits estimation of both the direct impacts in the affected sector and the indirect impacts that occur as the change in spending by the directly affected industry works its way through the economy. Based on production functions estimating the inputs that each industry must purchase from every other industry to produce its output, these models predict flows of money between sectors. I-O models also determine the proportion of sales that end up as income and taxes. Multipliers are estimated from I-O models based on the estimated re-circulation of spending within the region. The higher the propensity for households and firms within the region to purchase goods and services from local services, the higher the multipliers for the region will be.

IMPLAN is a nonsurvey-based regional I-O model including 528 sectors that can be constructed for any county-defined region in the U.S. IMPLAN's database is built from the National Income and Product Accounts (NIPA) published annually from the Bureau of Economic Analysis (BEA) and the 1977 BEA input-output model for the U.S. Data are designed to be internally consistent (i.e., county data sum to state totals and state data sum to national totals). IMPLAN can generate regional accounts for single counties, groups of counties, single states, groups of states, or the entire U.S. Data from numerous other sources are also used in building these regional accounts in IMPLAN. Most data entering IMPLAN's database do not represent actual county or state magnitudes. Instead, they are based on national values. For example, county employment in a given sector equals the NIPA-based state total for that sector multiplied by the ratio of county employment in that sector to state employment in that sector. The ratio is calculated directly from County Business Patterns (CBP), but the sector total for the state is not. Consequently, IMPLAN values for counties and states do not necessarily equal actual values reported in CBP or other data sources.

To analyze regional economic impacts using IMPLAN, an analyst must estimate the direct impacts of an economic activity or policy and provide them as input. A data file containing information on the region of interest provides information such as ratios of jobs to sales for each sector, the proportion of spending by individuals and firms located within the region that is spent within the region, and the amount that each sector purchases from each of the other sectors within the region per unit of output. The IMPLAN program uses these relationships to estimate the total regional impacts resulting from a given direct impact. Impact estimates are categorized as direct (exogenous impact resulting from policy or program), indirect (impacts resulting from changes in local input purchases by directly impacted sectors), and induced (impacts resulting from changes in household incomes due to changes in labor demand).

4.3.2 Data for the Affected Regions

As mentioned in Section 2, the taconite mining and processing facilities are concentrated in either Minnesota or Michigan. In Minnesota, all of the iron ore production occurs in Cook, Itasca, Lake, and Saint Louis counties. In Michigan, the production is primarily from the Empire and Tilden Mines in Marquette County. Thus, these counties have been identified as the major affected areas, where the majority of the economic impacts of the rule would be felt. Table 4-4 presents background information about the impacted regions. The counties range from very small (Cook County, MN) to relatively large (St. Louis County, MN). Cook County has low population, low employment, and a relatively small number of industries. St. Louis County, by contrast, has nearly 200,000 residents, more than 100,000 jobs, and a relatively

Table 4-4. Background of Affected Counties in 1998

County, State	Area (mile^2)	Population	Employment	# of Industries	# of Households	Household Income ($2002)[a]
Marquette, MI	1,821	61,757	31,918	139	23,843	**60,529**
Cook, MN	1,451	4,886	4,010	78	1,888	**70,201**
Itasca, MN	2,665	44,715	20,711	135	17,348	**56,162**
Lake, MN	2,099	10,773	5,494	101	4,239	**59,861**
St. Louis, MN	6,226	197,214	118,941	222	77,511	**70,602**

[a] All amounts were inflated to 1998 using the consumer price index available from the Bureau of Labor Statistics (<http://data.bls.gov/cgi-bin/surveymost>).

Source: MIG. 2001. IMPLAN county data.

diversified economy. The counties have relatively high median household incomes, which exceed the median household income of the state ($41,600) and the United States ($37,000).

4.3.3 Assessment of Regional Economic Impacts

The rule may affect the local economy in several ways, such as changes in sales and profits of local businesses, local employment, and local and state sales tax revenue. Generally, this rule is expected to have a mixed effect on the local economy because of decreased production of taconite and increased purchases of local labor and materials for implementing controls and conducting MRR activities. The following subsections describe the estimated economic impacts of the rule on the Minnesota four-county region and Michigan one-county region.

4.3.3.1 Effect of Regulation on Local Economy

The total direct impact on each region is estimated as the change in local expenditures resulting from the rule. The direct impact of the rule is estimated based on the results reported in Section 4.2, and includes expenditures to comply with the regulation (positive) and adjustments in output (which may be negative or positive). Generally, the direct impact includes the net effect of the reduction in local spending because output declines and the increase in local spending to implement the controls. In each region, some mines are projected to reduce their production of taconite, while other mines (those incurring costs of compliance that are relatively small) are projected to increase their production. For the Minnesota region, any reduction in taconite production will also result in a loss in government revenues because a portion of state revenues comes from taxes on the total production from taconite iron ore (Minnesota Department of Revenue, 2002). The impact of decreased output and tax revenue is estimated to be a net reduction in local spending of $0.8 million. For Michigan, the reduction in spending because output falls at one plant is outweighed by the increase in local spending to implement the controls and increasing production at another plant, resulting in a net increase of approximately $0.5 million for the Michigan region.

Table 4-5 lists the direct impacts on both the industry and local and state government. Although the direct impact of a change in iron pellet production is primarily felt in these sectors, many additional sectors of the economy will be affected to some extent through secondary (indirect and induced) impacts, as a result of the decreased or increased spending of the directly affected sectors. To estimate secondary impacts, it is necessary to incorporate the direct economic impacts estimates from Table 4-5 as inputs into IMPLAN to obtain estimated changes in other sectors, such as electric services, explosives, and motor freight transport and warehouses industries.

4.3.3.2 Impact of Regulation on Local Business Output

The projected reduction in iron ore production is expected to result in a corresponding change in the value of local business output, including direct, indirect, and induced impacts. Table 4-6 summarizes the total impact of the rule on the value of output, based on multipliers generated by IMPLAN for the four-county Minnesota region and the one-county Michigan region. For both regions analyzed, the total impact is estimated to be about 40 to 45 percent larger than the direct effect. Because EPA’s analysis focuses on these five counties, the only indirect effects reported are the reductions in purchases of inputs from other businesses within the two regions. Communities located outside of the regions may experience additional impacts, but these effects are expected to be much smaller than those within the regions and are not included in the analysis. Similarly, the induced effect measures only the reduction in goods and services purchased from the regions’ businesses as a result of a reduction in household income. However, households are likely to make at least some purchases outside the local area. Again, this means that there will be some additional induced impacts in other communities, but this analysis concentrates on the regions most directly affected by the reduction in taconite pellet production and does not attempt to quantify the outside-the-region impacts, as they are expected to be minimal.

Table 4-5. Direct Impact of Taconite NESHAP on Regions in Minnesota and Michigan ($2002)[a]

	Economic Impacts ($$10^3$)
Minnesota	
Compliance Costs and Output Loss	
EVTAC	191
Hibbing	760
Inland	234
MINNTAC	–1,236
National Steel Pellets	– 271
Northshore	– 373
Taconite Production Tax Reduction	
Education sector	– 42
Noneducation sector	–111
Total Direct Impacts in Minnesota	– 847
Michigan	
Compliance Costs and Output Gain or Loss	
Empire	295
Tilden	197
Total Direct Impacts in Michigan	492

[a] All amounts were inflated using the consumer price index available from the Bureau of Labor Statistics (<http://data.bls.gov/cgi-bin/surveymost>).

Source: Taconite Costs with Updated Industry Estimates 6-18-03.xls.
Minnesota Department of Revenue. 2002. Minnesota Mining Tax Guide 2002.

Table 4-6. Estimated Total Impacts of the Taconite NESHAP on Value of Output (10^3 $2002)[a]

	Minnesota	Michigan
Direct effect	–847	492
Indirect effect	–222	143
Induced effect	–168	69
Total Impact	–1,236	704

[a] All amounts were inflated using the consumer price index available from the Bureau of Labor Statistics (<http://data.bls.gov/cgi-bin/surveymost>).

Source: Minnesota IMPLAN Group (MIG). 2002. IMPLAN impact report of output.

4.3.3.3 Change in Employment

Another regional economic impact is the change in employment within the sectors that are affected by the rule. These changes are calculated by IMPLAN based on ratios of sales to employment for the affected industries in the two regions. As a result of the decrease in taconite production anticipated, mining facilities will need fewer employees. On the other hand, the rule requires more manpower in MRR activities. The reduction in employment is estimated to be 11 workers for the Minnesota region and none for Michigan. Table 4-7 summarizes the results of the employment analysis.

Table 4-7. Estimated Total Change in Employment (Number of Employees)

	Minnesota	Michigan
Direct effect	–6	2
Indirect effect	–2	1
Induced effect	–3	1
Total Impact	–11	4

Source: Minnesota IMPLAN Group (MIG). 2002. IMPLAN impact report of employment.

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APPENDIX A

MODEL DATA SET AND SPECIFICATION

The primary purpose of the EIA for the Taconite NESHAP is to describe and quantify the economic impacts associated with the rule. The Agency used a basic framework that is consistent with economic theory and the analyses performed for other rules to develop estimates of these impacts. This approach employs standard microeconomic concepts to model behavioral responses expected to occur with regulation. For more information, see the OAQPS Economic Resource Manual located at <http://www.epa.gov/ttn/ecas/econdata/Rmanual2/index.html>. This appendix describes the spreadsheet model in more detail and discusses how the Agency

- collected the baseline data set for the domestic iron ore and steel mill products market,
- characterized market supply and demand for each market,
- introduced a policy "shock" into the model by using control cost–induced shifts in the domestic supply functions, and
- used a solution algorithm to determine a new with-regulation equilibrium for each market.

A.1 Baseline Data Set

EPA collected the following data to characterize the baseline year, 2002:

Baseline Quantity—The *Skillings Mining Review* (2003) provided production data for iron ore mines. The American Iron and Steel Institute reported market data for steel mill products (see Table A-1).

Baseline Prices—The Agency obtained software providing average total costs of production for all iron producers in the world (Mine Cost, 2000). The Agency used the reported average total cost of the highest cost (marginal) mine as an approximation for the market price of iron ore. The 2001 average steel mill product price was obtained from the Bureau of the Census (U.S. Department of Commerce, 2002) by dividing total f.o.b value of shipments by quantity. Both prices were adjusted to 2002 using the appropriate producer price index.

Table A-1. Baseline Data Set, 2000

Market	Domestic Production (10^6 metric tons)	Imports (10^6metric tons)	Exports (10^6metric tons)	Price ($/metric ton)
Iron Ore	51	12	7	$55
Steel Mill Products	90	30	5	$532

Source: U.S. International Trade Commission. "SIC-1011: FAS Value by FAS Value for All Countries." <http://dataweb.usitc.gov>. As obtained July 5, 2001a.
U.S. International Trade Commission. "SIC-1011: Customs Value by Customs Value for All Countries." <http://dataweb.usitc.gov>. As obtained July 5, 2001b.
U.S. Department of Commerce, Bureau of the Census. 2002. *Steel Mill Products: MA331B(01)-1*. Washington, DC: Government Printing Office.
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Iron ore supply and demand elasticities—EPA estimated an industry supply elasticity for taconite using 42 observations of average cost and mine production data western hemisphere mines (Mine Cost, 2000). The following equation was employed: $\ln(Q) = b_0 - \beta_1 \ln(p) + \varepsilon$. Given this specification, β_1 can be interpreted as the market supply elasticity. The value of coefficient (1.08) is statistically significant at the 95 percent confidence level. The elasticity of demand in our analysis is derived as a function of the demand for steel mill products; its computed value is -0.14. Ho and Jorgenson (1998) report an export demand elasticity for metal mining of –0.92 (Table A-2).

Steel mill product supply and demand elasticities—The U.S. International Trade Commission (USITC, 2001c) reports supply elasticities for domestic and foreign flat-rolled steel products. For this analysis, we used the midpoint values (domestic supply elasticity = 3.5 and foreign supply elasticity = 15). For the domestic demand elasticity, the Agency used an econometric estimate (–0.59) computed for the Integrated Iron and Steel NESHAP economic impact analysis (EPA, 2000). Ho and Jorgenson (1998) report export demand elasticities for fabricated metal ranging from –1.1 to –1.9. We used an average value of –1.25 (Table A-2).

Table A-3. Supply and Demand Elasticities Used for the Market Models

Market	Supply	Demand
Iron Ore		
Domestic	1.08[a]	derived demand
Foreign	1.08[a]	–0.92[b]
Steel Mill Products		
Domestic	3.5[c]	–0.59[d]
Foreign	15[c]	–1.25[b]

[a] EPA econometric estimate using Mine Cost (2000).
[b] Ho, M., and D. Jorgenson. 1998. "Modeling Trade Policies and U.S. Growth: Some Methodological Issues." Presented at USITC Conference on Evaluating APEC Trade Liberalization: Tariff and Nontariff Barriers. September 11-12, 1997. <http://www.usitc.gov/wais/reports/arc/w3101.htm>.
[c] U.S. International Trade Commission (USITC). November 21, 2001c. Memorandum to the Commission from Craig Thomsen, John Giamalua, John Benedetto, Joshua Levy, International Economist. Investigation No. TA-201-73: STEEL—Remedy Memorandum.
[d] U.S. Environmental Protection Agency (EPA). 2000. *Economic Impact Analysis of Proposed Integrated Iron and Steel NESHAP. EPA-452/R-00-008.*

A.2 Discussion of Modeling Approach

The agency modeled the impacts of increased control costs using two standard partial equilibrium models—one for iron ore and one for the steel mill product market. Conceptually, we have linked these two standard partial equilibrium models by specifying the interactions between supply and demand for products and then solving for changes in prices and quantities across both markets simultaneously. For example, changes in the market price for iron ore would result in higher production costs for steel plants. Thus, these compliance costs would also indirectly affect the steel market. The Agency explicitly modeled these interactions to better characterize the distributional impacts on downstream iron and steel producers in the steel mill product markets. The following section discusses how the agency characterized market supply and demand for each market.

A.3 Market Supply

Market supply is composed of domestic production (d) and imports (m):

$$Q^S = q^{S_d} + q^{S_m} \tag{A.1}$$

A.3.1 Domestic and Import Supply

A.3.1.1 Domestic Taconite Producers

The change in quantity supplied by domestic *taconite* producers can be approximated as follows:

$$\Delta q^{S_d} = q_0^{S_d} \cdot \varepsilon^{S_d} \cdot \frac{\Delta p_t - c}{p_{t0}} \qquad \text{(A.2)}$$

where $q_0^{S_d}$ is the baseline quantity, ε^{S_d} is the domestic supply elasticity, the term Δp_t-c is the change in the producer's net price, and p_0 is the baseline price. The change in net price is composed of the change in market price resulting from the regulation (Δp_t) and the shift in the domestic supply function (c) resulting from the direct costs of compliance. The domestic producer's supply shift is calculated by dividing the annual compliance cost estimate for each facility by baseline output.

A.3.1.2 Domestic Steel Mill Product Producers Using the Basic Oxygen Process

Domestic steel producers using this process use taconite as an input to production. Their supply decision can be approximated as follows:

$$\Delta q^{S_d} = q_0^{S_d} \cdot \varepsilon^{S_d} \cdot \frac{\Delta p_s - \alpha \Delta p_t}{p_{s0}} \qquad \text{(A.2)}$$

where $q_0^{S_d}$ is the baseline quantity, ε^{S_d} is the domestic supply elasticity, the term $\Delta p - \alpha\, \Delta p_{ore}$ is the change in the producer's net price, and p_0 is the baseline price. The parameter α represents the amount of taconite input per unit of steel mill product (estimated 1.28 metric tons per unit of product) . The change in net price of steel is composed of the change in baseline price of steel resulting from the regulation and the shift in the domestic supply function of steel resulting from the increase price of taconite inputs. The domestic producer's supply shift is calculated using the equilibrium price projected by the taconite market model.

A.3.1.2 Unaffected Steel Mill Product Producers: Domestic and Foreign

The change in quantity supplied by domestic steel producer using electric processes and foreign producers can be approximated as follows:

$$\Delta q^{S_u} = q_0^{S_u} \cdot \varepsilon^{S_u} \cdot \frac{\Delta p}{p_0} \tag{A.3}$$

where $q_0^{S_u}$ is the baseline level of output, ε^{S_u} is the supply elasticity, and p_0 is the baseline price. These producers do not face increased pollution control costs resulting from the regulation and do not use taconite as an production input so their net price change equals the gross increase in the market price. As a result, producers increase output in response to higher prices.

A.3.2 Producer Welfare Measurement

For affected domestic supply, the change in producer surplus (PS) can be approximated with the following equation:

$$\text{Taconite: } \Delta PS_d = q_{d1} \cdot (\Delta p - c) - 0.5 \cdot \Delta q_d \cdot (\Delta p - c) \tag{A.4a}$$

$$\text{Affected Steel: } \Delta PS_d = q_{d1} \cdot (\Delta p - c) - 0.5 \cdot \Delta q_d \cdot (\Delta p - \alpha \Delta p_{ore}) \tag{A.4b}$$

where q_{d1} is the with-regulation quantity demanded. New control costs *or* higher input prices and output declines have a negative effect on affected domestic producer surplus. However, these losses are mitigated to some degree as a result of higher market prices.

In contrast to affected producers, unaffected domestic and foreign producers do not face additional pollution controls and their change in producer surplus can be approximated as follows:

$$\Delta PS_m = q_{m1} \cdot \Delta p + 0.5 \cdot \Delta q_m \cdot \Delta p \tag{A.5}$$

With regulation, both price and output increase for these producers leading to unambiguous producer surplus gains.

A.4 Market Demand

Market demand is composed of domestic consumption (d) and exports (x)

$$Q^{D_d} = q^{D_d} + q^{D_x} \qquad \text{(A.6)}$$

A.4.1 Domestic and Export Demand

The change in quantity demanded by domestic and foreign consumers can be approximated as follows:

$$\Delta q^{D_i} = q_0^{D_i} \cdot \eta^{D_i} \cdot \frac{\Delta p}{p_0} \qquad \text{(A.7)}$$

where q_0^D is baseline consumption, η^D is the demand elasticity of the respective consumer (i) and Δp is the change in the market price.

A.4.2 Consumer Welfare Measurement

The change in domestic and foreign consumer surplus in the steel mill product market is approximated as follows:

$$\Delta CS_i = - q_{i1} \cdot \Delta p + 0.5 \cdot \Delta q_i \cdot \Delta p \qquad \text{(A.8)}$$

As shown, higher market prices and reduced consumption lead to welfare losses for both domestic and foreign consumers. Note this calculation is only performed for the steel mill product consumers. Since taconite consumers are steel producers, their welfare loss is reflected in PS calculation in A.4b.

A.5 With Regulation Market Equilibrium Solution

The new with-regulation equilibrium arises where change in total market supply equals the change in market demand (i.e., $\Delta Q^s = \Delta Q^D$). We used the model equations outlined above and a solver application available in commercial spreadsheets to compute new equilibrium in prices and quantities.

APPENDIX B

SENSITIVITY ANALYSIS RESULTS

As noted in Section 4, EPA's analysis is based on the best estimates available of the responsiveness of supply and demand for taconite and steel to changes in their prices. This appendix examines the impact of varying the parameters of interest: the elasticities of demand and supply in both the taconite and steel markets. EPA performed four sensitivity analysis simulations. In each simulation, one set of parameters (elasticities of supply or elasticities of demand) is increased or decreased by 25 percent, relative to the estimates used in the main scenario. Table B-1 presents the design of the sensitivity analysis and the parameter estimates used in each simulation. Results of the simulations are shown in Tables B-2 through B-13. By comparing the results in Section 4 with the results in Tables B-2 through B-13, it can be demonstrated that substantial variations in the parameter estimates do not result in large changes in the estimated impacts.

Table B-1. Sensitivity Analysis

	Parameter Estimates in Main Scenario, Presented in Section 4	Sensitivity Analysis Simulations			
		1	**2**	**3**	**4**
Supply		25% increase	25% decrease		
Demand				25% increase	25% decrease
Iron Ore					
Domestic					
Supply	1.08	1.35	0.81	1.08	1.08
Demand	–0.14	–0.14	–0.14	–0.17	–0.11
Foreign					
Supply	0.66	0.83	0.50	0.66	0.66
Demand	–0.92	–0.92	–0.92	–1.14	–0.69
Steel Mill Products					
Domestic					
Supply	3.50	4.38	2.63	3.50	3.50
Demand	–0.59	–0.59	–0.59	–0.73	–0.44
Foreign					
Supply	15.00	18.75	11.25	15.00	15.00
Demand	–1.25	–1.25	–1.25	–1.55	–0.94

Table B-2. Market-Level Impacts: 2002

	Baseline	With Regulations	Change Absolute	Relative
Taconite				
Price ($/metric ton)	$55.31	$55.40	$0.10	0.176%
Quantity (10^6 metric tons)	63.671	63.613	–0.058	–0.092%
Domestic	51.219	51.131	–0.088	–0.172%
Imports	12.453	12.482	0.030	0.237%
Steel Mill Products				
Price ($/metric ton)	$532.00	$532.02	$0.02	0.004%
Quantity (10^6 metric tons)	119.636	119.633	–0.003	–0.003%
Domestic	89.984	89.956	–0.028	–0.031%
Basic Oxygen Process	44.350	44.313	–0.037	–0.083%
Electric	45.633	45.642	0.009	0.020%
Imports	29.652	29.677	0.025	0.084%

Table B-3. Market-Level Impacts: 2002

	Baseline	With Regulations	Change Absolute	Relative
Taconite				
Price ($/metric ton)	$55.13	$55.40	$0.09	0.170%
Quantity (10^6 metric tons)	63.671	63.633	–0.038	–0.060%
Domestic	51.219	51.163	–0.055	–0.108%
Imports	12.453	12.470	0.017	0.137%
Steel Mill Products				
Price ($/metric ton)	$532.00	$532.02	$0.02	0.004%
Quantity (10^6 metric tons)	119.636	119.633	–0.003	–0.003%
Domestic	89.984	89.967	–0.017	–0.019%
Basic Oxygen Process	44.350	44.329	–0.022	–0.049%
Electric	45.633	45.638	0.005	0.011%
Imports	29.652	29.666	0.014	0.046%

Table B-4. Market-Level Impacts: 2002

	Baseline	With Regulations	Change Absolute	Relative
Taconite				
Price ($/metric ton)	$55.31	$55.40	$0.09	0.171%
Quantity (10^6 metric tons)	63.671	63.621	–0.050	–0.079%
Domestic	51.219	51.145	–0.073	–0.143%
Imports	12.453	12.476	0.023	0.184%
Steel Mill Products				
Price ($/metric ton)	$532.00	$532.02	$0.02	0.004%
Quantity (10^6 metric tons)	119.636	119.632	–0.004	–0.003%
Domestic	89.984	89.691	–0.022	–0.025%
Basic Oxygen Process	44.350	44.321	–0.029	–0.065%
Electric	45.633	45.640	0.007	0.015%
Imports	29.652	29.671	0.018	0.062%

Table B-5. Market-Level Impacts: 2000

Main Scenario	Baseline	With Regulations	Change Absolute	Relative
Taconite				
Price ($/metric ton)	$55.31	$55.40	$0.10	0.177%
Quantity (10^6 metric tons)	63.671	63.625	–0.046	–0.073%
Domestic	51.219	51.149	–0.070	–0.137%
Imports	12.453	12.477	0.024	0.190%
Steel Mill Products				
Price ($/metric ton)	$532.00	$532.02	$0.02	0.004%
Quantity (10^6 metric tons)	119.636	119.633	–0.003	–0.002%
Domestic	89.984	89.961	–0.022	–0.025%
Basic Oxygen Process	44.350	44.321	–0.030	–0.067%
Electric	45.633	45.641	0.007	0.016%
Imports	29.652	29.672	0.020	0.067%

Table B-6. Domestic Industry-Level Impacts: 2002

	Change
Taconite	
Revenue ($\$10^6$)	\$2.97
Costs ($\$10^6$)	\$6.57
Production	–\$2.00
Compliance	\$8.57
Operating Profits	–\$3.60
Steel Mill Products	
Revenue ($\$10^6$)	–\$12.81
Costs ($\$10^6$)	–\$9.40
Production	–\$9.40
Compliance	\$0.00
Operating Profits	–\$3.41
Total Domestic	
Revenue ($\$10^6$)	–\$9.84
Costs ($\$10^6$)	–\$2.83
Production	–\$11.40
Compliance	\$8.57
Operating Profits	–\$7.02

Table B-7. Industry-Level Impacts: 2002

	Change
Taconite	
Revenue ($\$10^6$)	$3.86
Costs ($\$10^6$)	$7.65
Production	–$0.94
Compliance	$8.59
Operating Profits	–$3.79
Steel Mill Products	
Revenue ($\$10^6$)	–$6.93
Costs ($\$10^6$)	–$3.55
Production	–$3.55
Compliance	$0.00
Operating Profits	–$3.39
Total Domestic	
Revenue ($\$10^6$)	–$3.07
Costs ($\$10^6$)	$4.10
Production	–$4.48
Compliance	$8.59
Operating Profits	–$7.17

Table B-8. Domestic Industry-Level Impacts: 2002

	Change
Taconite	
Revenue ($\$10^6$)	$3.23
Costs ($\$10^6$)	$6.98
Production	–$1.60
Compliance	$8.58
Operating Profits	–$3.76
Steel Mill Products	
Revenue ($\$10^6$)	–$9.89
Costs ($\$10^6$)	–$6.50
Production	–$6.50
Compliance	$0.00
Operating Profits	–$3.39
Total Domestic	
Revenue ($\$10^6$)	–$6.66
Costs ($\$10^6$)	$0.48
Production	–$8.09
Compliance	$8.58
Operating Profits	–$7.15

Table B-9. Industry-Level Impacts: 2000—Simulation 4

	Change
Taconite	
Revenue ($\$10^6$)	$3.66
Costs ($\$10^6$)	$7.25
Production	–$1.33
Compliance	$8.58
Operating Profits	–$3.59
Steel Mill Products	
Revenue ($\$10^6$)	–$9.82
Costs ($\$10^6$)	–$6.40
Production	–$6.40
Compliance	$0.00
Operating Profits	–$3.42
Total Domestic	
Revenue ($\$10^6$)	–$6.15
Costs ($\$10^6$)	–$0.85
Production	–$7.73
Compliance	$8.58
Operating Profits	–$7.00

Table B-10. Social Costs: 2002

	Value ($\$10^6$)
Consumer Surplus Loss (–)/Gain (+)	–$2.84
Producer Surplus Loss (–)/Gain (+)	–$5.75
Domestic	–$7.02
Taconite Producers	–$3.60
Steel Mill Product Producers	–$3.41
Basic Oxygen Process	–$4.50
Electric	$1.08
Foreign Producers	$1.26
Total Social Costs	–$8.59

Table B-11. Social Costs: 2002

	Value ($\$10^6$)
Consumer Surplus Loss (–)/Gain (+)	–$2.61
Producer Surplus Loss (–)/Gain (+)	–$5.99
Domestic	–$7.17
Taconite Producers	–$3.79
Steel Mill Product Producers	–$3.39
Basic Oxygen Process	–$4.38
Electric	$1.00
Foreign Producers	$1.18
Total Social Costs	–$8.60

Table B-12. Social Costs: 2002

	Value ($\$10^6$)
Consumer Surplus Loss (–)/Gain (+)	–$2.64
Producer Surplus Loss (–)/Gain (+)	–$5.95
Domestic	–$7.15
Taconite Producers	–$3.76
Steel Mill Product Producers	–$3.39
Basic Oxygen Process	–$4.40
Electric	$1.01
Foreign Producers	$1.20
Total Social Costs	–$8.60

Table B-13. Social Costs: 2002

	Value ($\$10^6$)
Consumer Surplus Loss (–)/Gain (+)	–$2.86
Producer Surplus Loss (–)/Gain (+)	–$5.73
Domestic	–$7.00
Taconite Producers	–$3.59
Steel Mill Product Producers	–$3.42
Basic Oxygen Process	–$4.51
Electric	$1.09
Foreign Producers	$1.27
Total Social Costs	–$8.60

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16. ABSTRACT

This report evaluates the economic impacts of the final NESHAP for taconite iron ore producers. The industry impacts and social costs of the rule are estimated by incorporating the expected costs of compliance to a partial equilibrium model of the U.S. industry and projecting the market impacts for the various end-use markets. The report also provides an analysis of the impacts on companies owning taconite facilities, and on the geographic region in Minnesota and Michigan where taconite production is concentrated.

17. KEY WORDS AND DOCUMENT ANALYSIS

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