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United States Environmental Protection Agency

National Emission Standards for Hazardous Air Pollutants (NESHAP) for Taconite Iron Ore Processing Plants

Background Information for Proposed Standards

EPA 453/R-02-015
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U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Emission Standards Division
Research Triangle Park, North Carolina

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LIST OF ACRONYMS, SHORTENED NAMES, AND UNITS OF MEASURE

APCD	Air pollution control device
BID	Background Information Document
CAA	Clean Air Act
COMS	Continuous opacity monitoring system
CPMS	Continuous parameter monitoring system
CRF	Capital Recovery Factor
dcfm	Dry cubic feet per minute
dscf	Dry standard cubic feet
dscm	Dry standard cubic meters
Empire	Empire Iron Mining Partnership, Palmer, Michigan
ESP	Electrostatic precipitator(s)
EVTAC	EVTAC Mining, LLC, Forbes, Minnesota
g	Grams
gr	Grains
HAP	Hazardous air pollutant(s)
Hibbing	Hibbing Taconite Company, Hibbing, Minnesota
Inland	Ispat-Inland Steel Mining Company, Virginia, Minnesota
IPER	Industrial Process Equipment Rule
MACT	Maximum achievable control technology
Minntac	U.S. Steel Minnesota Ore Operations, Mountain Iron, Minnesota

MMBTU	Million British Thermal Units
MPCA	Minnesota Pollution Control Agency
MRR	Monitoring, recordkeeping, and reporting
National	National Steel Pellet Company, Keewatin, Minnesota
NESHAP	National Emission Standards for Hazardous Air Pollutants
Northshore	Northshore Mining Company, Silver Bay, Minnesota
NSPS	New Source Performance Standards
O & M	Operation and maintenance
OAQPS	Office of Air Quality Planning and Standards
OCH	Ore crushing and handling
PEC	Purchased Equipment Costs
PH	Pellet handling
PIC	Products of incomplete combustion
PM	Particulate matter
ppm	Parts per million
RSD	Relative standard deviation
Tilden	Tilden Mining Company, LC, Ishpeming, Michigan
VAPCCI	Vatavuk Air Pollution Control Cost Indexes
VOC	Volatile organic compound(s)

1.0 INTRODUCTION

The purpose of this document is to provide a summary of background information used in the development of maximum achievable control technology (MACT) standards for the taconite iron ore processing source category. Specifically, this document presents the procedures used to determine the MACT floor, the MACT level of control, and projected cost impacts and environmental impacts for the taconite iron ore processing source category. All references cited in this document are available in EPA's rulemaking docket.

The balance of this chapter provides a summary of the statutory basis for MACT standards and the selection of the source category. Chapter 2 provides an overview of the industry and detailed process descriptions, including a discussion of the different types of indurating furnaces used for the pelletizing process. A summary of current state and federal regulations applicable to taconite iron ore processing is also included in Chapter 2. Chapter 3 describes emission units in the taconite iron ore processing source category and provides estimates of baseline emissions of hazardous air pollutants (HAP) and particulate matter (PM) from the emission units. Emission control technologies used within the source category and the corresponding emissions reduction performance are summarized in Chapter 4. The MACT floor analysis and the determination of MACT levels of control are described in Chapter 5. Chapter 6 presents the projected emission control costs and the monitoring, recordkeeping, and reporting costs associated with the proposed National Emission Standards for Hazardous Air Pollutants (NESHAP). Finally, Chapter 7 presents the estimates for the reduction in HAP and PM air emissions and other environmental and energy impacts associated with the regulatory options in the proposed NESHAP.

1.1 STATUTORY BASIS

Section 112 of the Clean Air Act (CAA) requires the EPA to list categories and subcategories of major sources and area sources of HAP and to establish NESHAP for the listed source categories and subcategories. Major sources of HAP are those that have the potential to emit greater than 10 tons/yr of any one HAP or 25 tons/yr of any combination of HAP.

Section 112 of the CAA requires that EPA establish NESHAP for the control of HAP from both new and existing major sources. The CAA requires the NESHAP to reflect the maximum degree of reduction in emissions of HAP that is achievable. This level of control is commonly referred to as MACT.

The MACT floor is the minimum control level allowed for NESHAP and is defined under section 112(d)(3) of the CAA. In essence, the MACT floor ensures that the standard is set at a level that directs all major sources to achieve a level of control at least as stringent as that already achieved by the better-controlled and lower-emitting sources in each source category or subcategory. For new sources, the MACT floor cannot be less stringent than the emission control that is achieved in practice by the best-controlled similar source. The MACT standards for existing sources can be less stringent than standards for new sources, but they cannot be less stringent than the average emission limitation achieved by the best-performing 12 percent of existing sources in the category or subcategory (or the best-performing 5 sources for categories or subcategories with fewer than 30 sources).

In developing MACT, the EPA also considers control options more stringent than the floor. The EPA may establish standards more stringent than the floor after considering the additional costs and projected health and environmental benefits of achieving further emissions reductions.

1.2 SELECTION OF SOURCE CATEGORY

Section 112(c) of the CAA requires EPA to list all categories of major and area sources of HAP for which we will develop national emission standards. The EPA published the initial list of source categories on July 16, 1992 (57 FR 31576). "Taconite Iron Ore Processing" is one of the source categories on the initial list. The listing was based on EPA's determination that taconite iron ore processing plants may reasonably be anticipated to emit a variety of HAP listed in section 112(b) in quantities sufficient to be major sources.

Taconite iron ore processing plants separate and concentrate iron ore from taconite, a low-grade ore, and produce taconite pellets, which are approximately 60 percent iron. The taconite iron ore processing source category includes, but is not limited to, ore crushing and handling emission units, ore dryers, indurating furnaces, and finished pellet handling emission units. Taconite pellets are currently produced at eight sites in the United States–six in Minnesota and two in Michigan.

2.0 OVERVIEW OF THE TACONITE IRON ORE PROCESSING INDUSTRY

This chapter presents an overview of the taconite iron ore processing industry in the United States. Section 2.1 provides a general description of the industry. More detail on the various stages in processing taconite iron ore is given in Section 2.2. Section 2.3 summarizes the existing state and federal air emissions standards that affect the taconite iron ore processing industry.

2.1 INDUSTRY DESCRIPTION

This description of the taconite iron ore processing industry is focused on three areas: ore characterization and geographic distribution (Section 2.1.1), product markets and characterization (Section 2.1.2), and economic trends (Section 2.1.3).

2.1.1 Ore Characterization and Geographic Distribution

Taconite is a hard, banded, low-grade iron ore, and is the predominant iron ore remaining in the United States. Ninety-nine percent of the crude iron ore processed in the United States is taconite. The taconite ore is processed to increase the iron concentration and shaped into pellets for use in blast furnaces to make iron and steel.

Iron ore is mined and processed in the United States mainly in the Mesabi Range of northern Minnesota and the Marquette Range of the Upper Peninsula of Michigan. The taconite source category is comprised of eight facilities operating in the United States - six facilities in Minnesota and two facilities in Michigan.[1] Figure 2.1-1 shows the locations of these facilities while Table 2.1-1 provides company names along with site locations of their mining and pelletizing plants.

The Mesabi Range, located approximately 65 miles north of Duluth, Minnesota, consists of an iron formation that runs approximately 120 miles from Grand Rapids, MN to Babbitt, MN with a width ranging from 400 to 750 feet. The iron ore material that is mined, concentrated, and pelletized is magnetite, or magnetic taconite. Due to geologic variability along the Mesabi Range, the taconite ore can actually be divided into two distinct types, one much harder than the other. This difference in hardness affects both grinding and crushing circuit designs for the Minnesota facilities. National Steel Pellet Company and Hibbing Taconite Company (hereafter referred to as National and

Hibbing) operate in areas where the ore is softer and, consequently, can process the taconite ore with considerably less crushing and grinding than the companies that mine the harder taconite ore.

Figure 2.1-1: Locations of Taconite Iron Ore Processing Facilities

Table 2.1-1: U.S. Taconite Iron Ore Plant Locations

State	Company (Informal Name)	Mine Location (City)	Pelletizing Plant Location (City)
Minnesota	National Steel Pellet Company (National)	Keewatin	Keewatin
	Hibbing Taconite Company (Hibbing)	Hibbing	Hibbing
	U.S. Steel Minnesota Ore Operations (Minntac)	Mountain Iron	Mountain Iron
	EVTAC Mining, LLC (EVTAC)	Eveleth	Forbes
	Ispat-Inland Steel Mining Company (Inland)	Virginia	Virginia
	Northshore Mining Company (Northshore)	Babbitt	Silver Bay
Michigan	Tilden Mining Company, LC (Tilden)	Ishpeming	Ishpeming
	Empire Iron Mining Partnership (Empire)	Palmer	Palmer

Two taconite plants (Empire and Tilden) are located in the Marquette Range of the Upper Peninsula of Michigan. Empire processes only magnetite ore (Fe_3O_4), whereas Tilden processes both magnetite ore (four months per year) and hematite ore (eight months per year). Tilden is the only taconite mine in the United States processing the non-magnetic hematite ore (Fe_2O_3).[2] According to personnel at the Michigan plants, both the magnetite and hematite ores mined from the Marquette Range are more fine-grained than the magnetite ore mined in Minnesota. Furthermore, within the Marquette Range, the hematite ore is more fine-grained than the magnetite ore. The grain size of the ore can be a factor in particulate matter (PM) and hazardous air pollutant (HAP) emissions.

2.1.2 Product Markets and Characterization

Because of their requisite strength, consistency in size and chemical composition, and optimum metallurgical properties, taconite pellets have been used for decades in iron-and-steel-making blast furnaces.[1] In fact, about 98 percent of the demand for taconite pellets comes from the iron and steel industry. The remaining demand comes mostly from the cement industry but also from manufacturers of heavy-medium materials, pigments, ballast, agricultural products, and specialty chemicals. Ninety-seven percent of the processed iron ore shipped to the iron and steel industry is in the form of agglomerated pellets. Other forms of processed iron ore include sinter and briquettes. On average, taconite pellets are 3/8-inch to 1/2-inch in diameter and are composed of 63 to 67 percent iron and approximately 5 percent silica. Other taconite pellet constituents may include phosphorus, manganese, magnesium, lime, sulphur, and alumina.

There are basically two types of taconite pellet products: standard (acid) pellets and fluxed pellets. Fluxed pellets, which contain a certain amount of fluxstone (limestone and/or dolomite) in addition to all the constituents of standard pellets, are more valuable to clients in the iron and steel industry, because these pellets eliminate the need to add more fluxing agents. Fluxed pellets are sometimes characterized by a basicity ratio, which is a mass ratio of the sum of calcium oxide (CaO) and magnesium oxide (MgO) divided by the sum of silicon oxide (SiO_2) and aluminum oxide (Al_2O_3), as shown in the following example equation:[1]

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

Fluxed pellets with a basicity ratio equal to or greater than 1.0 are called fully fluxed pellets. Energy demand during induration for fully fluxed pellets is higher than that during production of standard pellets due to the added calcination. To meet this higher energy demand, auxiliary burners are usually added to the indurating furnace when making fully fluxed pellets. In addition, the breakdown of the fluxstone during the induration process often leads to increased emissions of hydrogen fluoride and hydrogen chloride. For these reasons, in comparison to the production of standard pellets the production of fully fluxed pellets often leads to higher air pollutant emissions.[1]

2.1.3 Economic Trends

Iron ore production in North America (United States and Canada) in 1997 was estimated to be approximately 101.4 million long tons.[3] Although this production level represents a four percent increase from 1996, it remains well below the record 123 million long tons produced in 1981 before the severe recession in the iron and steel industry.

Iron ore pellet production in North America (United States and Canada) was 79 million long tons in 1999.[4] Table 2.1-2 provides North American iron ore and iron ore pellet production from 1990 to 1999. Table 2.1-3 illustrates taconite pellet production of individual plants in the United States in 1999.

Table 2.1-2: North American (United States and Canada) Iron Ore and Iron Ore Pellet Production From 1990 to 1999

Year	Iron Ore Production (million long tons)	Iron Ore Pellet Production (million long tons)
1999	Not available	79.4
1998	Not available	86.1
1997	101.4	87.1
1996	97.6	83.8
1995	99.5	84.8
1994	92.9	79.8
1993	88.2	72.6
1992	87.7	73.1
1991	91.6	73.4
1990	90.9	76.5

Table 2.1-3: Taconite Pellet Production for Individual Plants in the United States in 1999 [4]

Taconite Plant	Annual Capacity (million long tons)	Actual Output (million long tons)
Minntac	15.3	13.0
Empire	8.4	7.1
Hibbing	8.0	6.9
Tilden	7.8	6.2
National	5.3	5.3
EVTAC	3.5	4.4
Northshore	4.7	3.9
Inland	2.8	2.8
United States Total	55.8	49.6

2.2 PROCESS DESCRIPTION

Production of taconite pellets can generally be described by the following steps:

- Mining of crude ore;
- Ore crushing and handling;
- Concentrating (e.g., milling, magnetic separation, and chemical flotation);
- Agglomerating (e.g., dewatering, drying, and balling);
- Indurating; and
- Finished pellet handling.

It is important to note, mining of the crude ore is the only step listed above that is not included in the definition of the taconite iron ore processing source category. A discussion of the crude ore mining is included in Section 2.2.1 to provide an overall understanding of taconite iron ore production. A general process flow diagram for taconite iron ore processing is provided in Figure 2.2-1. A more detailed description of each processing step is provided in Sections 2.2.2 through 2.2.6.

2.2.1 Mining of Crude Ore[1]

The mining of taconite, a tough and abrasive low-grade ore common to Minnesota and Michigan, is especially difficult because of the extreme hardness of the ore. Because of this hardness, drilling, blasting, crushing, and grinding are required to extract the ore. Miners must remove millions of tons of rock and surface material before they can drill and blast the taconite. Mining tasks consist of overburden removal, drilling, blasting, and removal of waste rock and crude taconite ore from the open pit.

After the ore deposit is uncovered, rotary drills are used to bore holes approximately 16 inches in diameter to a depth of 45 to 55 feet into the taconite ore. Explosives, typically a mixture of ammonium nitrate and fuel oil, are pumped into the holes, and blasts are fired to free the taconite ore. Huge electric shovels with up to 33-cubic-yard buckets load the crude ore into 240-ton haulage trucks that transport the crude ore to the primary, or coarse, crushers. Smaller 170-ton haulage trucks are used for miscellaneous material hauling (tailing, filter cake, pellets).

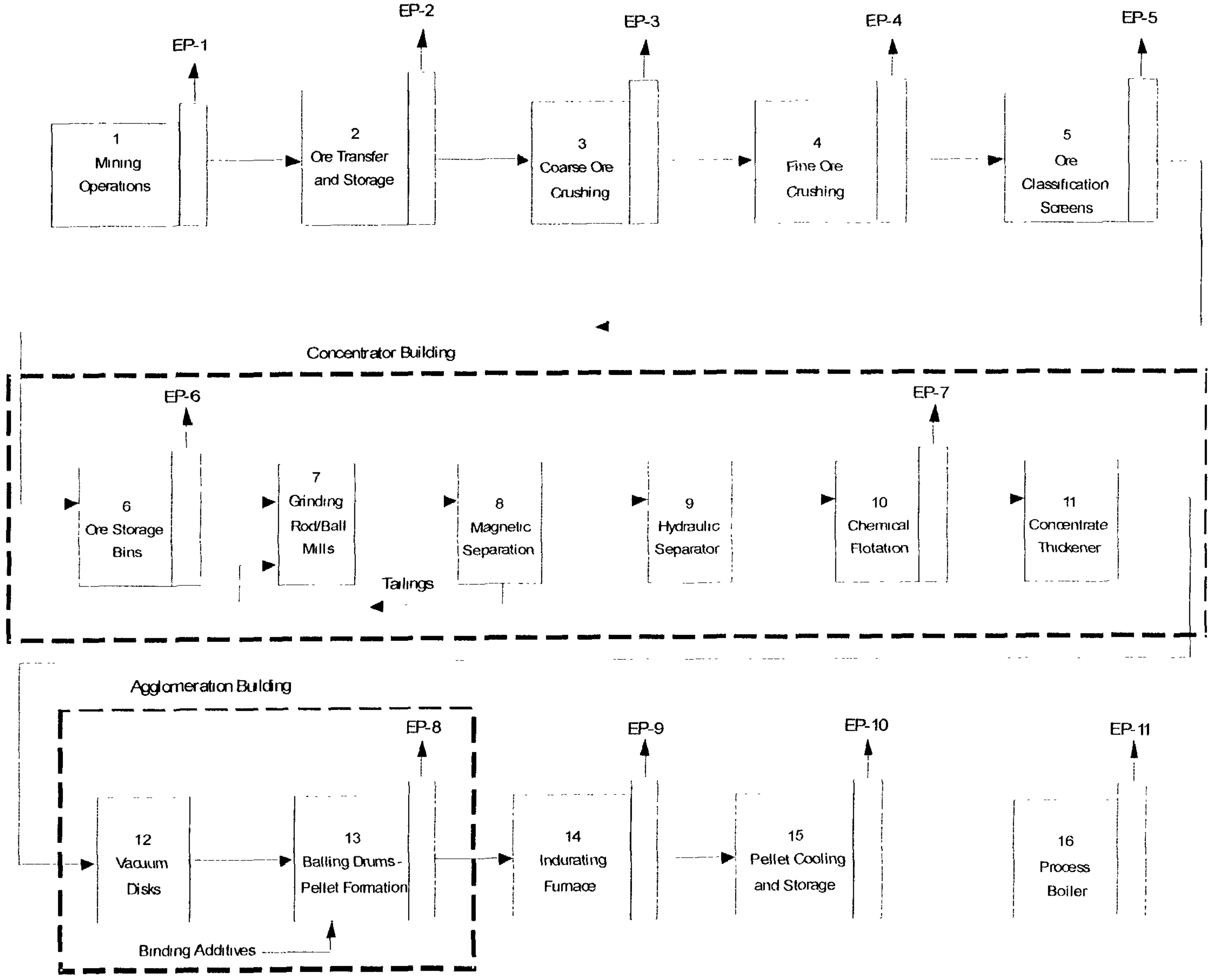

Figure 2.2-1 Process Flow Diagram for Taconite Iron Ore Processing

Most of the taconite plants have their mining operations co-located with their pelletizing operations. EVTAC and Northshore are the only two companies that have the pelletizing facility apart from the mining site. EVTAC has its mining operations at Eveleth, while its pelletizing operations are located approximately 10 miles south at Forbes. Similarly, Northshore operates a taconite mine at Babbitt and a processing plant at Silver Bay. Both companies have linked the separate mining and pelletizing operations with rail lines.

2.2.2 Ore Crushing and Handling

Liberation is the first step in processing crude taconite ore and consists mostly of crushing and grinding. The ore must be ground to a particle size sufficiently close to the grain size of the iron-bearing mineral to allow for a high degree of mineral liberation. Most of the taconite used today requires very fine grinding. Prior to grinding, the ore is dry-crushed in up to four stages, depending on the hardness of ore. Gyratory cone crushers are generally used for all stages of crushing. Primary crushing reduces the harder crude ore from run-of-mine size to about six-inch-diameter size, while fine crushing stages further reduce the material to 3/4-inch-diameter size. The softer ore reduces to this smaller size with primary crushing only. Intermediate vibratory screens placed on the exit side of a crusher remove undersized material from the feed before it enters the next crusher. Table 2.2-1 summarizes the number of crushing stages operating at each of the eight taconite plants.

Table 2.2-1: Crushing Stages Operated at Taconite Processing Plants[a]

Plant	Stages of Crushing	Number of Primary Crushers	Number of Secondary, Tertiary, and Fine Crushers
Empire	two	2	1
EVTAC	four	2	15
Hibbing	single	2	2
Inland	three	2	7
Minntac	three	3	43
National	single	2	0
Northshore	three	2	16
Tilden	single	1	0

a Includes primary, secondary, tertiary, and fine crushers; does not include rod and ball mills.

2.2.3 Concentrating (Milling, Magnetic Separation, Hydraulic and Chemical Flotation, Thickening)

The concentration phase of taconite ore processing includes several stages of grinding, magnetic separation, and chemical flotation. These concentration processes increase the iron content of the processed ore from approximately 30 percent by weight to approximately 63 to 67 percent by weight.

After the ore is crushed, it is conveyed to large ore storage bins at the concentrator building. Then water is typically added to the ore as it is conveyed into rod/ball mills or autogenous mills. Rod/ball mills are used in several stages to grind the taconite ore further to the consistency of coarse beach sand. A rod/ball mill is a large horizontal cylinder that rotates on its horizontal axis and is charged with heavy steel rods or balls, and taconite ore with water slurry. The rods/balls tumble inside the mill and grind the ore into finer particle sizes. An alternative to rod/ball mill grinding is to feed the crushed ore directly to wet or dry semiautogenous or autogenous grinding mills, then to pebble or ball mills. The term autogenous means that grinding media like the steel balls and rods are not required. Instead, the tumbling action of the ore in the rotating mills is sufficient to reduce it to a consistency of beach sand. Pebble mills, which also operate on the autogenous principle, are usually used after autogenous mills. Pebbles about 2 inches in size, which are screened from the primary mill, are used as grinding media.

After the autogenous or rod/ball grinding mills, the ground magnetite ore is transported as slurry to the first stage of magnetic separation. The magnetic separation apparatus is comprised of a horizontal steel cylinder that contains a magnetic element. As the cylinder rotates, the magnetic element remains stationary, providing a magnetic field to the bottom half of the cylinder. The rotating cylinder, sometimes known as a cobber, is partially submerged in the taconite ore slurry allowing the iron-bearing particles to adhere to the magnetized cylinder surface. As the cylinder surface rotates past the magnetic field, the iron-bearing ore drops from the cylinder surface and into a weir located just below the point where the magnetic field ends. Ore material not picked up by the magnetic separators is rejected as non-magnetic gangue or tailings. Tailings are sometimes reground to extract as much iron as possible; otherwise, they are discharged to a large tailing basin.

After it is magnetically separated, the iron-bearing slurry flows into a hydraulic concentrator where excess water is removed through gravity separation. Sediment collected at the bottom of the hydraulic concentrator is passed on to the flotation plant. In the flotation plant, residual gangue (silica) is separated from the fine iron-bearing particle slurry. This operation requires the use of two water chemical additives and aeration to create a "froth." The first chemical additive used is an alcohol-based frother, which enables the formation of stable air bubbles in the aerated tank. The second chemical additive used is an alkylamine collector, which helps silica particles attach to the rising air bubbles. A third chemical additive sometimes used is a mineral oil defoamer, which is used to destabilize air bubbles because froth is difficult to pump in downstream processes.

A flotation line is comprised of rectangular tanks equipped with aerators. Silica-bearing particles in the slurry adhere to air bubbles generated by the aerators. The silica and air bubbles form a grayish-black froth that floats to the surface of each flotation line and flows over a weir. The froth overflow is then sent on for regrinding in another ball mill to liberate the residual iron. Underflow from the flotation line contains an iron-rich concentrate that is collected. This iron-rich concentrate becomes the raw material for producing taconite pellets in the agglomerating operation.

Since only about one-third of the crude taconite becomes a shippable product for iron making, a large amount of gangue is generated. Fine tailings and other gangue streams discharged from the magnetic separation and flotation plant operations are diverted to a tailings thickener (clarifier). Sediment collected at the bottom of the thickener is removed for disposal in a tailings basin. The overflow from the thickener is wastewater that is recycled back into the ore processing system. Plants mining taconite ore from the western Mesabi range, which has a low silica content, do not require the flotation step of the process.

When processing hematite ore at Tilden Mining, there is no magnetic separation step. Instead, Tilden has developed a flotation system for the mine's fine-grained hematite ore. The finely ground mineral particles are conditioned by adding caustic soda and a dispersant in the grinding process. A cooked corn starch is then introduced for the purpose of selectively flocculating the very fine iron particles in 55-foot-diameter tanks. Here the flocculated iron particles settle and are recovered in the underflow while the fine silica tailings are carried away in the overflow. The material is then fed to the flotation circuit, consisting of three hundred 500-cubic-foot flotation cells, where further separation occurs. Silica is removed in the froth overflow through a process known as amine flotation, leaving a high-grade iron ore concentrate.

Next, the concentrate thickening tanks remove excess water from the iron-rich concentrate, increasing the solid content of the mixture from approximately 40 percent by weight to approximately 65 percent by weight. The material is then pumped into concentrate slurry storage tanks. To produce fluxed pellets, a mixture of limestone and dolomite (carbonate of calcium and magnesium) is added to the slurry storage tanks at a composition and rate tailored to the customer's specifications.

2.2.4 Agglomerating (Dewatering, Balling)

Filtering using vacuum disk filters for final dewatering operations increases the solids content of the concentrate from approximately 65 percent by weight to approximately 90 percent by weight. The Tilden plant, which processes a finer-grained ore, uses rotary dryers after the disc filters for further drying of the ore. These rotary dryers repeatedly tumble the wet ore concentrate through a heated air stream to reduce the amount of entrained moisture in the ore.

Next, the ore is mixed with powdered bentonite or dolomite and conveyed to the balling drums, which are inclined, rotating cylinders. Bentonite and dolomite are binding agents that improve the formation of "green balls," or unfired pellets, and the physical qualities of the pellets. The ore tumbles in the balling drums and agglomerates into 3/8-inch diameter pellets. A roll screen at the discharge end of the balling drum is used for pellet size control. Inland uses unique balling discs, rather than balling drums, to make green balls. After leaving the balling drums, the pellets are the proper size and shape, but they are too soft for handling. The green balls are conveyed to the indurating furnace on conveyor belts or traveling metal grates. Once the pellets exit the balling drum, they are relatively dry and, therefore, have the potential to emit particulate HAP.

2.2.5 Indurating[1]

During the indurating process, the unfired taconite pellets are hardened and oxidized in the indurating furnace at a fusion temperature between 2,290°F and 2,550°F. The induration of the green pellets is actually an oxidation process in which the magnetite is converted into hematite. Indurating is responsible for most of the air pollutant emissions from a taconite plant. Natural gas is commonly used as the primary fuel for the indurating furnaces, with distillate fuel oil often used as a back up. Some indurating furnaces are also capable of using coal, petroleum coke, or sawdust as alternative fuels.

Two types of indurating furnaces are currently used within this source category: straight grate furnaces and grate kiln furnaces. The indurating furnace process begins at the point where the grate feed conveyor discharges the unfired pellets onto the furnace traveling grate and ends where the hardened pellets exit the indurating furnace cooler.

2.2.5.1 Straight Grate Indurating Furnace

In straight grate indurating furnaces, a continuous bed of unfired pellets is carried on a metal grate through different furnace temperature zones. Each zone will have either a heated upward draft or downward draft blown through the pellets. A layer of fired pellets is placed on the metal grate prior to the addition of unfired pellets. This hearth-layer allows for even airflow through the pellet bed and acts as a buffer between the metal grate and the exothermic heat generated from the oxidation of taconite pellets in the indurating stage. Before the pellets can be oxidized, all remaining moisture is driven off in the first two stages of the furnace, the updraft and downdraft drying zones. Unfired pellets must be heated gradually; otherwise, moisture in the unfired pellets expands too quickly and causes the pellets to explode. After they are dried, the pellets enter a preheat zone of the furnace where the temperature is gradually increased for the indurating stage. The next zone is the actual firing zone for induration, where the pellets are exposed to the highest temperature. The fired pellets then enter the post-firing zone, where the oxidation process is completed. Finally, the pellets are cooled by the intake of ambient air, typically in two stages of cooling.

A unique characteristic of straight grate furnaces is that approximately 30 percent of the fired pellets are recycled to the feed end of the furnace for use as the hearth layer. The remaining pellets are transported by conveyor belts to storage areas. A schematic of a straight grate furnace is provided in Figure 2.2-2.

Waste gases from the straight grate furnace are discharged primarily through two ducts: the hood exhaust, which handles the cooling and drying gases; and the windbox exhaust, which handles the preheat, firing, and after-firing gases. For a typical straight grate furnace, the two discharge ducts are combined into one common header before the flow is divided into several ducts to be exhausted to the atmosphere after control.

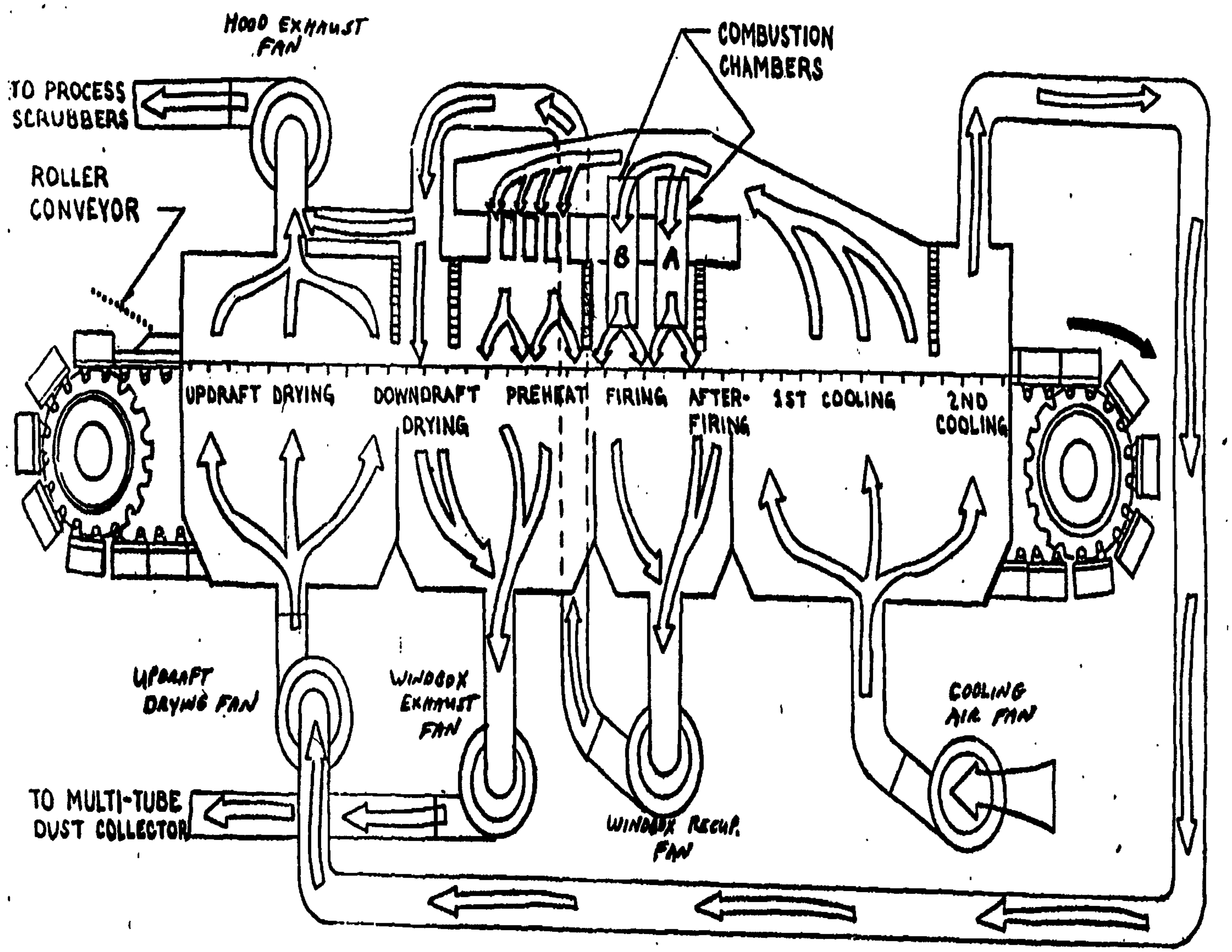

Figure 2.2-2: Schematic of a Straight Grate Indurating Furnace

2.2.5.2 Grate Kiln Indurating Furnace

The grate kiln indurating furnace system consists of a traveling grate, a rotary kiln, and an annular cooler. The grate kiln system represents a newer generation of indurating furnaces and is widely used by the taconite plants. As with the straight grate furnace system, the grate kiln system is also a counterflow heat exchanger, with the unfired pellets and indurated pellets moving in a direction opposite to that of the process gas flow. A six-inch bed of unfired pellets is laid on a continuously moving, horizontal grate. The traveling grate carries the unfired pellets into a dryer/preheater that resembles a large rectangular oven. Here the unfired pellets are gradually dried by hot air at a temperature of 700°F. In the second half of the traveling grate stage of the process, the unfired pellets pass through the preheater, where they are heated to a temperature of 2,000°F. The traveling grate then discharges the dry, preheated pellets into the rotary kiln.

Final induration of the pellets occurs as they tumble down the rotating kiln. The rotary kiln typically operates at a temperature of 2,300 to 2,400°F to ensure that the iron pellets are oxidized from a magnetite structure into a hematite structure. The hardened pellets are then discharged to a large annular-shaped cooler, which is an integral part of an elaborate energy recuperation system. The fired pellets discharged from the kiln first enter the primary cooling zone of the annular cooler, where ambient air is brought in to cool the pellets in a counter-current flow. After the pellets heat the ambient air to approximately 2,000°F, it is then used as preheated combustion air in the rotary kiln. As the cooled pellets enter a final cooling zone, additional ambient air is used to cool the pellets further. Air exiting the final cooling zone is heated to approximately 1,000°F and is used to maintain the temperature in the dryer section of the traveling grate. Pellets exiting the final cooling zone are cooled to an average temperature of 175 to 225°F. Combustion air from the rotary kiln, which is approximately 2,000°F, is used to maintain the temperature in the preheat section of the traveling grate.

Pellet cooler vent stacks are atmospheric vents in the cooler section of a grate kiln indurating furnace. Pellet cooler vent stacks exhaust cooling air that is not returned for heat recuperation. Straight grate furnaces do not have pellet cooler vent stacks. The pellet cooler vent stack should not be confused with the cooler discharge stack, which is in the pellet loadout or dumping area. New grate kiln furnace designs eliminate the cooler vent stack by recirculating the air through the furnace.

Table 2.2-2 identifies the types and number of indurating furnaces used at the eight taconite plants. A schematic of the grate kiln indurating furnace is shown in Figure 2.2-3.

Table 2.2-2: Types and Number of Indurating Furnaces Used at Taconite Processing Plants

Plant	Type of Indurating Furnaces	Number of Indurating Furnaces
Hibbing	Straight grate	3
Northshore	Straight grate	3
Inland	Straight grate	1
Minntac	Grate kiln	5
Empire	Grate kiln	4
EVTAC	Grate kiln	2
Tilden	Grate kiln	2
National	Grate kiln	1
	Total	21

2.2.6 Finished Pellet Handling

Finished pellet handling is the physical transfer of fired taconite pellets from the indurating furnace to the finished pellet stockpiles at the plant. Finished pellet handling includes, but is not limited to, the following emission units: furnace discharge or grate discharge, and finished pellet screening, transfer, and storage.

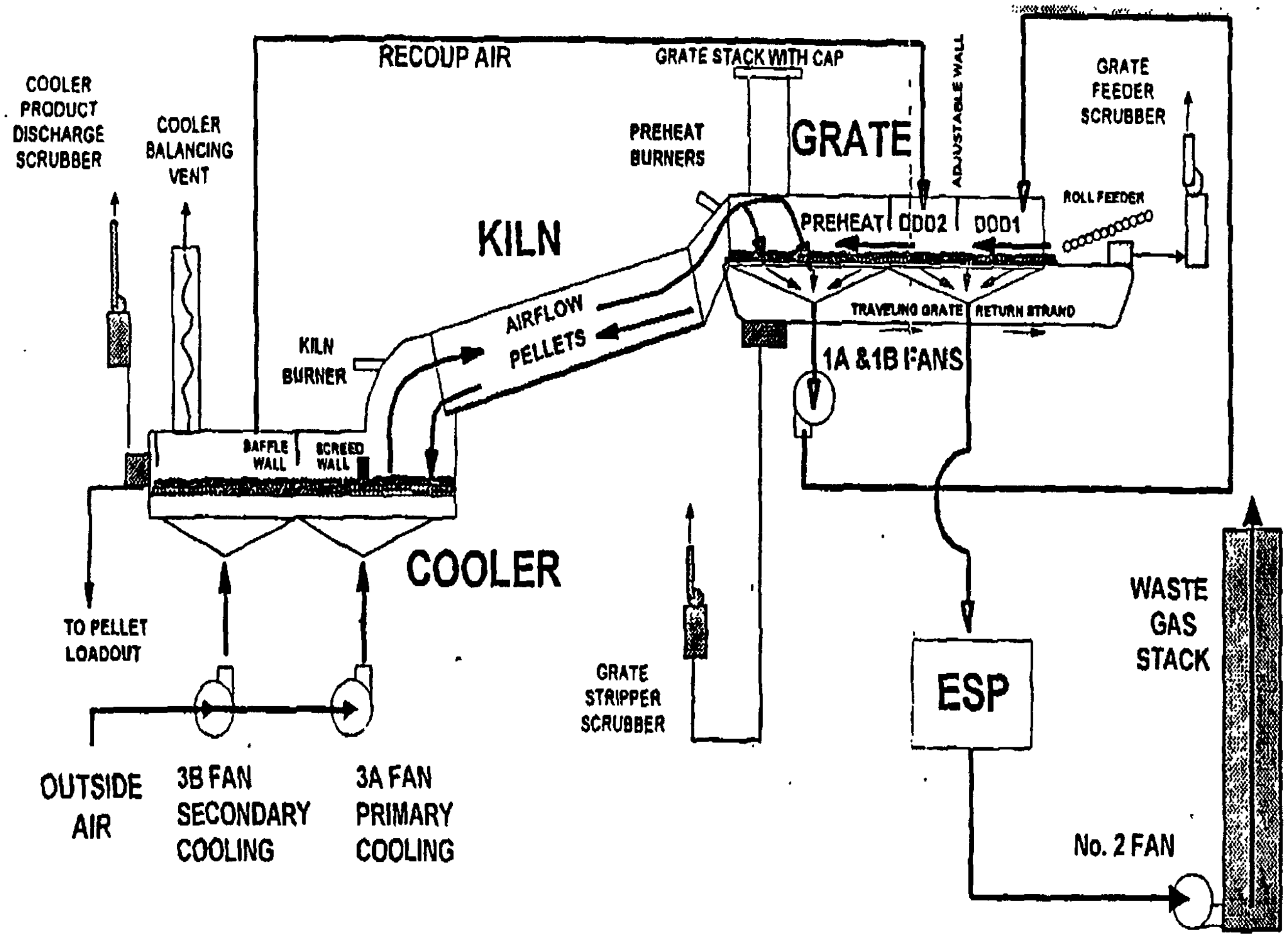

Figure 2.2-3: Schematic of a Grate Kiln Indurating Furnace

2.3 SUMMARY OF CURRENT REGULATIONS

This section summarizes existing legislation that affects the taconite iron ore processing industry. Section 2.3.1 presents pertinent state regulations for Minnesota taconite plants, and Section 2.3.2 presents pertinent state regulations for Michigan taconite plants. Section 2.3.3 summarizes the applicable Federal regulations.

2.3.1 Minnesota's Industrial Process Equipment Rule

The Minnesota Industrial Process Equipment Rule (IPER)[5], sets limits which are empirically dependent on the air flow as shown in the equation below:

$$\text{Allowed emissions (gr/dscf)} = 1.7627 \times FR_{\text{corrected}}^{\;-0.3241}$$

where:

$FR_{\text{corrected}}$ = corrected air flow rate in cubic feet/minute, and is calculated from FR actual,

$$= FR_{\text{actual}} \times \frac{528}{T + 660} \times \frac{P}{14.7} \times \left(\frac{1 - \%\ \text{moisture}}{100} \right)$$

where:

T = temperature in degrees Fahrenheit

P = pressure in psi

Most of the ore crushing and handling (OCH) and finished pellet handling (PH) emission units at taconite plants in Minnesota are subject to the IPER. As indicated above, the Minnesota IPER establishes PM concentration emission limits as a function of volumetric flow. Therefore, the emission limit becomes more stringent as volumetric flow increases. Particulate matter emission limits for OCH and PH emission units under the IPER range from approximately 0.030 gr/dscf to approximately 0.095 gr/dscf. Due to its proximity to Lake Superior, Northshore is subject to these more-stringent limits: 0.002 gr/dscf for tertiary crushing and some storage/transfer points, 0.010 gr/dscf for cobbing and some storage/transfer points, and 0.030 gr/dscf for all other emission points.

Most of the indurating furnaces in Minnesota are also subject to the State's IPER. Particulate matter emission limits for indurating furnaces under the IPER range from 0.025 to 0.050 gr/dscf. Again, due to its proximity to Lake Superior, Northshore, which operates straight grate furnaces, is subject to a more stringent State limit of 0.010 gr/dscf.

2.3.2 Michigan's Emissions Standards

The particulate emission limits for Michigan plants are also mostly based on air flow rates, with most of the sources subject to limits of 0.037 to 0.085 gr/dscf of exhaust gas, or 0.065 to 0.15 lb/1,000 lb.[6,7] The OCH and PH emission units at Tilden and Empire are subject to a State PM emission limit of 0.052 gr PM/dscf of exhaust gas (0.1 lb/1,000 lb).

Tilden and Empire, both of which operate grate kiln furnaces, are subject to State PM emission limits for the indurating furnaces. The State PM emission limits are also determined by air flow rates. The furnaces at Tilden are subject to a PM emission limit of 0.04 gr/dscf of exhaust gas (0.065 lb/1,000 lb). Furthermore, emissions for the grate kilns at Tilden are also limited to maximum emissions for four metallic HAP (arsenic, cadmium, total chromium, and lead) as illustrated in Table 2.3-1.[7] At Empire, the two larger furnaces are subject to a PM emission limit of 0.06 gr/dscf of exhaust gas (0.10 lb/1,000 lb), and the two smaller kilns are subject to a PM emission limit of 0.09 gr/dscf of exhaust gas (0.15 lb/1,000 lb).

Both of the ore dryers at Tilden are subject to Michigan's PM emission limit of 0.1 pound of PM per 1,000 pounds of exhaust gas, which equates to approximately 0.052 gr/dscf.

Table 2.3-1: Allowed Metal Emissions from Each of the Two Tilden Indurating Furnaces[7]

Metal	12-Calender-Month-Period Emissions (tons)
Arsenic	0.0058
Cadmium	0.0058
Chromium (total)	0.0058
Lead	0.017

2.3.3 Federal Regulations

In 1984 the EPA promulgated a New Source Performance Standard (NSPS) for Metallic Mineral Processing Plants (40 CFR Part 60, Subpart LL). The Metallic Mineral Processing NSPS applies only to units that commenced construction or modification after August 24, 1982. The Metallic Mineral Processing NSPS applies to the following emission units in metallic mineral processing plants:

> "Each crusher and screen in open-pit mines; each crusher, screen, bucket elevator, conveyor belt transfer point, thermal dryer, product packaging station, storage bin, enclosed storage area, truck loading station, truck unloading station, railcar loading station, and railcar unloading station at the mill or concentrator..."

Therefore, the Metallic Mineral Processing NSPS covers many of the OCH, PH, and ore dryer emission units at a taconite plant, but it does not cover indurating furnaces.

The Metallic Mineral Processing NSPS limits PM emissions to 0.05 grams/dscm (0.022 gr/dscf) and opacity at 7 percent for stacks and 10 percent for fugitive emission points. The NSPS requires that test Method 5 or 17 be used to determine compliance with the PM emission limits and that test Method 9 be used to determine compliance with the opacity limits. In addition, the NSPS requires parametric monitoring of air pollution control device (APCD) operation, such as scrubber pressure drop and scrubbing liquid flow rate.

The taconite industry is a mature, low-growth industry; therefore, new facilities are not being built and new units are not being installed with significant frequency. Because of this, only a handful of emission units are subject to the Metallic Mineral Processing NSPS.

2.4 REFERENCES

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2. Letter from John G. Meier, Cliffs Mining Services Company, to Al Vervaert, EPA. Request for Separate Michigan Magnetite and Hematite Standards. May 16, 2000.

3. D.N. Skillings. North American Iron Ore Industry to Again Exceed 100 Million Gross Tons in 1998, Highest in 18 Years, Skillings Mining Review, Vol. 87, No. 30, July 1998.

4. D.N. Skillings, US/Canadian Iron Ore Production in 2000. Skillings Mining Review, July 2000.

5. Minnesota Pollution Control Agency (MPCA). Facts about the Industrial Process Equipment Rule, AQ Doc. #4.06, February 1998.

6. Empire Iron Mining Partnership, Palmer, Michigan. Supplement to Permit No. 484-87B, November 26, 1996.

7. Tilden Magnetite Partnership, Isheming, Michigan. Supplement to Permit No. 511-87C, November 13,1996.

3.0 EMISSION UNITS AND BASELINE HAP EMISSIONS

This chapter identifies and describes the points of particulate matter (PM) and hazardous air pollutant (HAP) emissions within the taconite iron ore processing source category. This chapter also presents the estimated baseline PM and HAP emissions. There are a total of 396 HAP emitting units within the taconite source category. The vast majority of the emission units (87 percent) are located within the ore crushing and handling (OCH) and finished pellet handling (PH) affected sources. Although the OCH and PH emission units constitute the majority of the units, they represent only 21 percent of particulate matter (PM) emissions and 1.2 percent of the HAP emissions from the taconite source category. Indurating furnaces, which represent approximately 12 percent of all emission units, are a large combustion source, and therefore, emit large quantities of combustion byproducts such as products of incomplete combustion, or PIC (e.g., formaldehyde), acid gases, and PM. Due to their enormous size, indurating furnaces contribute almost 80 percent of the PM emissions and almost 99 percent of the HAP emissions from the source category.

In general, taconite iron ore processing emits three types of HAP: metallic HAP in the form of PM, acidic gases (hydrochloric and hydrofluoric acid), and PIC.[1] Table 3.0-1 indicates which types of HAP are emitted from each affected source in the taconite source category. Section 3.1 of this chapter describes the population of emission units within the taconite iron ore processing source category. Section 3.2 of this chapter provides the basis and results of the estimated baseline PM and HAP emissions.

Table 3.0-1: Types of HAP Emitted from Each Affected Source in the Taconite Source Category

Affected Source	PM	Metals	Acid Gases	PIC
Ore Crushing and Handling	X	X		
Indurating Furnaces	X	X	X	X
Finished Pellet Handling	X	X		
Ore Dryers	X	X		

Due to the geologic nature of the taconite iron ore deposits in the Mesabi Range in Northeast Minnesota, there is potential for the occurrence of contaminant asbestos in some taconite iron ore mining areas. It is unclear whether these fibers would be considered a HAP as defined in Section 112 of the CAA. A work group within EPA is currently studying asbestos that occurs as a contaminant from mining and mineral processing operations, including taconite iron ore mining and processing. Decisions on whether to regulate asbestos that might occur as a contaminant in taconite iron ore mining and processing and other potential industries will be based on information gathered in the study.

3.1 EMISSION UNITS

A list of all known emission units at all existing taconite iron ore processing operations is provided in Appendix A, Table 1. This table represents a compilation of information from Title V permits, test reports, and communications with industry representatives and state regulatory agencies. Table 3.1-1 summarizes the number of emission units in each affected source at each plant. There are a total of 396 emission units in the taconite industry. Sixty-seven percent of these emission units (264 units) are in the OCH affected source, and 21 percent (82 units) are in the PH affected source. Nearly one third of all emission units are located at the Minntac taconite plant in Mountain Iron, Minnesota.

Table 3.1-1: Number of Emission Units in Each Affected Source at Each Taconite Plant

Plant	Ore Crushing and Handling	Indurating Furnace Stacks (# Furnaces)	Finished Pellet Handling	Ore Drying	Total Number of Emission Units
US Steel Minntac	88	5 (5)	17	0	110
Northshore	58	13 (3)[a]	9	0	80
EVTAC	34	3 (2)	6	0	43
Empire	19	4 (4)	16	0	39
Hibbing	15	12 (3)	9	0	36
Tilden	18	4 (2)	7	3	32
Inland	16	4 (1)	9	0	29
National	16	2 (1)	9	0	27
Total	264	47 (21)	82	3	396

[a] Northshore has another furnace, furnace 5, which is shut down. Furnace 5 has three stacks.

3.1.1 Ore Crushing and Handling

The number of OCH emission units at each plant, shown in Table 3.1-1, primarily depends on the number of crushing stages and the volume of taconite ore processed. As mentioned in Chapter 2, the number of crushing stages depends on the hardness of the iron ore. Iron ore in the eastern mines is harder, requiring up to six stages of crushing, with each stage supported by a series of conveyors and storage bins. Iron ore in the western mines is softer and can be processed with only one stage of crushing. Minntac, which has three crushing stages and processes the largest quantity of iron ore, has the largest number of OCH emission units. National, which has only one crushing stage, has the smallest number of OCH emission points.

Table 3.1-2 provides a description of OCH emission unit characteristics. All of the OCH emission units operate at ambient temperatures. The volumetric flow rate of exhaust from OCH emission units ranges from 3,500 acfm to 90,000 acfm, with an average volumetric flow rate around 25,000 acfm. The ore contains a nominal quantity of moisture; therefore, the moisture content of the exhaust is also nominal.

Table 3.1-2: OCH Emission Unit Characteristics

Affected Source	Exhaust Volumetric Flow Rate (acfm)		Temperature (°F)	Moisture Content of Ore
Ore Crushing and Handling	Maximum	90,000	100	Nominal
	Minimum	3,500	Ambient	Nominal
	Average	25,000	Ambient	Nominal

3.1.2 Indurating Furnaces

The number of emission points associated with indurating furnaces depends on the number of furnaces and the number of stacks on each furnace. For example, each of the 5 furnaces at Minntac has 1 stack, whereas each of the 3 furnaces at Hibbing has 4 stacks. Thus, Hibbing has 12 indurating furnace emission points and Minntac has only 5 indurating furnace emission points. The number of furnace emission points and the number of furnaces at each taconite plant is shown in Table 3.1-1.

Table 3.1-3 provides a description of indurating furnace emission unit characteristics. When the unfired pellets first enter the furnace, they contain approximately 9 percent moisture.[2] Before the pellets can be oxidized, all of the remaining moisture must be driven off. This occurs in the first stages of the furnace, referred to as the drying zones. Temperatures inside indurating furnaces gradually increase to over 2,400°F. Furnace exhaust gases are usually cooled through an extensive heat recovery process down to 130 to 250°F before being released. The volumetric flow rate of exhaust from indurating furnace stacks far exceeds the volumetric flow rates from OCH or PH emission units, with a range from 58,000 acfm to 528,000 acfm and an average of 255,000 acfm.

Table 3.1-3: Indurating Furnace Emission Unit Characteristics

Affected Source	Furnace Exhaust Volumetric Flow Rate (acfm)		Stack Temperature (°F)	Moisture Content of Ore (percent)
Indurating Furnace[a,b]	Maximum	528,000	250	9
	Minimum	58,000	165	0
	Average	255,000	130	NA

[a] The temperature inside the indurating furnace can exceed 2,400 °F but emission gases are cooled in a heat recovery process prior to release.

[b] The unfired pellets entering the furnace have a moisture content of 9 percent.

NA = Not applicable

3.1.3 Finished Pellet Handling

The number of PH emission units at a plant depends largely on the number of indurating furnaces (i.e., one PH line for each indurating furnace). The number of PH emission units at each taconite plant is shown in Table 3.1-1. Table 3.1-4 provides a description of finished pellet handling emission point characteristics. At the beginning of the finished pellet handling process, iron ore pellets are still warm, so the process exhaust temperatures are around 150°F. After additional pellet cooling, process exhaust temperatures drop back to ambient conditions. The exhaust volumetric flow rate for pellet handling emission units is similar to that for emission units in ore crushing and handling. Specifically, the air flow ranges from 1,600 acfm to 116,000 acfm, with an average of 25,000 acfm. The ore contains a nominal quantity of moisture; therefore, the moisture content of the exhaust gas is nominal.

Table 3.1-4: Finished Pellet Handling Emission Unit Characteristics

Affected Source	Exhaust Volumetric Flow Rate (acfm)		Temperature (°F)	Moisture Content of Ore
Finished Pellet Handling	Maximum	116,000	100	Nominal
	Minimum	1,600	Ambient	Nominal
	Average	25,000	Ambient	Nominal

3.1.4 Ore Dryers

Ore drying includes ore dryers located upstream of the balling drums. There are only two ore dryers in the taconite industry and both are located at Tilden. The taconite concentrate at Tilden contains a higher percentage of fine particles than the taconite concentrate at other taconite plants. Therefore, the Tilden taconite concentrate requires additional drying prior to entering the balling drums. The two existing ore dryers are designed such that one dryer has one stack and the other dryer has two stacks. Thus, the ore dryers affected source includes a total of three emission units. Table 3.1-5 provides a description of ore dryer emission point characteristics. The volumetric flow rate of exhaust from ore dryer emission units is higher than that of OCH or PH emission units, but less than that of indurating furnaces. When taconite ore concentrate enters the ore dryer, it typically has a moisture content of 12.2 percent. The ore dryers reduce the moisture content of the ore to approximately 5 percent.

Table 3.1-5: Ore Drying Emission Unit Characteristics

Affected Source	Exhaust Volumetric Flow Rate (acfm)		Temperature (°F)	Moisture Content of Ore (percent)
Ore Drying	Maximum	104,842	1,800	12.2
	Minimum	77,023	1,800	5
	Average	90,932	1,800	NA

NA = Not applicable

3.2 ESTIMATES OF BASELINE PM AND HAP EMISSIONS

A total of 935 tons of HAP are emitted by the taconite industry each year, with indurating furnaces constituting 98.8 percent of the baseline HAP emissions. Although only 1.2 percent of the overall HAP emissions come from OCH, PH, and ore drying, these operations contribute approximately 30 percent of the metallic HAP emissions. Acid gases and PIC make up over 96 percent of the total HAP emissions from the taconite source category, with metallic HAP comprising the remainder. The facilities with the highest baseline HAP emissions are Minntac (341 tons/yr) and National (273 tons/yr).

As stated earlier, PM emissions serve as a surrogate for metallic HAP emissions. A total of 14,500 tons of PM are emitted by the taconite affected source each year. Nearly one-fourth of this amount (approximately 3,100 tons) comes from emission units associated with OCH, PH, and ore dryers. Of the 11,400 tons of PM per year emitted from indurating furnaces, 63 percent (approximately 9,100 tons) is contributed by only two indurating furnaces–Minntac Line 3 and National Line 2.

The estimated baseline HAP and PM emissions from taconite iron ore plants are summarized in Table 3.2-1. As shown in the table, all of the taconite iron ore facilities emit more than 10 tons of HAP per year and, thus, are major sources of HAP.

Table 3.2-1: Baseline PM and HAP Emissions from Taconite Iron Ore Plants

Plant	Process[a]	Baseline PM Emissions (tons/year)	Baseline HAP Emissions (tons/year)				
			Metallic HAP		Acid Gases	PIC	Total HAP
Minntac	OCH	607	0.0031	3.2	0	0	3
	PH	169	0	0.2	0	0	0
	FURN	9,097	0.0819	9.7	205	122	337
	TOTAL	9,873	0.0849	13	205	122	341
EVTAC	OCH	518	0.0052	2.1	0	0	2
	PH	30	0.0003	0.0	0	0	0
	FURN	284	0.0565	1.4	23	35	59
	TOTAL	833	0.0619	3.5	23	35	62
Northshore	OCH	565	0.0001	1.5	0	0	1
	PH	132	0	0.2	0	0	0
	FURN	172	0.0085	2.7	31	38	72
	TOTAL	869	0.0085	4.3	31	38	74
National	OCH	97	0.0005	0.5	0	0	0
	PH	59	0	0.1	0	0	0
	FURN	801	0.0598	4.4	262	6	272
	TOTAL	957	0.0603	4.9	262	6	273
Hibbing	OCH	94	0.0000	0.3	0	0	0
	PH	108	0.0000	0.0	0	0	0
	FURN	203	0.1062	2.8	19	9	30
	TOTAL	405	0.1062	3.1	19	9	31
Inland	OCH	109	0	0.5	0	0	1
	PH	79	0.0000	0.1	0	0	0
	FURN	54	0.0167	1.0	32	21	54
	TOTAL	243	0.0167	1.6	32	21	54
Empire	OCH	101	0.0003	0.4	0	0	0
	PH	54	0	0.0	0	0	0
	FURN	609	0.0151	1.0	38	4	43
	TOTAL	765	0.0154	1.4	38	4	44
Tilden	OCH	39	0.0001	0.2	0	0	0
	PH	22	0.0001	0.0	0	0	0
	FURN	219	0.0001	0.9	47	7	56
	DRYERS	259	0.0009	1.1	0	0	1
	TOTAL	539	0.0012	2.2	47	7	57
TOTAL	OCH	2,129	0.0093	8.7	0	0	9
	PH	654	0.0004	0.6	0	0	1
	FURN	11,441	0.3446	23.9	657	243	924
	DRYERS	259	0.0009	1.1	0	0	1
	TOTAL	14,483	0.3542	34.2	657	243	935

[a] OCH = Ore Crushing and Handling; PH = Pellet Handling; DRYERS = Ore drying; FURN = Indurating Furnace

3.2.1 Ore Crushing and Handling Emissions

Emissions from OCH operations are primarily PM emitted as dry ore is physically ground, crushed, screened, and conveyed through the OCH process to the indurating furnaces. Emissions of PM and HAP associated with the OCH affected source result from the following dry operations: all stages of crushing (i.e., primary, secondary, tertiary, and fine crushing), conveying, transferring, pan feeding, ore storage in bins/silos, and grate feeding. Wet operations, such as wet milling, magnetic separation, hydraulic separation, chemical flotation, concentrate thickening in the concentrator area, vacuum disk filtering, and pelletizing with the balling drums, are excluded because the water effectively suppresses all emissions from these operations.

A total of 2,129 tons of PM are emitted from OCH emission units per year. Nearly 80 percent of these emissions come from three plants: Minntac, EVTAC, and Northshore. A total of 9 tons of metallic HAP are emitted from OCH emission units per year. The HAP content of emitted PM depends on the chemical composition of the iron ore. Seventy-eight percent of the metallic HAP emissions from OCH are emitted by Minntac, EVTAC, and Northshore.

3.2.1.1 Baseline OCH Particulate Matter Emissions

To estimate baseline PM emissions for the OCH affected source, we assigned a baseline PM concentration and a volumetric flow rate to each OCH emission unit (see Table 2, Appendix A). Particulate matter emissions test data were available for 46 OCH emission units. For the 218 OCH emission units without PM test data, the following assumptions were made:

- All of the available PM emissions test data for emission units equipped with a venturi scrubber, impingement scrubber, or a baghouse were at or below the MACT performance level of 0.008 gr/dscf. Therefore, we assumed that all OCH emission units equipped with one of these APCD types would operate at a PM concentration baseline of 0.008 gr/dscf. Emission units with PM emission test data below 0.008 gr/dscf were assumed to be at 0.008 gr/dscf for the baseline and when determining the PM emissions at the MACT level (see Chapter 7). This results in an emission reduction of zero for these units. If the baseline PM emissions were based on an actual test value below 0.008 gr/dscf for an emission unit, then the result of "achieving" the MACT level would be an increase in emissions for that unit. It was decided that an emission reduction of zero is a more accurate representation of the actual emission reduction that can be expected for these units.

- The baseline PM emissions concentration for units equipped with a multiclone, rotoclone, or mable-bed scrubber was based on available PM test data or the MACT level of 0.008 gr/dscf, whichever was greater. If test data were not available for an emission unit, we assigned that unit a value based on test data from the most similar tested emission unit. The baseline PM emissions concentration was then based on this assigned value or the MACT level of 0.008 gr/dscf, whichever was greater.

To estimate baseline PM emissions, the baseline concentration level of each emission unit was multiplied by the volumetric exhaust flow rate (dcfm) of the emission unit. Most exhaust flow rates were available from Title V permit data. If the provided flow rates were in units of acfm, the ideal gas law was used to convert to dcfm. If exhaust flow rates were not available for an emission unit, the exhaust flow rate for the most similar emission unit was used. Table 2 of Appendix A shows the exhaust flow rate and the total estimated baseline PM emissions for each OCH emission unit. Table 3.2-1 shows the total baseline PM emissions for the OCH affected source for each taconite plant.

3.2.1.2 Baseline OCH Metallic HAP Emissions

Since the intrinsic composition of taconite ore contains a variety of metallic HAP (manganese, lead. chromium, arsenic, etc.), metallic HAP are part of the PM being emitted from OCH emission units. The concentration of metallic HAP in the taconite ore varies with mine location and locations within a mine. The measured metals composition of iron ore at Minntac, EVTAC, Northshore, National, Hibbing, and Inland is listed in Table 3.2-2. The metals composition of ores at Empire and Tilden was not available. For the purposes of this analysis, values for the metals composition of the ores at Empire and Tilden were based on the average metals composition at the other six facilities.

The PM emissions from OCH emission units were assumed to have the same proportion of metallic HAP as determined in the taconite ore. Thus, to determine individual metallic HAP emissions, the OCH PM emissions total from each plant was multiplied by the percent of the ore composition each metallic HAP represents at that plant. The estimated baseline metallic HAP emissions from OCH is shown in Table 3.2-3 for each plant. For example, the antimony emissions at Minntac were calculated by multiplying the Minntac OCH PM emissions, in tons, by the percent of antimony in the Minntac ore, as shown in the calculation below.

$$(607 \text{ tons PM}) (8.07 \text{ tons antimony}/1{,}000{,}000 \text{ tons PM}) = 4.90 \times 10^{-3} \text{ tons antimony}$$

Based on these calculations, the total baseline metallic HAP emissions from OCH is 8.66 tons. The metallic HAP emissions from OCH are dominated by manganese, which constitutes 8.45 tons or 98 percent of the total emissions. All other metallic HAP are emitted at levels less than 130 lbs/year.

Table 3.2-2: Ore Crushing and Handling, Composition of Taconite Iron Ore (ppm by weight)[1]

Element	Plant							
	Minntac	EVTAC	Northshore	National	Hibbing	Inland	Empire[a]	Tilden[a]
Antimony, Sb	8.07	12	3.62	8.07	0.84	12	7.43	7.43
Arsenic, As	14.7	15	7.54	14.7	13.2	20.2	14.22	14.22
Beryllium, Be	2.12	5	2.2	2.12	1.2	0.8	2.24	2.24
Cadmium, Cd	1.05	< 0.5	0.02	1.05	0.03	0.8	0.58	0.58
Chromium, Cr	23.5	24	47	23.5	49.7	1	28.12	28.12
Cobalt, Co	10	48	8.7	10	6.1	6.9	14.95	14.95
Lead, Pb	13.1	20	0.5	13.1	1.3	6	9	9.00
Manganese, Mn	5107	3900	2578	5107	3119	4700	4085.17	4085.17
Mercury, Hg	5.06	< 10	0.11	5.06	0.11	0.11	3.41	3.41
Nickel, Ni	7.04	13	3.5	7.04	4.3	1.5	6.06	6.06
Selenium, Se	10.8	< 5	0.3	10.8	< 0.3	10	6.2	6.2

a Element compositions for Empire and Tilden were not available; values were obtained by averaging the other facility composition values.

Table 3.2-3: Ore Crushing and Handling, Baseline Emissions of Elements (tons/year)

Element	Plant								Total
	Minntac	EVTAC	Northshore	National	Hibbing	Inland	Empire	Tilden	
Antimony, Sb	4.90e-03	6.22e-03	2.04e-03	7.79e-04	0.00e+00	1.31e-03	7.53e-04	2.89e-04	1.64e-02
Arsenic, As	8.92e-03	7.78e-03	4.26e-03	1.42e-03	1.24e-03	2.20e-03	1.44e-03	5.54e-04	2.78e-02
Beryllium, Be	1.29e-03	2.59e-03	1.24e-03	2.05e-04	1.00e-04	8.73e-05	2.27e-04	8.72e-05	5.84e-03
Cadmium, Cd	6.37e-04	< 0.0003	1.13e-05	1.01e-04	2.81e-06	8.73e-05	5.83e-05	2.24e-05	1.18e-03
Chromium, Cr	1.43e-02	1.24e-02	2.65e-02	2.27e-03	4.66e-03	1.09e-04	2.85e-03	1.09e-03	6.42e-02
Cobalt, Co	6.07e-03	2.49e-02	4.91e-03	9.65e-04	6.00e-04	7.53e-04	1.51e-03	5.82e-04	4.03e-02
Lead, Pb	7.95e-03	1.04e-02	2.82e-04	1.26e-03	1.00e-04	6.55e-04	9.12e-04	3.50e-04	2.19e-02
Manganese, Mn	3.10e+00	2.02e+00	1.46e+00	4.93e-01	2.93e-01	5.13e-01	4.14e-01	1.59e-01	8.45e+00
Mercury, Hg	3.07e-03	< 0.00518	6.21e-05	4.88e-04	0.00e+00	1.20e-05	3.45e-04	1.33e-04	9.30e-03
Nickel, Ni	4.27e-03	6.74e-03	1.98e-03	6.79e-04	4.00e-04	1.64e-04	6.14e-04	2.36e-04	1.51e-02
Selenium, Se	6.55e-03	< 0.00259	1.69e-04	1.04e-03	< 0	1.09e-03	6.28e-04	2.41e-04	1.23e-02
Total	3.16e+00	2.10e+00	1.50e+00	5.02e-01	3.00e-01	5.19e-01	4.23e-01	1.63e-01	8.66e+00

3.2.2 Indurating Furnace Emissions

The indurating furnace affected source includes the emissions from each indurating furnace stack. Furnaces emit three types of pollutants: PM (serving as a surrogate for metallic HAP) from the handling and movement of the pellets; products of incomplete combustion (PIC), such as formaldehyde, from the burning of natural gas to fire the furnace; and acid gases, from the presence of chlorides and fluorides in pellet additives, such as dolomite and limestone.

Over three-quarters of the PM emissions from the taconite source category, or approximately 11,400 tons of PM per year, are emitted from the indurating furnace affected source. Sixty-three percent of the total PM emissions, or roughly 9,100 tons of PM per year, are contributed by only two furnaces - Minntac Line 3 and National Line 2. Emissions of HAP from indurating furnaces constitute 98.8 percent of the baseline HAP emissions from all taconite plants. Acid gases and PIC make up over 97 percent of the total HAP emissions from indurating furnaces, whereas metallic HAP make up less than 3 percent of the total HAP emissions from indurating furnaces.

3.2.2.1 Baseline Indurating Furnace PM Emissions

Particulate matter test data are available for all 21 of the indurating furnaces. The baseline PM emission concentration (gr/dscf) used for each indurating furnace was based on the PM test data for that furnace or the MACT level, whichever was greater. Therefore, the assumptions regarding the baseline PM emission concentration made for OCH were not necessary for the indurating furnaces.

To calculate baseline PM emissions, the baseline PM concentration (gr/dscf) for each indurating furnace stack was multiplied by the volumetric flow rate (dcfm) of the corresponding indurating furnace stack. Volumetric flow rates for furnace stacks were obtained from the available PM emissions test reports. Appendix A, Table 3 shows the air flow rate (dscfm) and the total estimated baseline PM emissions (tons/yr) for each indurating furnace stack.
Table 3.2-1 shows the total baseline PM emissions (tons/yr) for indurating furnaces by plant.

3.2.2.2 Baseline Indurating Furnace Metallic HAP Emissions

Indurating furnaces emit PM as taconite pellets are heated, conveyed, and tumbled (in grate kilns) within the furnace. Since the taconite ore contains intrinsic concentrations of metallic HAP compounds, the PM emissions also include metallic HAP. In contrast to the metallic HAP emission estimates for the OCH affected source, which were based on the elemental composition of the taconite ore, the baseline metallic HAP emission estimates from indurating furnaces are based on actual EPA Method 29 measurements of metallic HAP emissions. Based on the available Method 29 data, the MPCA developed metallic HAP emission factors for the indurating furnaces at each of the plants. These HAP emission factors, in units of ppb per ton of pellets fired, are presented in Table 3.2-4.

To determine the baseline metallic HAP emissions for each plant, the emission factor for each plant was multiplied by the average annual tons of pellets fired and divided by 1×10^9. Table 3.2-5 shows the corresponding baseline metallic HAP emissions (tons/yr) for each plant. For example, the antimony emissions at Minntac were calculated as follows:

$$[(13.30 \text{ ppb/ton pellets})(15{,}530{,}667 \text{ tons of pellets produced})] / 1 \times 10^9 = 0.207 \text{ tons/yr}$$

The taconite pellet production was based on the average amount of ore produced at each facility from 1998 to 2000 (see Table 3.2-6).[3,4,5]

Based on this methodology, the total baseline metallic HAP emissions from indurating furnaces is estimated as 23.9 tons/yr. Metallic HAP compounds that are emitted in the largest quantity include: arsenic (6.5 tons/yr), manganese (5.8 tons/yr), lead (4.4 tons/yr), nickel (2.8 tons/yr), and chromium (2.0 tons/yr), which constitute 90 percent of the total metallic HAP emissions from indurating furnaces.

Table 3.2-4: Indurating Furnace HAP Emission Factors[a]

Pollutant	Unit	Plant							
		Minntac	EVTAC[b]	Northshore	National	Hibbing	Inland	Empire	Tilden[c]
PIC									
Benzene	lb/MMBtu	< 0.00206	< 0.00206	< 0.00098	0.0042	< 0.00206	< 0.00206	< 0.00031	< 0.00040
Toluene	lb/MMBtu	< 0.00229	< 0.00229	< 0.00098	0.0001	< 0.00229	< 0.00229	< 0.00031	< 0.00040
Hexane	lb/MMBtu	< 0.00206	< 0.00206	< 0.00106	< 0.00004	< 0.00206	< 0.00206	< 0.00031	< 0.00040
Formaldehyde	lb/MMBtu	0.02173	0.02173	0.02173	0.00072	0.00105	0.02173	< 0.00112	< 0.00213
Acid Gases									
Hydrogen chloride	*lb/ton pel.*	0.01556[d]	0.00345[d]	0.00768	0.03096	0.00395	0.01776	0.006195	0.0098413
Hydrogen fluoride	lb/ton pel.	0.01089	0.00562	0.00562	0.05594	< 0.00039	< 0.00253	0.002728	0.0027273
Metals									
Antimony, Sb	ppb pellets	< 13.30	< 1.15	< 63.00	13.97	< 0.530	< 13.30	< 7.800	< 8.400
Arsenic, As	ppb pellets	208	151.97	56.3	186	< 95.30	12.1	21.75	< 8.400
Beryllium, Be	ppb pellets	< 1.26	0.2239	< 1.26	0.583	< 1.26	< 0.666	< 1.565	< 8.400
Cadmium, Cd	ppb pellets	2.68	1.254	2.34	0.355	< 1.25	2.68	10.1	10.1
Chromium, Cr	ppb pellets	67	13.371	< 67.00	54.2	< 4.07	7.95	10.1	< 8.400
Cobalt, Co	ppb pellets	< 1.40	< 0.95	< 1.26	3.37	< 5.83	< 0.666	< 7.800	< 8.400
Lead, Pb	ppb pellets	147	13.14	47.4	29.5	94	147	13.25	33.65
Manganese, Mn	ppb pellets	107	35.44	65.8	352	104	107	24.05	< 8.400
Mercury, Hg	ppb pellets	< 5.272[e]	11.23	1.82	9.92	12.4	5.31	1.77	0.0083
Nickel, Ni	ppb pellets	57.2	38.224	257	24.7	7.32	20.4	8.55	16.85
Selenium, Se	ppb pellets	13.5	13.5	13.5	50.8	< 5.35	7.7	< 7.800	11.8

[a] Emission factors for Minntac, EVTAC, Northshore, National, Hibbing and Inland are taken from Reference 1. Emission factors of Empire and Tilden for PIC (factors of benzene, toluene, and hexane are assumed to be equal), acid gases, and metals were taken from Reference 6.

[b] Separate metal emission factor estimates were given for the two lines at EVTAC. Line 1 was assumed to produce 30% of the pellets and line 2 was assumed to produce 70% of the pellets. The plant-wide emission factor for each metal was calculated by weighting the line emission factors by their corresponding production percentage.

[c] All pellets are assumed to be made of hematite.

[d] Emission factors are calculated according to the values given in Reference 6 and to the formula: Emission Factor = (Total pollutant emission X 2,000) / Production Value)

[e] Emission factor is calculated according to the values given in Reference 6 and to the formula: Emission Factor = (Total pollutant emission X 1,000,000,000) / Production Value).

Table 3.2-5: Indurating Furnace Baseline HAP Emissions (tons/year)

Pollutant	Plant								Total
	Minntac	EVTAC	Northshore	National	Hibbing	Inland	Empire	Tilden	
Benzene	< 8.950	< 2.582	< 1.523	4.887	< 2.445	< 1.536	< 0.646	< 0.896	< 23.5
Toluene	< 9.950	< 2.870	< 1.523	0.116	< 2.718	< 1.708	< 0.646	< 0.896	< 20.4
Hexane	< 8.95	< 2.582	< 1.647	< 0.0465	< 2.445	< 1.536	< 0.646	< 0.896	< 18.7
Formaldehyde	94.412	27.232	33.767	0.838	1.246	16.203	2.303	4.730	< 180.7
PIC Total	< 122.3	< 35.3	< 38.5	< 5.9	< 8.9	< 21.0	< 4.2	< 7.4	< 243.4
Hydrogen chloride	120.830	8.672	17.860	93.340	16.908	27.937	26.361	37.169	< 349.1
Hydrogen fluoride	84.565	14.127	13.069	168.652	< 1.670	< 3.980	11.610	10.301	< 308.0
Acid Gas Total	205.400	22.800	30.900	262.000	< 18.6	< 31.9	38.000	47.500	< 657.0
Antimony, Sb	< 0.207	< 0.006	< 0.293	0.084	< 0.005	< 0.042	< 0.066	< 0.063	< 0.8
Arsenic, As	3.230	0.764	0.262	1.122	< 0.816	0.038	0.185	< 0.063	< 6.5
Beryllium, Be	< 0.020	0.001	< 0.006	0.004	< 0.011	< 0.002	< 0.013	< 0.063	< 0.1
Cadmium, Cd	0.042	0.006	0.011	0.002	< 0.011	0.008	0.086	0.076	< 0.2
Chromium, Cr	1.041	0.067	< 0.312	0.327	< 0.035	< 0.025	< 0.086	< 0.063	< 2.0
Cobalt, Co	< 0.022	< 0.005	< 0.006	0.020	< 0.050	< 0.002	< 0.066	< 0.063	< 0.2
Lead, Pb	2.283	0.066	0.221	0.178	0.805	0.463	0.113	0.254	4.400
Manganese, Mn	1.662	0.178	0.306	2.123	0.890	0.337	0.205	< 0.063	< 5.8
Mercury, Hg	< 0.082	0.057	0.009	0.060	0.106	0.017	0.015	0.000	< 0.3
Nickel, Ni	0.888	0.192	1.195	0.149	0.063	0.064	0.073	0.127	2.800
Selenium, Se	0.210	0.068	0.063	0.306	< 0.046	0.024	< 0.066	0.089	< 0.9
Metals Total	< 9.7	< 1.4	< 2.7	4.400	< 2.8	< 1.0	< 1.0	< 0.9	< 23.9
Total	< 337.3	< 59.5	< 72.1	< 272.3	< 30.3	< 53.9	< 43.2	< 55.8	< 924.3

Table 3.2-6: Taconite Production and Heat Input Values

Plant	Taconite Production (tons/year)				Heat Input (MMBTU/yr)[d]
	1998[a]	1999[b]	2000[c]	Avg.	
Minntac	15,891,680	14,572,320	16,128,000	15,530,667	8,689,563
EVTAC	5,449,920	4,928,000	4,704,000	5,027,307	2,506,414
Northshore	4,872,000	4,376,960	4,704,000	4,650,987	3,107,882
National	5,927,040	5,962,880	6,199,301	6,029,740	2,327,239
Hibbing	8,736,000	7,728,000	9,218,720	8,560,907	2,373,854
Inland	3,086,720	3,136,000	3,215,520	3,146,080	1,491,336
Empire	9,087,680	7,952,000	8,492,409	8,510,696	4,102,156
Tilden	7,717,920	6,902,560	8,040,533	7,553,671	4,449,112

[a] Reference 3.
[b] Reference 4.
[c] Reference 5.
[d] Heat input was calculated by multiplying energy usage factors (in MMBTU/ton of pellets produced) by the average production value (in tons/yr). The energy usage factors are from Table 1 of Reference 6 and from Table 2 of Reference 1.

3.2.2.3 Baseline Indurating Furnace PIC Emissions

Products of incomplete combustion (PIC), such as formaldehyde, are released from indurating furnaces at very low concentrations as a result of burning fuels, such as natural gas. Formaldehyde has been measured through stack testing at Empire, National, Hibbing, and Northshore at concentrations that are typically less than 1 ppm. It is suspected that other PIC such as hexane, benzene, and toluene are also emitted, but generally in concentrations below test method detection limits. Only National has measured concentrations of benzene and toluene above test method detection limits. The Minnesota Pollution Control Agency (MPCA) developed emission factors for hexane, benzene, and toluene from stack tests for which the mass recovered was below the detection limit for the pollutant (indicated with the algebraic symbol "<"). Thus, the emissions for hexane, benzene, and toluene may be less than, but should not be greater than the indicated value. The emission factors for four PIC are shown in Table 3.2-4.

The PIC emissions factors are in units of lbs of pollutant or HAP per million btu of furnace input energy. Therefore, the baseline PIC emissions are based on indurating furnace heat input rather than the quantity of pellets fired. The heat input values shown in Table 3.2-6 were calculated by multiplying energy usage factors (in MMBtu/ton of pellets produced) by the average production value (in tons/yr). The baseline PIC emissions from indurating furnaces was calculated by multiplying the emission factors by the heat input and divided by 2,000. The estimated baseline PIC emissions (tons/yr) are presented in Table 3.2-5. For example, the formaldehyde emissions at Minntac were calculated as follows:

[(8,689,563 MMBtu/yr)(0.02173 lb/MMBtu)] / 2,000 = 94.41 tons/year

Based on these calculations the total baseline PIC emissions from indurating furnaces is less than 243.4 tons. The PIC emissions are dominated by formaldehyde, which constitutes 180.7 tons, or 74 percent of the total PIC emissions. Four taconite plants, Minntac, EVTAC, Northshore, and Inland, emit over 89 percent of the total PIC.

3.2.2.4 Baseline Indurating Furnace Acid Gas Emissions

Acid gases (hydrochloric acid and hydrofluoric acid) are emitted from indurating furnaces at very low concentrations, typically less than 3 ppm. Acid gases are formed in the indurating furnace due to the presence of chlorides and fluorides in pellet additives, such as dolomite and limestone. Hydrochloric acid and hydrofluoric acid have been measured through stack testing at Inland, National, Northshore, and Hibbing. The MPCA has developed emission factors for these sources based on the stack concentrations measured for the respective plants. For plants that did not have test data, the MPCA developed emission factors based on the available emissions data from the tested taconite plants. Emission factors for stacks equipped with wet APCD were based on stack test data from Northshore and Hibbing. Emission factors for stacks equipped with dry APCD were based on stack test data from National. The stack test data from Inland were not used to estimate acid gas emissions from other sources due to the large quantity of fluxstone, a unique additive in use at that plant. The emission factors for both hydrochloric acid and hydrofluoric acid are shown in Table 3.2-4.

To determine the baseline acid gas emissions for each taconite plant, the emission factor for each plant was multiplied by the tons of pellets fired and divided by 2,000. Table 3.2-5 shows the baseline acid gas emissions for each taconite plant. For example, the hydrochloric acid emissions at Minntac were calculated as follows:

[(0.01556 lb/ton pellets)(15,530,667 tons of pellets produced)] / 2,000 = 120.83 tons/year

The taconite pellet production was based on the average amount of ore produced at each facility from 1998 to 2000 (see Table 3.2-6).[3,4,5]

Based on these calculations the total acid gas emissions from indurating furnaces is less than 657 tons/yr. The emissions of hydrochloric acid and hydrofluoric acid are similar in magnitude at less than 349 tons/yr and less than 308 tons/yr, respectively. Over 71 percent of the acid gas emissions are emitted from the furnaces at two taconite plants: Minntac and National.

3.2.3 Finished Pellet Handling (PH) Emissions

Finished PH operations include all operations after the indurating furnace, such as cooler discharge, finished pellet conveying, screening, and transfer. Pellet handling emissions result from physical abrasion of the pellets as they pass along the process line from the indurating furnaces to transfer points.

Finished pellet handling emission units emit a total of 654 tons of PM per year. Approximately 75 percent of the PM emissions are emitted from Minntac, Northshore, Hibbing, and Inland. The HAP content of the PM emissions depends on the composition of the hardened taconite pellets. It is estimated that only 1 ton of metallic HAP emissions is emitted from PH emission units per year.

3.2.3.1 Baseline PH Particulate Matter Emissions

To estimate baseline PM emissions for the PH affected source we assigned a baseline PM emission concentration (tons/yr) to each PH emission unit (see Table 2 in Appendix A). Particulate matter emissions test data were not available for each of the 82 PH emission units. Therefore, the following assumptions were made:

- Since all of the available PM emissions test data for emission units equipped with a venturi scrubber, impingement scrubber, or a baghouse were at or below the MACT level of 0.008 gr/dscf, we assumed that all emission units equipped with this type of APCD would have a PM emissions concentration of 0.008 gr/dscf. Emission units with PM emission test data below 0.008 gr/dscf were assumed to be at 0.008 gr/dscf for the baseline and when determining the PM emissions at the MACT level (see Chapter 7). This results in an emission reduction of zero for these units. If the baseline PM emissions were based on an actual test value below 0.008 gr/dscf for an emission unit, then the result of "achieving" the MACT level would be an increase in emissions for that unit. It was decided that an emission reduction of zero is a more accurate representation of the actual emission reduction that can be expected for these units.

- The baseline PM emissions concentration for units equipped with a multiclone, rotoclone, or mable-bed scrubber was based on the PM test data or the MACT level of 0.008 gr/dscf, whichever was greater. If test data were not available, the baseline PM emissions concentration was based on test data from the most similar tested emission unit(s) or the MACT level of 0.008 gr/dscf, whichever was greater.

To calculate baseline PM emissions, the baseline PM concentration level of each PH emission unit was multiplied by the volumetric air flow rate (dcfm) of the emission unit. Volumetric flow rates for most PH emission units were available from Title V permit data. If volumetric flow rates were provided in units of acfm, the ideal gas law was used to convert to dcfm. If volumetric flow rates were not available for an emission unit, the volumetric flow rate for the most similar PH emission unit was used. Table 2 in Appendix A shows the volumetric flow rate and the total estimated baseline PM emissions for each PH emission unit. Table 3.2-1 shows the total baseline PM emissions (tons/yr) for PH by plant.

3.2.3.2 Baseline PH Metallic HAP Emissions

Since the intrinsic composition of taconite ore contains metallic HAP (manganese, lead, chromium, arsenic etc.), metallic HAP is part of the PM being emitted from PH emission units. The concentration of metals in the ore varies with location. The measured metals composition of the fired pellets at Minntac, EVTAC, Northshore, National, Hibbing, and Inland is listed in Table 3.2-7. The composition of the ores at Empire and Tilden was not available. For the purposes of this analysis, the metals composition of the fired pellets at Empire and Tilden was based on the average of the values at the other six facilities.

The PM emissions from PH emission units were assumed to have the same proportion of metallic HAP as was found in the fired pellets. Thus, to determine the metallic HAP emissions, the total PH PM emissions from each taconite plant was multiplied by the percent of the fired pellets composition each metallic HAP represents at that plant. The estimated baseline metallic HAP emissions from PH are shown in Table 3.2-8 for each taconite plant. For example, the antimony emissions at Minntac were calculated by multiplying the Minntac PH emissions of PM (tons/yr) by the percent of antimony in the Minntac ore (see calculation below).

$$(169 \text{ tons})\ (0.414 \text{ ppm}/1{,}000{,}000) = 6.99 \times 10^{-5} \text{ tons/year}$$

Based on these calculations the total baseline metallic HAP emissions from all PH emission units is 0.604 tons/year. The metallic HAP emissions from PH are dominated by manganese, which constitutes 0.57 tons/year, or 94 percent of the total emissions. All other metallic HAP are emitted at levels less than 35 lbs/year.

Table 3.2-7: Finished Pellet Handling, Metallic HAP Composition of Fired Taconite Pellets, ppm by weight[1]

Metallic HAP	Plant							
	Minntac	EVTAC	Northshore	National	Hibbing	Inland	Empire[a]	Tilden[a]
Antimony, Sb	0.414	17	0.487	0.414	0.305	12	5.1	5.1
Arsenic, As	4.88	9	2.16	4.88	8.97	20.2	8.35	8.35
Beryllium, Be	0.742	6	0.6	0.742	0.95	1.1	1.69	1.69
Cadmium, Cd	0.028	< 0.5	0.03	0.028	< 0.02	0.8	0.23	0.23
Chromium, Cr	23.6	124	29.1	23.6	15.4	1	36.12	36.12
Cobalt, Co	7.06	61	10.2	7.06	2.3	0.8	14.74	14.74
Lead, Pb	0.58	27	0.4	0.58	0.85	6	5.9	5.9
Manganese, Mn	968	940	1169	968	666	330	840.17	840.17
Mercury, Hg	0.002	< 10	0.002	0.002	0.002	0.08	1.68	1.68
Nickel, Ni	5.64	5	7.33	5.64	3.1	0.4	4.52	4.52
Selenium, Se	0.28	< 5	0.27	0.28	< 0.3	10	2.69	2.69

[a] Element compositions for Empire and Tilden were not available; values were obtained by averaging the other facility composition values.

Table 3.2-8: Finished Pellet Handling, Baseline Emissions of Metallic HAP, (tons/year)

Metallic HAP	Plant								Total
	Minntac	EVTAC	Northshore	National	Hibbing	Inland	Empire	Tilden	
Antimony, Sb	6.99e-05	5.18e-04	6.45e-05	2.43e-05	3.30e-05	9.49e-04	2.76e-04	1.12e-04	2.05e-03
Arsenic, As	8.24e-04	2.74e-04	2.86e-04	2.87e-04	9.69e-04	1.60e-03	4.52e-04	1.84e-04	4.87e-03
Beryllium, Be	1.25e-04	1.83e-04	7.94e-05	4.36e-05	1.03e-04	8.70e-05	9.14e-05	3.71e-05	7.50e-04
Cadmium, Cd	4.73e-06	< 1.52e-05	3.97e-06	1.65e-06	< 2.16e-06	6.33e-05	1.27e-05	5.15e-06	1.09e-04
Chromium, Cr	3.98e-03	3.78e-03	3.85e-03	1.39e-03	1.66e-03	7.91e-05	1.96e-03	7.94e-04	1.75e-02
Cobalt, Co	1.19e-03	1.86e-03	1.35e-03	4.15e-04	2.49e-04	6.33e-05	7.98e-04	3.24e-04	6.25e-03
Lead, Pb	9.79e-05	8.23e-04	5.30e-05	3.41e-05	9.19e-05	4.75e-04	3.19e-04	1.30e-04	2.02e-03
Manganese, Mn	1.63e-01	2.87e-02	1.55e-01	5.69e-02	7.20e-02	2.61e-02	4.55e-02	1.85e-02	5.66e-01
Mercury, Hg	3.38e-07	< 3.05e-04	2.65e-07	1.18e-07	2.16e-07	6.33e-06	9.10e-05	3.70e-05	4.40e-04
Nickel, Ni	9.52e-04	1.52e-04	9.70e-04	3.32e-04	3.35e-04	3.16e-05	2.45e-04	9.94e-05	3.12e-03
Selenium, Se	4.73e-05	< 1.52e-04	3.57e-05	1.65e-05	< 3.24e-05	7.91e-04	1.46e-04	5.91e-05	1.28e-03
Total	1.71e-01	3.67e-02	1.61e-01	5.95e-02	7.55e-02	3.02e-02	4.99e-02	2.03e-02	6.04e-01

3.2.4 Ore Dryer Emissions

Emissions from ore dryers are primarily PM from the physical handling of the dry ore as it is tumbled in the rotary dryers. The HAP content of the PM emissions depends on the composition of the taconite iron ore. Ore dryer emission units emit a total of 259 tons of PM per year. It is estimated that only 1 ton of metallic HAP emissions is emitted from ore dryer emission units per year.

3.2.4.1 Baseline Ore Dryer Particulate Matter Emissions

To estimate baseline PM emissions for the ore dryer affected source, we assigned a baseline PM emission concentration to each of the ore dryer units (see Table 4 in Appendix A). Particulate matter emissions test data are available for each of the three ore dryer stacks; therefore, assumptions regarding the baseline PM emission concentration were not necessary. The baseline PM emission concentration for each ore dryer was based on the PM test data for that ore dryer stack or the MACT level, whichever was greater.

To calculate baseline PM emissions, the baseline PM concentration level of each ore dryer emission unit was multiplied by the volumetric flow rate (dcfm) of the emission unit. The volumetric flow rates were available from the PM emissions test data. Table 4 in Appendix A shows the volumetric flow rate and the total estimated baseline PM emissions for each ore dryer emission unit. The total baseline PM emissions for ore dryers, estimated to be 259 tons per year, are emitted from one taconite plant: Tilden.

3.2.4.2 Baseline Ore Dryer Metallic HAP Emissions

Since the intrinsic composition of taconite ore contains metallic HAP (manganese, lead, chromium, arsenic, etc.), metallic HAP are part of the PM being emitted from ore dryer emission units. The concentration of metals in the ore varies with location. The composition of the taconite ore at Tilden was not available. For the purposes of this analysis, the metals composition of the ore at Tilden was based on the average of the values at the six facilities with ore composition data. The average metals composition of the ore is listed in Table 3.2-9.

The PM emissions from ore dryer emission units were assumed to have the same proportion of metallic HAP as was found in the ore. Thus, to determine the metallic HAP emissions, the value for the total ore dryer PM emissions from Tilden was multiplied by the average percent composition of each metallic HAP in the ore. For example, the manganese emissions at Tilden were calculated by multiplying the Tilden ore dryer PM emissions (tons/year) by the percent of manganese in the ore (see calculation below).

(259 tons) (4085.17 ppm/1,000,000) = 1.06 tons/year

Based on these calculations the total baseline metallic HAP emissions from ore dryers is 1.08 tons/year. The metallic HAP emissions from ore dryers are dominated by manganese, which constitutes 1.06 tons/year, or 98 percent of the total emissions. The estimated baseline metallic HAP emissions from ore dryers are shown in Table 3.2-9 for Tilden.

Table 3.2-9: Ore Dryer Composition of Ore (ppm by weight)
and Baseline Emissions of Metallic HAP (tons/year)

Metallic HAP	Average Composition in Ore (ppm by weight)	Tilden Baseline Metallic HAP Emissions (tons/year)
Manganese, Mn	4085.17	1.06
Chromium, Cr	28.12	0.01
Cobalt, Co	14.95	0
Arsenic, As	14.22	0
Lead, Pb	9	0
Antimony, Sb	7.43	0
Selenium, Se	6.2	0
Nickel, Ni	6.06	0
Mercury, Hg	3.41	0
Beryllium, Be	2.24	0
Cadmium, Cd	0.58	0
Total		1.08[a]

[a] The total value differs from the sum of the column values due to rounding.

3.3 REFERENCES

1. Minnesota Pollution Control Agency (MPCA). Taconite Iron Ore Industry in the United States - A Background Information Report for MACT Determination, for EPA Order No. D-6226-NAGX, December, 1999.

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4.0 EMISSION CONTROL TECHNIQUES

This chapter presents a description of air pollution control devices (APCDs) typically used to capture and control hazardous air pollutant (HAP) and particulate matter (PM) emissions from taconite iron ore processing operations. Section 4.1 identifies and describes each type of APCD commonly used within the taconite source category. Section 4.2 characterizes the current distribution of these APCDs among the affected sources within the taconite source category.

4.1 DESCRIPTION OF CONTROL DEVICES

Emission units within the ore crushing and handling (OCH), indurating furnace, finished pellet handling (PH), and ore dryer affected sources emit PM containing metallic HAP. Control devices such as wet scrubbers, baghouses, electrostatic precipitators (ESP), multiclones, and rotoclones are designed to control PM emissions and, thus, metallic HAP emissions. Indurating furnaces also emit acid gases (e.g., hydrochloric acid and hydrofluoric acid) and products of incomplete combustion (PIC), such as formaldehyde. Only wet control devices, such as wet scrubbers and wet ESP, are effective for controlling acid gas and PIC emissions. Each type of APCD currently used in the taconite source category is described in the following subsection.

4.1.1 Wet Scrubbers

Wet scrubbers use an aqueous stream to remove PM from a gaseous emission stream. Scrubber efficiency is dependent on particle size. In general, efficiency is highest for particles between 0.5 and 5.0 µm in diameter. The particle size of PM in emissions in the taconite source category ranges from 2 to 176 µm in diameter. It is expected that wet scrubbers on taconite emission units can achieve approximately 99 percent control efficiency for PM.[1] Four types of wet scrubbers are used in the taconite iron ore industry: venturi, venturi rod, impingement, and packed bed.

4.1.1.1 Venturi Scrubbers

In venturi scrubbers, a pressure differential between high-velocity gases and free-flowing water is used to create droplets that entrap PM, hold the particles in suspension, and deliver them as a highly concentrated slurry. Venturi scrubbers have gradually converging and then diverging sections that are connected by a narrow throat. The decreased volume of the throat increases the velocity of air. Typically, water is introduced upstream of the throat and flows down the converging sides into the throat, where it is atomized by the gaseous stream. Once the liquid is atomized, it collects particles from the gas impacting into the liquid. As the mixture decelerates in the expanding (diverging) section, further impact causes the droplets to agglomerate. After the particles are trapped by the liquid, a separator, such as a cyclone, demister, or swirl vane, removes the scrubbing liquid from the cleaned gas stream. The scrubbing liquid, along with collected particles, flows downward to the slurry discharge, and the cleaned gas exits through the top gas outlet.

Venturi scrubber collection efficiencies range from 70 to 99 percent for PM.[1] Though capable of incidental control of volatile organic compounds (VOC), venturi scrubbers are generally limited to the control of PM and gases with a high water solubility.[1]

4.1.1.2 Venturi Rod Scrubbers

The venturi rod scrubber, though operating on the same principles as the venturi scrubber, has a bed of parallel metal rods instead of a decreasing diameter and narrow throat. The narrow spaces between the rods in effect create a series of parallel venturi throats, which increase the gas velocity. As with the venturi scrubber, the atomized liquid traps the particles and a cyclone, demister, or swirl vane removes the scrubbing liquid from the cleaned gas stream. The scrubbing liquid carries the collected particles downward to the slurry discharge, and the cleaned gas exits through the top gas outlet.

Venturi rod scrubbers can achieve more than 99 percent efficiency for PM.[2] Though capable of incidental control of VOC, venturi rod scrubbers are generally limited to the control of PM and gases with a high water solubility.

4.1.1.3 Impingement Scrubbers

Impingement scrubbers consist of a vertical chamber with a series of baffles or plates mounted horizontally inside a hollow shell. The plates are perforated or slotted to allow for the passage of gas and water. Water is introduced above the plates and flows down through the holes while contaminated air flows up through the holes. The water droplets are atomized at the edges of each orifice. The atomized droplets collect the PM in the gas stream. The PM-laden liquid flows out the bottom of the chamber.

Impingement scrubbers primarily remove PM from the flue gas but can also remove acid gases and PIC. Collection efficiencies for impingement scrubbers range from 50 to 90 percent for PM greater than 1 μm in diameter. Collection efficiencies for fine PM (diameter $< 1 \mu m$) are much lower. Control device vendors estimate removal efficiencies in the range of 95 to 99 percent for inorganic gases.[3]

4.1.1.4 Packed Bed Scrubbers

Packed bed scrubbers consist of two to three packed beds, each approximately 3 inches deep. Each bed requires a pressure drop of about 5 inches of water. The dirty gas enters a sprayed region below the packed bed. Coarse spray nozzles provide water to the underside of the bed, which operates in a flooded condition. Bubbles and mist generated in the bed create a turbulent layer that rises about 6 inches above the bed. Dirty water overflows through a pipe passing through the packed bed. The air then passes through a zigzag entrainment separator.

Packed bed scrubbers are capable of controlling water-soluble inorganic gases and VOC, as well as PM. They can achieve 95 to 99 percent reduction in inorganic gases and a 50 to 95 percent reduction in PM.[1]

4.1.2 Baghouses

In a fabric filter, flue gas is passed through a tightly woven fabric, which removes PM from the flue gas by sieving and other mechanisms. Although fabric filters may be in the form of sheets and cartridges, the most common fabric filters are cylindrical bags that are typically housed together in a group arrangement referred to as a baghouse. As PM accumulates and dust cakes form on the filters, the efficiency of the baghouse increases significantly. To prevent the dust cake from becoming too heavy, baghouses have a shaking, pulse jet, or reverse flow mechanism to remove the build-up on the bags.

Baghouses differ from scrubbers in that they are not constant-efficiency devices. In other words, if operated properly, baghouses yield a relatively constant outlet PM concentration regardless of the inlet PM concentration. Typical outlet PM concentrations for the taconite source category range from 0.003 to 0.01 gr/dscf. Baghouses do not control acid gas or PIC emissions.

4.1.3 Electrostatic Precipitators (ESP)

An ESP is a PM control device that uses electrical forces to attract particles entrained within an exhaust stream onto collection surfaces. The entrained particles are given an electrical charge as they pass through a corona, a region where gaseous ions flow. Electrodes in the center of the flow lane are maintained at high voltage to generate an electrical field that forces the particles to the collector walls. In dry ESP, the collector walls are knocked, or "rapped," by various mechanical means to dislodge the particles, which slide down into a collection hopper. The hopper is emptied periodically, as it becomes full. Dust is removed through a dust-handling system, such as a pneumatic conveyor, and is then disposed of in an appropriate manner. In wet ESP, the collector walls are either intermittently or continuously washed by a spray of liquid, usually water. A drainage system that collects the wet effluent replaces the collection hoppers used by dry ESP. After the wet effluent is collected, it is often managed in an on-site water treatment system.[4]

Both dry and wet ESP are capable of achieving efficiencies between 99 and 99.9 percent removal for PM, including very small particles (diameter < 1 µm).[1] Dry ESP do not control acid gas or PIC emissions. Wet ESP are often used to control acid mists and can provide incidental control of water-soluble PIC emissions.

4.1.4 Multiclones

A multiclone is a system of several small cyclones operating in parallel. A cyclone is essentially a settling chamber in which gravitational acceleration is replaced by centrifugal acceleration. The incoming gas is forced into circular motion down the conical-shaped chamber near the inner surface of the tube. At the bottom of the cyclone, the gas turns and spirals up through the center of the tube and out the top of the cyclone. Particles in the gas stream are forced toward the cyclone walls by the centrifugal force of the spinning gas but are opposed by the fluid drag force of the gas traveling through and out of the cyclone. For large particles, inertial momentum overcomes the fluid drag force so that the particles reach the cyclone wall and fall down into a collection hopper. Small particles may leave with the exiting gas.

Multiclones typically remove only particles larger than 5 μm. Their control efficiencies, ranging from 50 to 90 percent,[1] make them much less efficient than other control options. For this reason, multiclones are generally referred to as "precleaners" and are often used to reduce inlet PM loading to downstream APCDs. Multiclones do not control acid gas or PIC emissions.

4.1.5 Rotoclones

Rotoclones clean the air by the combined action of centrifugal force and a thorough intermixing of water and dust-laden air. The flow of air through a stationary, partially submerged impeller pulls a turbulent curtain of water with it. Additional water is introduced at the narrowest portion of the impeller opening through a specially designed slot in the bottom. This water flow upward through the slot increases interaction between dust and water, thus increasing collection efficiency. Centrifugal force is exerted by rapid changes in the direction of the air flow. The centrifugal force causes dust particles to penetrate the water film and become permanently trapped. Any entrained moisture in the cleaned air is removed by specially designed eliminators or curved baffles.

Rotoclones, which can technically be categorized as wet scrubbers, are primarily used to control PM. However, in this application, rotoclones tend to be less efficient than the other types of wet scrubbers or baghouses. Removal efficiencies for PM range from 80 to 99 percent. Rotoclones do not control acid gas or PIC emissions.

4.2 DISTRIBUTION OF CONTROLS

This section describes the number and types of APCDs currently in use at each taconite iron ore processing plant and summarizes the use of each type of device throughout the taconite source category. The discussion of the distribution of APCDs is organized into four subsections, each dealing with one of the four affected sources within the taconite source category:

- OCH operations,
- Indurating furnaces,
- PH operations, and
- Ore dryers.

In general, OCH emissions are predominantly controlled with wet scrubbers or baghouses. Emissions from indurating furnaces are controlled either with wet scrubbers or ESP. Emissions from the PH affected source are predominantly controlled with wet scrubbers, and emissions from ore dryers are controlled by cyclones and impingement scrubbers in series.

4.2.1 Control Techniques for Ore Crushing and Handling Emission Units

The OCH affected source consists of 264 emission units from the following process units: primary crushers, secondary crushers, tertiary crushers, fine crushers, storage bins, ore conveyors, and ore transfer points. These dry processes emit PM from the physical crushing and handling of the ore. The ore from each of the taconite mines contains metals that have been identified as HAP. These HAP are emitted as a part of the total PM.

As shown in Table 4.2-1, wet scrubbers are the predominant APCDs for the OCH affected source, accounting for 60 percent of the control equipment used. About 19 percent of the OCH emission units are equipped with baghouses. The remaining 21 percent of OCH emission units are equipped with a rotoclone, multiclone, or ESP.

Table 4.2-2 shows the OCH control equipment by taconite plant. Almost half of all wet scrubbers are marble/packed bed type scrubbers and are located at one facility, Minntac. Five taconite plants, Minntac, National, Hibbing, Empire, and Tilden, control most OCH emission units with wet scrubbers. EVTAC uses rotoclones and some baghouses to control PM emissions from OCH emission units, whereas Northshore uses baghouses and multiclones. Inland uses wet scrubbers and baghouses to control PM emissions from OCH emission units.

Table 4.2-1: Distribution of Control Equipment Used on OCH Emission Units

Control Equipment	Number of Emission Units	Percent of Emission Units
Wet Scrubber	160	60 %
Baghouse	50	19 %
Rotoclone	23	9 %
Multiclone	29	11 %
ESP	2	1 %
Total	264	100%

Table 4.2-2: Distribution of OCH Control Equipment by Taconite Plant

Plant	Wet Scrubber	Baghouse	Rotoclone	Multiclone	ESP	Total
Minntac	85	3				88
EVTAC	2	10	22			34
Northshore		30	1	27		58
National	14			2		16
Hibbing	15					15
Inland	10	6				16
Empire	19					19
Tilden	15	1			2	18
Total	160	50	23	29	2	264

4.2.2 Control Techniques for Indurating Furnaces

The indurating furnace affected source includes emissions from the furnace only. The emission points may be identified as hood exhaust or waste gas stack emissions. Although indurating furnace hood exhausts and waste gas stacks make up only 12 percent of the total number of emission points, indurating furnace emissions account for almost 99 percent of total HAP emissions from the taconite source category. The HAP of concern from indurating furnaces include metallic HAP, acid gases, and PIC. Emissions of metallic HAP, such as antimony, arsenic, beryllium, cadmium, chromium, cobalt, manganese, nickel and selenium, can be controlled by controlling total PM with a wet scrubber, baghouse, or ESP. Emissions of acid gases, such as hydrochloric acid and hydrofluoric acid, and PIC, such as formaldehyde, can be controlled by wet control devices such as wet ESP and wet scrubbers.

As shown in Table 4.2-3, approximately half of the indurating furnace emission points are equipped with wet scrubbers and the remainder are equipped with ESP. Three indurating furnace stacks are equipped with multiclones. Specific information concerning the operating parameters of the current control devices is provided in Table 1 of Appendix B.

Table 4.2-4 lists the indurating furnace control equipment by plant. Four taconite plants, EVTAC, Hibbing, Inland, and Minntac, use wet scrubbers. Three taconite plants, Empire, Northshore and Tilden, use ESP. Only two plants, Minntac and National, use other devices as the primary means of emissions control for an indurating furnace. In the case of National, a multiclone is in use. At Minntac, the device is similar to a multiclone but is a simpler, gravity-settling device.

Table 4.2-3: Distribution of Control Equipment Used on Indurating Furnaces

Control Equipment	Number of Indurating Furnace Stacks	Percent of Indurating Furnace Stacks
Wet Scrubber	23	47 %
ESP	23	47 %
Multiclone	3	6 %
Total	49	100%

Table 4.2-4: Distribution of Indurating Furnace Control Equipment by Taconite Plant

Plant	Number of Indurating Furnaces	Wet Scrubber	ESP	Multiclone[a]	Total Number of Indurating Furnace Stacks[b]
Minntac	5	4		1	5
EVTAC	2	3			3
Northshore	3		13		13
National	1			2	2
Hibbing	3	12			12
Inland	1	4			4
Empire	4		4		4
Tilden	2		6		6
Total	21	23	23	3	49

[a] The control device at Minntac is not technically a multiclone but is a gravity-settling device similar to a multiclone.

[b] Total includes primary emission control devices only, not precleaners.

4.2.3 Control Techniques for Finished Pellet Handling

The PH affected source consists of 82 emission points from the following processes: pellet cooling, screening, conveying, and storage. The HAP of concern in the PH affected source is primarily metallic HAP. Most metallic HAP can be controlled with common PM controls, such as wet scrubbers and baghouses.

Table 4.2-5 shows that almost 90 percent of the PH emission units are equipped with wet scrubbers. Table 4.2.6 shows that 7 of the 8 facilities use wet scrubbers almost exclusively to control emissions from their PH emission units. Most of the PH emission units at Northshore are equipped with rotoclones.

4.2-5: Distribution of Control Equipment Used on PH Emission Units

Control Equipment	Number of Emission Units	Percent of Emission Units
Wet Scrubber	71	87 %
Rotoclone	9	11 %
Baghouse	2	2 %
Total	82	100%

Table 4.2-6: Distribution of PH Control Equipment by Taconite Plant

Plant	Wet Scrubber	Rotoclone	Baghouse	Total
Minntac	17			17
EVTAC	6			6
Northshore		8	1	9
National	8	1		9
Hibbing	9			9
Inland	8		1	9
Empire	16			16
Tilden	7			7
Total	71	9	2	82

4.2.4 Control Techniques for Ore Dryers

There are only two ore dryers in the taconite source category, both located at Tilden. The HAP of concern in the ore dryer affected source is primarily metallic HAP. Most metallic HAP can be controlled with common PM control devices, such as wet scrubbers and baghouses.

One ore dryer is equipped with two cyclones and an impingement scrubber in series for PM control. The exhaust gas stream of the second dryer is split into two streams that discharge through separate stacks. Each of these exhaust streams is also equipped with two cyclones and an impingement scrubber in series.

4.3 REFERENCES

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5.0 DETERMINATION OF THE MAXIMUM ACHIEVABLE CONTROL TECHNOLOGY (MACT) FLOOR AND MACT

This chapter and its associated appendix present the methodologies and background data used to establish the MACT floor and MACT for each of the four affected sources within the taconite iron ore processing source category. Section 5.2 presents a combined discussion of ore crushing and handling (OCH) and finished pellet handling (PH); Section 5.3 deals with indurating furnaces; and Section 5.4 discusses ore dryers.

5.1 INTRODUCTION

The following subsections provide basic information on the statutory requirements for establishing MACT, the various approaches used to identify the MACT floor, and the justification for using PM emissions as a surrogate for emissions of metallic HAP compounds.

5.1.1 Statutory Requirements

Section 112 of the CAA requires that EPA establish NESHAP for the control of HAP from both new and existing major sources of HAP emissions. The CAA requires the NESHAP to reflect the maximum degree of reduction in emissions of HAP that is achievable. This level of control is commonly referred to as the most achievable control technology (MACT).

The MACT floor is the minimum control level allowed for NESHAP and is defined under section 112(d)(3) of the CAA. In essence, the MACT floor establishes the standard at a level that ensures that all major sources achieve the level of control at least as stringent as that already achieved by the better-controlled and lower-emitting sources in each source category or subcategory. For new sources, the MACT floor cannot be less stringent than the emission control that is achieved in practice by the best-controlled similar source. The MACT standards for existing sources can be less stringent than standards for new sources, but they cannot be less stringent than the average emission limitation achieved by the best-performing 12 percent of existing sources in the category or subcategory (or the best-performing 5 sources for categories or subcategories with fewer than 30 sources).

In developing MACT, EPA also considers control options that are more stringent than the MACT floor. The EPA may establish standards more stringent than the MACT floor based on the consideration of the cost of achieving the emissions reductions, any health and environmental impacts, and energy requirements.

5.1.2 MACT Floor Approaches

Historically, the EPA has taken varied approaches to establishing the MACT floor for different HAP source categories, depending on the type, quality, and applicability of available data. The three approaches most commonly used involve reliance on the following:

- Existing State and Federal regulations or permit limits,
- Source test data that characterize actual emissions, and
- Use of a technology floor with an accompanying demonstrated achievable emission level that accounts for process and/or air pollution control device variability.

Each of these MACT floor approaches was evaluated when developing the MACT floor for each of the four affected sources in the taconite iron ore processing source category: ore crushing and handling (OCH), indurating furnaces, finished pellet handling (PH), and ore dryers. Refer to the corollary discussions under each of the primary subheadings below.

5.1.3 PM as a Surrogate for Metallic HAP

As mentioned in previous chapters, metallic HAP are released from all four affected sources. When released, each of the metallic HAP compounds, except elemental mercury, behaves as PM. As a result, strong correlations exist between PM emissions and emissions of the individual metallic HAP compounds. What's more, control technologies used for the reduction of PM emissions achieve comparable levels of reduction of metallic HAP emissions, so standards requiring good control of PM emissions will also achieve a similar level of control of metallic HAP emissions. Therefore, for the taconite iron ore processing source category the EPA has established standards for the reduction of total PM as a surrogate pollutant for individual metallic HAP compounds.

5.2 ORE CRUSHING AND HANDLING AND FINISHED PELLET HANDLING - MACT FLOOR AND MACT LEVEL OF CONTROL FOR PARTICULATE MATTER

Although OCH and PH are defined as separate affected sources, the available test data on both sources for the MACT floor and MACT analyses were combined. This is consistent with EPA's usual practice in developing MACT standards in organizing, as appropriate, the available information for similar HAP-emitting equipment into related groups for the purpose of determining MACT floors and MACT. As appropriate, separate affected source definitions are maintained for the purpose of defining applicability of the relevant standards. Emissions from OCH are primarily PM emitted from the dry ore as it is physically ground, crushed, screened, and conveyed. Emissions from PH are primarily PM emitted from the finished pellets as they are screened and conveyed. The HAP content of the emitted PM from both OCH and PH depends on the intrinsic composition of the iron ore being processed.

This section is organized into five subsections that discuss existing regulations, available PM emissions test data, our approach in determining the MACT floor, and our approach in establishing MACT for both existing and new sources.

5.2.1 Existing State and Federal Regulations

The New Source Performance Standards (NSPS) for Metallic Mineral Processing Plants (40 CFR part 60, subpart LL) applies only to units that commenced construction or modification after August 24, 1982. As a result, only some of the OCH and PH emission units in Minnesota, and none of the OCH and PH emission units in Michigan, are subject to these NSPS. The NSPS limit PM emissions from each emission unit to 0.022 gr/dscf (0.05 grams/dscm). However, most of the OCH and PH emission units in Minnesota are subject to the State's Industrial Process Equipment Rule (IPER). The Minnesota IPER establishes PM concentration emission limits as a function of volumetric flow. The emission limit becomes more stringent as volumetric flow increases. Particulate matter emission limits for OCH and PH emission units under the IPER range from approximately 0.030 gr/dscf to 0.095 gr/dscf. Due to its proximity to Lake Superior, Northshore is subject to the following more stringent limits: 0.002 gr/dscf for tertiary crushing and some storage/transfer points, 0.010 gr/dscf for cobbing and some storage/transfer points, and 0.030 gr/dscf for the rest of the emission points. The two Michigan plants, Empire and Tilden, are subject to a State PM emission limit of 0.1 pounds of PM per 1,000 pounds of exhaust gas, which equates to approximately 0.052 gr/dscf.

5.2.2 Particulate Matter Test Data

We identified 264 emission units within the OCH affected source and 82 emission units within the PH affected source at the eight taconite plants (346 emission units total). Particulate matter emissions from both operations are controlled primarily with medium-energy wet scrubbers (i.e., venturi-rod scrubbers, impingement scrubbers, and marble bed scrubbers). Baghouses, low-energy wet scrubbers (i.e., rotoclones), multiclones, and electrostatic precipitators (ESP) are also used.

A total of 99 PM emissions tests were available for the OCH and PH emission units. Thirty-nine of these PM emissions tests were not used in the analysis for one of the following reasons (see Table 1 of Appendix C for available test data from these 39 emission tests):

- Fifteen tests were set aside from the analysis because of one of the following reasons: the test did not consist of at least three runs, the control device malfunctioned during one or more of the test runs, or the control device tested was subsequently replaced or modified and is no longer in existence.
- Nine tests were set aside because the results are unusually high and appear to be unrepresentative. These include tests of 3 venturi scrubbers, 4 baghouses, 1 marble bed scrubber, and 1 impingement scrubber. The measured emissions values in these nine tests were up to 25 times higher than the average value from the 60 tests used in the analysis.
- Fifteen tests were set aside because they represented duplicate tests of an emission unit. For each emission unit with multiple test data, the test that yielded the highest emission value was used in the analysis as the best measure of long-term performance for that emission unit.

The remaining 60 PM emissions tests (see data presented in Table 2 of Appendix C) were used in the OCH/PH MACT analysis. Each test is composed of three 1-hour test runs, with the results expressed in PM concentration units of gr/dscf. These 60 PM emissions tests account for 17 percent of the combined 346 OCH and PH emission units in the source category and include representative data on all crushing stages, screening operations, conveyor transfer points, and storage bins, as well as finished pellet screening operations and conveyor transfer points. These tests also cover the full range of control devices applied to OCH and PH emission units. Therefore, these 60 tests provide representative data for the source category's OCH and PH emission units.

5.2.3 Determination of the MACT Floor

As discussed in Section 5.1.2, in determining the MACT floor for a HAP source category the EPA looks first for useful and appropriate values in existing State and Federal emission limitations. The actual OCH and PH PM emission rates reported in the 60 emission tests were compared to the State and Federal emissions limitations to determine whether the limitations provided a reasonable representation of actual emissions and performance. Actual PM emission rates are on the order of 0.002 to 0.010 gr/dscf, whereas, the levels generally allowed under the State and Federal emissions limitations range from 0.022 to 0.095 gr/dscf. Based on this comparison, it is clear that actual PM emissions are considerably lower than the levels allowed by State emission limits and the metallic mineral processing NSPS. Furthermore, the State and Federal PM emission limits do not realistically represent performance achieved in practice by the best performing sources. Therefore, the MACT floor for OCH and PH was not based on the levels allowed by the State and Federal emission limitations.

Next, the available emissions data were examined to determine if the MACT floor could be based on actual emissions. The available, valid PM emissions tests account for 17 percent of the OCH and PH emission units and include representative data on all emission unit types (crushers, screens, conveyors, storage bins, etc.) and all control devices. Therefore, it was concluded that the available information on actual emissions is adequate for the purpose of determining the requisite MACT floors for new and existing sources. The available test data were evaluated by process stage (i.e., primary crushing, secondary crushing, tertiary crushing, grate feed, and finished pellet handling) to determine whether PM emissions varied depending on process stage (Figure 5-1). There were no discernable differences in the types of controls or the level of controlled PM emissions among the various process stages. Consequently, it was concluded that distinguishing by process stage was unnecessary and it was feasible to establish one PM emission limit that would apply to all OCH and PH emission units.

The MACT floor was determined on the basis of each plant's flow-weighted mean PM emissions for all tested OCH and PH units. As an average of the emissions from all emitting units, each plant's flow-weighted mean PM concentration value takes into account the normal variability in emissions among different units within the two affected sources and provides a reasonably accurate representation of the overall level of control that is being achieved at each affected source. Table 5.2-1 shows the number of PM emissions tests available for each plant and the calculated flow-weighted mean PM emissions for each plant. The flow-weighted mean PM emissions value was calculated for each plant using the following equation:

$$C_w = \frac{\sum_{i=1}^{n} C_i Q_i}{\sum_{i=1}^{n} Q_i}$$

Where:

C_w = Flow-weighted mean concentration of particulate matter for all emission units within the affected source, grains per dry standard cubic foot (gr/dscf);
C_i = Three-run average particulate matter concentration from emission unit "i", gr/dscf;
Q_i = Three-run average volumetric flow rate of stack gas from emission unit "i", dscf/hr; and
n = The number of emission units in the affected source.

For Tilden, Inland, and Empire, the flow-weighted mean PM emissions could not be calculated because there was insufficient PM emissions test data: Empire had no PM emissions test data, while Tilden and Inland had only two tested units each. Each of the remaining five plants had PM emissions test data for 6 to 21 units.

The flow-weighted mean PM concentration values for each of the five plants were 0.0047, 0.0050, 0.0059, 0.0114 and 0.0116 gr/dscf. The MACT floor of 0.008 gr/dscf for the OCH and PH affected sources was determined as the average of the flow-weighted mean PM concentrations for the five plants. Based on the available PM emissions test data, a level of 0.008 gr/dscf for OCH and PH emission units can be achieved by most baghouses, impingement scrubbers, marble-bed scrubbers, and venturi scrubbers. However, the rule requires that plants achieve the 0.008 gr/dscf limit based on the flow-weighted average of all of their OCH and PH emission units. Therefore, a plant could achieve this using a combination of units with PM emissions below 0.008 gr/dscf and units with PM emissions above 0.008 gr/dscf.

Table 5.2-1: Flow-Weighted Mean PM Emissions for Tested OCH and PH Units by Plant

Plant	Number of PM Emissions Tests	Flow-Weighted Mean PM Emissions (gr/dscf)
EVTAC	11	0.0116
National	9	0.0114
Hibbing	9	0.0059
Northshore	6	0.0050
Minntac	21	0.0047
Tilden	2	NA
Inland	2	NA
Empire	0	NA
	Average of the Top Five	0.008

NA - Not available due to insufficient PM emissions test data.

5.2.4 Determination of MACT for Existing Sources

The next increment of control beyond the floor is the installation of impingement scrubbers capable of meeting a concentration limit of 0.005 gr/dscf, which is equivalent to the level of control the EPA anticipates requiring for new sources (see Section 5.2.5). It is estimated that, for all plants to achieve the MACT floor level of 0.008 gr/dscf, existing APCDs will have to be replaced at 54 OCH emission units and 11 PH emission units (see Section 6.2). If the PM emissions levels for OCH and PH are reduced from 0.008 to 0.005 gr/dscf, existing APCDs will need to be replaced on an additional 44 emission units (38 OCH units and 6 PH emission units) as shown in Table 3 of Appendix C. It was assumed that units installing APCDs to meet the level of 0.008 gr/dscf (the MACT standard) would not incur any additional costs to meet the level of 0.005 gr/dscf. This assumption is based on the fact that the costs for achieving the 0.008 gr/dscf limit are based on replacing existing APCDs with impingement scrubbers capable of achieving a limit of 0.005 gr/dscf. It was also assumed that all emission units equipped with venturi scrubbers would meet a 0.005 gr/dscf PM emission level. This assumption is based on the fact that the PM emissions for 12 out of the 15 tested emissions units currently equipped with venturi scrubbers are well below 0.005 gr/dscf.

The costs of replacing the existing APCDs for each of the 44 emission units are shown in Table 3 of Appendix C. These costs were determined using the same control costs and procedures as described in Sections 6.2.2 and 6.2.3 of this document. The additional capital cost of replacing the existing APCDs on these 44 emission units with new impingement scrubbers capable of achieving 0.005 gr/dscf is estimated to be $3.5 million, and the total annual cost (including annualized capital costs) is estimated to be $585,000 per year. This estimate includes the cost of increased usage of electricity, estimated to be an additional 2,870 mega-watt hours per year, which is required due to the greater energy requirements of the new scrubbers.

The incremental reduction in total PM emissions achieved by reducing the PM concentration from 0.008 to 0.005 gr/dscf was determined by calculating the difference between the PM emissions for the affected units at 0.008 gr/dscf and at 0.005 gr/dscf (see Table 3 of Appendix C). The resulting PM emission reduction for the 44 emission units is approximately 112 tons/year. In Chapter 7 of this document, it is shown that at a PM emission level of 0.008

gr/dscf, the total PM emissions from all OCH and PH emission units is 2,263 tons/year. Therefore, reducing the level to 0.005 gr/dscf results in a 4.9 percent reduction in the total PM emissions from all OCH and PH emission units:

[(112 tons PM/year)/(2,263 tons PM/year)] x 100 = 4.9 percent reduction in PM

As discussed in Section 5.1.3, PM is used as a surrogate for metallic HAP. Therefore, a 4.9 percent reduction in PM is assumed to equal a 4.9 percent reduction in total metallic HAP. This correlates to an incremental reduction in metallic HAP emissions of 0.37 tons (see Table 5.2-2).

The incremental cost per additional ton of HAP reduced in going from 0.008 to 0.005 gr/dscf is $2.1 million. This is calculated by dividing the annual cost of $584,577 by the annual HAP emission reduction of 0.37 tons. The EPA has determined that the high cost, coupled with the small reduction in HAP emissions, does not justify this beyond-the-floor alternative at this time. The EPA could not identify any other beyond-the-floor alternatives. Consequently, the EPA chose the floor level of control of 0.008 gr/dscf as MACT for existing sources.

Table 5.2-2: HAP Metal Emissions Reduction from OCH and PH at a Level of 0.005 gr/dscf

Affected Source	HAP Emissions at MACT (0.008 gr/dscf) in tons/year	Percent Reduction at 0.005 gr/dscf Level	Emission Reduction at 0.005 gr/dscf Level in tons/year
OCH	7.02	5%	0.347
PH	0.52	5%	0.026
Total	7.54	5%	0.373

5.2.5 Determination of MACT for New Sources

For new OCH and PH affected sources, the EPA selected a PM outlet concentration of 0.005 gr/dscf as new source MACT. The 0.005 gr/dscf level corresponds to the best performing source (plant) with the lowest flow-weighted mean PM concentration (Table 5.2-1). Based on available PM emissions test data, a level of 0.005 gr/dscf for OCH and PH emission units can be achieved by most baghouses, impingement scrubbers, and venturi scrubbers. However, the rule requires plants to achieve the 0.005 gr/dscf limit based on the flow-weighted average of all of their OCH and PH emission units. A plant could meet this requirement using a combination of units with PM emissions below 0.005 gr/dscf and units with PM emissions above 0.005 gr/dscf.

5.3 INDURATING FURNACES

There are 21 indurating furnaces at the eight operating taconite plants. Fourteen of the furnaces are grate kiln designs and seven are straight grate designs. Since these two furnace design types have unique physical and operational differences, EPA is establishing subcategories within the indurating furnace affected source to accommodate these differences. EPA is also differentiating the grate kiln furnaces based on the type of ore processed (i.e., hematite versus magnetite ore).

5.3.1 Indurating Furnaces Processing Magnetite

This section is organized into five subsections that discuss existing regulations, available PM emissions test data, our approach in determining the MACT floor, and our approach in establishing MACT for both existing and new sources.

5.3.1.1 Existing State and Federal Regulations

Most of the indurating furnaces in Minnesota are subject to the State's IPER. Particulate matter emission limits for indurating furnaces under the IPER range from 0.025 to 0.05 gr/dscf. Due to its proximity to Lake Superior, Northshore, which operates straight grate furnaces, is subject to a more stringent State limit of 0.01 gr/dscf. The two Michigan plants, Empire and Tilden, both of which operate grate kiln furnaces, are subject to State PM emission limits also based on air flow rates. Tilden, which operates two furnaces, has a PM emission limit of 0.065 pounds of PM per 1,000 pounds of exhaust gas (0.04 gr/dscf). Empire, which operates four grate kilns, has a PM emission limit of 0.10 pounds of PM per 1,000 pounds of exhaust gas (0.06

gr/dscf) for its two larger furnaces, and 0.15 pounds of PM per 1,000 pounds of exhaust gas (0.09 gr/dscf) for its two smaller furnaces.

5.3.1.2 Particulate Matter Test Data

As stated earlier, there are 21 indurating furnaces at the eight operating taconite plants, but because many furnaces have multiple stacks, these furnaces represent a total of 47 emission points (see Table 3.1-1). The test data for each furnace consists of a test for each furnace stack, with multiple tests for furnaces that discharge through more than one stack. Each valid test consists of three 1-hour test runs, with the results expressed in gr/dscf. For the furnaces with multiple stacks, the PM emissions value for an individual furnace was calculated as the flow-weighted mean concentration of PM emissions from all associated stacks.

A total of 61 PM emissions tests are available for indurating furnaces processing magnetite. Sixteen of the PM emissions tests were determined to be invalid due to the following reasons (see Table 4 of Appendix C for available test data from these 16 emission tests. Note that 2 of the emissions tests listed in Table 4 of Appendix C are for indurating furnaces processing hematite. The hematite tests are discussed in Section 5.3.2.):

- Six tests were set aside from the analysis because the tests did not consist of at least three test runs for each furnace stack.
- Seven tests were set aside from the analysis because there was no dry catch data available for the tests.
- The 11/97 test for EVTAC line 1 was set aside from the analysis because the unit was tested at a minimum production rate (75% of the maximum) and the unit has been shut down since June of 1999. Based on comments from the plant, the 11/97 test for EVTAC line 1 is not representative of the system and the plant recommends that, if and when line 1 is restarted, a new PM emissions test should be conducted to obtain an accurate measurement of its PM emissions.[1]
- Two tests were set aside from the analysis because either the test was conducted under atypical process conditions or the control device was subsequently replaced or modified and is no longer in existence.

The remaining 45 PM emissions tests, shown in Table 5 of Appendix C, were used for the MACT floor and MACT analysis. Table 5.3-1 shows the number of valid tests available for each of the 21 indurating furnaces. Six of the seven straight grate furnaces and twelve of the fourteen grate kiln furnaces have credible PM test data available for magnetite ore processing. Valid PM test data for magnetite processing are not available for EVTAC Line 1, Tilden Line 1, and Northshore Line 6.

5.3.1.3 Determination of the MACT Floor

Existing State PM emission limitations were examined as an option for establishing the MACT floor. However, a comparison of existing State limitations with the 45 actual PM emissions tests shows that the State limitations are generally set at a level much higher than the actual emissions. The average concentration of actual PM emissions measured from all 18 furnaces when processing magnetite ranges from 0.005 to 0.02 gr/dscf, which is about 5 times lower than the typical State PM emissions limitation. Therefore, it was concluded that the State PM emission limits and permit conditions do not realistically represent the emission levels actually achieved in practice by the best performing sources.

Next, available emissions data were examined to determine if the MACT floor could be based on actual emissions. At least one valid PM emissions test is available for 18 of the 21 furnaces while processing magnetite. Therefore, given the amount and quality of available PM emissions test data, it was concluded that the available information on actual emissions is more than adequate for the purpose of determining the requisite MACT floors for new and existing sources.

As a first step in the MACT floor and MACT analysis for indurating furnaces, the appropriateness of using a plant-wide average approach was explored. The plant-wide average approach would be similar to that used for OCH and PH. Specifically, under the plant-wide average approach the flow-weighted average PM emissions would be calculated for all of the indurating furnaces at each plant. Then the MACT floor would be calculated based on the mean of the top 5 plant-wide flow-weighted averages. Although PM emissions test data are available

Table 5.3-1: Number of Valid PM Emissions Tests for Indurating Furnaces Processing Magnetite

Furnace Type	Plant	Furnace Line	Number of Valid Tests
Grate Kiln	Empire	Line 1	3
		Line 2	2
		Line 3	2
		Line 4	3
	EVTAC	Line 1	0
		Line 2	3
	Minntac	Line 3	2
		Line 4	2
		Line 5	4
		Line 6	2
		Line 7	7
	National	Line 2	2
	Tilden	Line 1	0
		Line 2	3
Straight Grate	Hibbing	Line 1	1
		Line 2	3
		Line 3	1
	Inland	Line 1	1
	Northshore	Line 6	0
		Line 11	2
		Line 12	2
		Total	45

for 18 of the 21 furnaces, there are very few furnace data points per plant. Two plants have only one furnace, and another two plants have PM emissions data for only one of their two furnaces. Therefore, for half of the facilities, the available test data are insufficient to calculate a plant-wide value. Therefore, it was determined that the plant-wide average approach was not feasible.

As an alternative approach, the 21 indurating furnaces were treated as separate emission units. As a first step, EPA looked at all furnaces (straight grate and grate kiln) with multiple PM emissions tests to account for the variability inherent in the performance tests. There are 12 grate kiln furnaces and three straight grate furnaces for which there are two or more emissions tests. To quantify the variability between tests for each of these furnaces, a relative standard deviation (RSD) was calculated for each furnace (see Table 6 of Appendix C). The RSD was calculated by dividing the standard deviation of the data by the mean of the data and multiplying the result by 100. The RSD provides a measure of the variability of the PM test data for each furnace relative to the mean of the PM test data for each furnace. The RSD is expressed as a percentage for each furnace, and these percentages were then compared between furnaces.

The number of multiple PM emissions tests available for straight grate furnaces is limited. Specifically, there are multiple PM emissions tests for only three of the seven straight grate furnaces, and only one of these has more than two PM emissions tests. Therefore, it was determined that, by itself, the PM emissions data for straight grates is insufficient to capture the full range of variability between tests. The variability between tests for a given indurating furnace is due to normal variability in process operation and control device performance, as well as measurement error. These factors affect all furnaces similarly, and their affect on emissions is largely independent of furnace type and ore type. Therefore, given the limited amount of multiple PM emissions tests for straight grate furnaces and the fact that the above factors affect all furnaces similarly, RSD values for all furnaces were considered together (grate kilns and straight grates) when determining the overall variability. When straight grates and grate kilns are combined, 15 of the 21 furnaces have multiple PM emissions tests. The RSD for the 15 furnaces with multiple test data ranged from 9 to 111 percent and averaged 37 percent (see Table 6 of Appendix C). This indicates that on average, the PM emissions tests for each furnace are within plus or minus 37 percent of the mean of the emissions tests.

The average RSD of 37 percent was applied to each emission test to include a measure of variability to each test (see Table 5 of Appendix C). Next, a level of performance was assigned to each of the 19 furnaces for which actual emissions data exist. For each furnace for which there are two or more tests, the highest test value was chosen as the representative value of performance for that furnace. Selecting the highest of the test results provides more assurance that the inherent operational variability is fully accounted for in the selection of the representative value. For those furnaces for which only one test exists, that test result is the assigned value of performance. Table 5.3-2 shows the PM emissions values that were used in the MACT floor and MACT analysis for each of the 18 indurating furnaces for which PM emissions data for magnetite processing were available.

Since there are fewer than 30 sources in the straight grate and grate kiln indurating furnace subcategories, the MACT floors were determined using the five best-performing sources. Each indurating furnace was ranked within its subcategory according to its flow-weighted mean concentration of PM emissions after application of the RSD adjustment for variability. The five furnaces in each subcategory with the lowest adjusted PM concentration were identified as the best-performing sources (Table 5.3-3). The MACT floor was then determined as the mean PM concentration value for the five best-performing sources. The adjusted PM concentration values for the five best-performing grate kiln furnaces were 0.0085, 0.0090, 0.0112, 0.0123, and 0.0123 gr/dscf (Table 5.3-3). The mean of these five values was determined to be 0.011 gr/dscf. Based on the available PM emissions test data, a level of 0.011 gr/dscf for grate kiln indurating furnaces can be achieved by most venturi scrubbers and ESP. The adjusted PM concentration values for the five best-performing straight grate furnaces were 0.0082, 0.0090, 0.0094, 0.0105, and 0.0126 gr/dscf (Table 5.3-3). The mean of these five values was determined to be 0.010 gr/dscf. Based on the available PM emissions test data, a level of 0.010 gr/dscf for straight grate indurating furnaces can be achieved by most venturi scrubbers and ESP.

Table 5.3-2: PM Emissions Values Used in the MACT Floor and MACT Analysis for Indurating Furnaces Processing Magnetite

Furnace Type	Plant	Furnace Line	PM Emission Control Device	Highest Test Adjusted with the RSD (gr/dscf)
Grate Kiln	Empire	Line 1	Dry ESP	0.0133
		Line 2	Dry ESP	0.0112
		Line 3	Dry ESP	0.0090
		Line 4	Dry ESP	0.0085
	EVTAC	Line 2	Venturi Scrubber	0.0171
	Minntac	Line 3	Multiclone	1.0375
		Line 4	Venturi Scrubber	0.0123
		Line 5	Venturi Scrubber	0.0123
		Line 6	Venturi Scrubber	0.0301
		Line 7	Venturi Scrubber	0.0269
	National	Line 2	Multiclone	0.1824
	Tilden	Line 2	Dry ESP	0.0166
Straight Grate	Hibbing	Line 1	Venturi Scrubber	0.0082
		Line 2	Venturi Scrubber	0.0090
		Line 3	Venturi Scrubber	0.0155
	Inland	Line 1	Venturi Scrubber	0.0094
	Northshore	Line 11	Wet ESP	0.0126
		Line 12	Wet ESP	0.0105

5.3.1.4 Determination of MACT for Existing Sources

The next increment of control beyond the floor is the installation of venturi scrubbers or dry ESP capable of meeting a concentration limit of 0.006 gr/dscf, which is equivalent to the level of control required for new straight grate furnaces and new grate kiln furnaces (see section 5.3.1.5). It is estimated that, in order for all plants to achieve the MACT floor level of 0.011 gr/dscf for grate kilns, the existing APCDs on five grate kiln indurating furnaces will need to be replaced (see Section 6.3). In addition, it is estimated that, in order to achieve the MACT floor level of 0.010 gr/dscf for straight grates, the existing APCD on one straight grate indurating furnace will need to be replaced (see Section 6.3). If the PM emissions levels for grate kiln furnaces and straight grate furnaces were to be reduced further to 0.006 gr/dscf, existing APCDs would need to be replaced or modified on an additional 4

Table 5.3-3: Top Five Best-Performing Grate Kilns and Straight Grates

Furnace Type	Rank	Plant	Furnace Line	PM Emission Control Device	Highest Test Adjusted with the RSD (gr/dscf)
Grate Kiln	1	Empire	Line 4	Dry ESP	0.0085
	2	Empire	Line 3	Dry ESP	0.0090
	3	Empire	Line 2	Dry ESP	0.0112
	4	Minntac	Line 4	Venturi Scrubber	0.0123
	5	Minntac	Line 5	Venturi Scrubber	0.0123
	Average of the Top Five Best Performers				0.011
Straight Grate	1	Hibbing	Line 1	Venturi Scrubber	0.0082
	2	Hibbing	Line 2	Venturi Scrubber	0.0090
	3	Inland	Line 1	Venturi Scrubber	0.0094
	4	Northshore	Line 12	Wet ESP	0.0105
	5	Northshore	Line 11	Wet ESP	0.0126
	Average of the Top Five Best Performers				0.010

grate kiln furnace stacks and 7 straight grate furnace stacks (see Table 7 of Appendix C). In making this determination, it was assumed that units installing controls to meet the level of 0.011 for grate kilns and 0.010 for straight grates (the MACT standard) would not incur any additional costs to meet the level of 0.006 gr/dscf. This assumption is based on the fact that the costs for achieving the 0.0011 and 0.010 gr/dscf limits are based on replacing existing control equipment with venturi scrubbers that are capable of achieving a limit of 0.006 gr/dscf.

The costs of replacing or upgrading the existing controls for each of the 11 affected furnace stacks are shown in Table 7 of Appendix C. The replacement costs for venturi scrubbers were determined using the same capital costs as described in Sections 6.3.2 and 6.3.3 of this document and the annual costs shown in Table 8 of Appendix C. Since some of the affected furnace stacks are currently controlled by ESP, a retrofit ESP cost was developed from an industry cost estimate for a new ESP as shown in Table 7 of Appendix C.[2] The retrofit costs were estimated to be 35 percent of the replacement cost. The annual costs for the ESP are shown in Table 9 of Appendix C. For straight grate furnaces, the additional capital cost of going from a level of 0.010 gr/dscf to a level of 0.006 gr/dscf was estimated to be $71.2 million, and the total additional annual cost (including annualized capital costs) was estimated to be $11.4 million. For grate kiln furnaces, the additional capital cost of going from a level of 0.011 gr/dscf to a level of 0.006 gr/dscf was estimated to be $28.5 million and the total additional annual cost (including annualized capital costs) was estimated to be $5.3 million. These costs include the cost of additional electricity, which is required due to the greater energy requirements of the new scrubbers and ESP. For grate kiln furnaces the energy increase is expected to be 36,297 mega-watt hours per year. For straight grate furnaces the energy increase is expected to be 17,139 mega-watt hours per year.

The incremental reduction in PM achieved by reducing the PM concentration level from 0.011 gr/dscf for grate kilns and 0.010 gr/dscf for straight grates to 0.006 gr/dscf was determined as follows (Table 5.3-4):

- As indicated above, it was assumed that units installing controls to meet the level of 0.011 for grate kilns and 0.010 for straight grates (the MACT standard) would not incur any additional costs to meet the level of 0.006 gr/dscf. Therefore, no additional emission reductions were credited to these emission units.

- For grate kilns, going from 0.011 gr/dscf to 0.006 gr/dscf represents a 45 percent PM emission reduction for each affected emission unit. Therefore, the PM emission reduction for each affected unit was calculated by multiplying the PM emissions at MACT by 45 percent.
- For straight grates, going from 0.010 gr/dscf to 0.006 gr/dscf represents a 40 percent PM emission reduction for each affected emission unit. Therefore, the PM emission reduction for each affected unit was calculated by multiplying the PM emissions at MACT by 40 percent.

The incremental reduction in HAP achieved by reducing the PM concentration level from 0.011 gr/dscf and 0.010 gr/dscf for straight grates to 0.005 gr/dscf was determined as follows (Table 5.3-5):

- The total HAP emissions value at MACT for the affected plant was multiplied by the percent of the plant's total volumetric flow that the affected emission units represent. This provides an estimate of the total HAP emissions at MACT for the affected emission units.
- The total HAP emissions value at MACT for the affected emission units was then multiplied by the percent PM emissions reduction (45 percent for grate kilns and 40 percent for straight grates) to yield the HAP emission reduction.

The additional reduction in HAP achieved from grate kilns is estimated to be 12.8 tons/year. Therefore, the incremental cost per additional ton of HAP reduced for grate kiln furnaces is $414,000/ton [($5.3 million/year)/(12.8 tons/year)] = $414,000/ton]. The additional reduction in HAP achieved from straight grate furnaces is estimated to be 30 tons/year. Therefore, the incremental cost per additional ton of HAP reduced for straight grate furnaces is $379,000/ton [($11.38 million/year)/(30 tons/year)] = $379,000/ton. EPA believes that the high cost, coupled with the small reduction in HAP emissions, does not justify this above-the-floor alternative for either furnace subcategory. No other above-the-floor alternatives were identified.

Consequently, the EPA has chosen the MACT floor levels of control of 0.010 gr/dscf for straight grate furnaces and 0.011 gr/dscf for grate kiln furnaces as MACT for existing indurating furnaces.

Table 5.3-4: PM Emission Reductions Resulting from a Level of 0.006 gr/dscf for Grate Kiln and Straight Grate Furnaces Processing Magnetite

Furnace Type	Plant	Furnace Line	PM Emissions at MACT (tons/year)	Percent PM Emissions Reduction	PM Emissions Reduction at 0.006 gr/dscf (tons/year)
Grate Kiln	Empire	Line 1	113	45%	51
		Line 2	134	45%	60
	Minntac	Line 4	166	45%	75
		Line 5	175	45%	79
	Total		588	45%	265
Straight Grate	Hibbing	Line 1A	11	40%	4
		Line 1B	12	40%	5
		Line 3	61	40%	24
	Inland	Line 1	54	40%	22
	Northshore	Line 6	59	40%	24
		Line 11	58	40%	23
		Line 12	54	40%	22
	Total		286	40%	115

Table 5.3-5: HAP Emission Reductions Resulting from a Level of 0.006 gr/dscf for Grate Kiln and Straight Grate Furnaces Processing Magnetite

Furnace Type	Plant	Furnace Lines	HAP Emission Reduction (tons/year)		
			Acid Gases	Metals	Total
Grate Kiln	Empire	Lines 1 and 2	0	0.3	0.3
	Minntac	Lines 4 and 5	12.3	0.2	12.5
		Total	12.3	0.5	12.8
Straight Grate	Hibbing	Lines 1A, 1B, 3	2.8	0.5	3.3
	Inland	Line 1	12.8	0.4	13.2
	Northshore	Lines 6, 11, 12	12.4	1.1	13.5
		Total	28	2	30

5.3.1.5 Determination of MACT for New Sources

For the new source MACT analysis, the PM emissions test results were not adjusted for variability. EPA believes that a variability adjustment is not necessary because new emission controls can be engineered to account for variability in process operation and control device performance, as well as measurement error. The unadjusted PM emissions concentrations for each straight grate furnace and for each grate kiln furnace were ranked from the lowest to the highest values.

The furnace with the lowest PM outlet concentration of 0.006 gr/dscf was selected as new source MACT for new straight grate indurating furnaces processing magnetite. EPA believes that this furnace, which is controlled by a venturi scrubber, represents the best controlled similar source among the seven operating straight grate furnaces.

The furnace with the lowest PM outlet concentration of 0.006 gr/dscf was selected as the new source MACT for new grate kiln indurating furnaces processing magnetite. EPA believes that this furnace, which is controlled by a dry ESP, represents the best controlled similar source among the 14 operating grate kiln furnaces.

5.3.2 Indurating Furnaces Processing Hematite

There are two indurating furnaces in the taconite iron ore source category that process hematite ore. Both furnaces are grate kiln designs located at the Tilden plant in Michigan. At this plant hematite is processed approximately 8 months of the year and magnetite is processed the remainder of the year. Both furnaces processing hematite are similar in design, size (25 feet in diameter and 160 feet long), operating conditions, production rates, and air pollution control. Exhaust gases from each furnace are controlled by three ESP, three dry units on one furnace and one wet and two dry units on the other furnace. All corresponding ESP for each furnace have similar configurations, including number of chambers and fields, and collection area; and similar operating conditions, including volumetric air flow, gas inlet temperature, primary and secondary currents, and primary and secondary voltages.

This section is organized into five subsections that discuss existing regulations, available PM emissions test data, our approach in determining the MACT floor, and our approach in establishing MACT for both existing and new sources.

5.3.2.1 Existing State and Federal Regulations

Both furnaces processing hematite are subject to Michigan's PM emission limit of 0.065 pounds of PM per 1,000 pounds of exhaust gas (approximately 0.04 gr/dscf).

5.3.2.2 Particulate Matter Test Data

As discussed earlier, many indurating furnaces have multiple stacks, and hence, multiple emission units. One PM emissions test is available for Tilden Line 1 and three PM emissions tests are available for Tilden Line 2 while processing hematite. Two of the PM emissions tests for Tilden Line 2 were determined to be invalid (see Table 4 of Appendix C). The May 16, 2000 test for Tilden Line 2 was determined to be unusually high and appears to be unrepresentative for this unit. The July 13, 2000 test was rejected because each of the three indurating furnace stacks was not tested independently; during this test stacks A and B were tested together. The remaining two PM emissions tests, one each for Tilden Line 1 and Line 2, were used in the MACT analysis for indurating furnaces processing hematite (see Table 5 of Appendix C).

5.3.2.3 Determination of the MACT Floor

Existing State PM emission limitations were examined as an option for establishing the MACT floor. However, a comparison of existing State limitations with data on actual PM emissions shows that the State limitations are generally set at a level much higher than the actual emissions. The average concentration of actual emissions measured from the two furnaces when processing hematite ranges from 0.017 to 0.018 gr/dscf, which is about half the State PM emissions limitation. Therefore, it was concluded that the State PM emission limit does not realistically represent the emission levels actually achieved in practice by the two furnaces when processing hematite.

Next, available emissions data were examined to determine if the MACT floor could be based on actual emissions. Credible PM test data are available for both of the furnaces while processing hematite. Therefore, it was concluded that this available information on actual emissions is adequate for the purpose of determining the requisite MACT floors for new and existing sources.

A variability analysis for furnaces processing hematite could not be conducted because multiple valid PM emissions tests are not available for these furnaces. As a result, the RSD adjustment of 37 percent that was used for furnaces processing magnetite was also used for furnaces processing hematite. This adjustment accounts for the process, control device, and measurement variability. As noted previously, these factors affect all furnaces similarly, and their affect on emissions is largely independent of furnace type and ore type. Therefore, EPA believes it is appropriate to apply the RSD calculated for furnaces processing magnetite to furnaces processing hematite. Since there are only two indurating furnaces processing hematite, and these furnaces are ostensibly identical in design, size, operation and emissions control, EPA selected the MACT floor based on the higher of the two PM concentration values (0.023 and 0.025 gr/dscf) after application of the RSD adjustment for variability. The resulting MACT floor for existing grate kiln indurating furnaces processing hematite is 0.025

gr/dscf. Based on the available PM emissions data, a level of 0.025 gr/dscf for indurating furnaces processing hematite can be achieved by an ESP.

5.3.2.4 Determination of MACT for Existing Sources

The next increment of control beyond the floor is the installation of a dry ESP capable of consistently meeting a concentration limit of 0.018 gr/dscf, which is equivalent to the level of control required for new grate kiln furnaces processing hematite (see Section 5.3.2.5). In order to achieve the MACT floor level of 0.025 gr/dscf for indurating furnaces processing hematite, Tilden will not have to replace or upgrade existing APCDs at any emission units (see Section 6.4). If the PM emissions level for indurating furnaces processing hematite is reduced from 0.025 gr/dscf to 0.018 gr/dscf, existing APCDs will need to be upgraded for Tilden Line 1, Stack A and Line 2, Stacks B and C.

The costs of upgrading the existing controls for each of the three affected furnace stacks are shown in Table 7 of Appendix C. The retrofit ESP cost was developed from an industry cost estimate for a new ESP as shown in Table 7 of Appendix C.[2] The retrofit costs were estimated to be 35 percent of the replacement cost. The annual costs for the ESP are shown in Table 9 of Appendix C. The additional capital cost of going from a level of 0.025 gr/dscf to a level of 0.018 gr/dscf was estimated to be $25.9 million, and the total annual cost (including annualized capital costs) was estimated to be $4.9 million. These costs include the cost of additional electricity that would be needed primarily to meet the greater energy requirements of the upgraded dry ESP. The energy increase is expected to be 34,898 mega-watt hours per year.

The incremental reduction in PM achieved by reducing the PM concentration level from 0.025 gr/dscf to 0.018 gr/dscf represents a 28 percent PM emission reduction for each affected emission unit. Therefore, the PM emission reduction for each affected unit was calculated by multiplying the PM emissions at MACT by 28 percent (Table 5.3-6).

Table 5.3-6: PM Emission Reductions Resulting from a Level of 0.018 gr/dscf for Furnaces Processing Hematite

Furnace Type	Plant	Furnace Line	PM Emissions at MACT (tons/year)	Percent PM Emissions Reduction	PM Emissions Reduction at 0.018 gr/dscf (tons/year)
Grate Kiln	Tilden	Line 1A	271	28%	76
		Lines 2B and 2C	251	28%	71
		Total	522	28%	147

The incremental reduction in HAP achieved by reducing the PM concentration level from 0.025 gr/dscf to 0.018 gr/dscf was determined as follows:

- The total HAP emissions value at MACT for the affected plant was multiplied by the percent of the plant's total volumetric flow that the affected units represent. This provides an estimate of the total HAP emissions at MACT for the affected emission units.
- The total HAP emissions value at MACT for the affected emission units was then multiplied by the percent PM emissions reduction (28 percent) to yield the HAP emission reduction.

The additional reduction in HAP achieved from grate kilns processing hematite is estimated to be 0.25 tons/year. Therefore, the incremental cost per additional ton of HAP reduced for grate kiln furnaces processing hematite is $19,599,076/ton [($4.94 million/year)/(0.3 tons/year) = $19,599,076/ton]. The EPA believes that the high cost, coupled with the minimal reduction in HAP emissions, does not justify this above-the-floor alternative. No other above-the-floor alternatives were identified. Consequently, the EPA has chosen the MACT floor level of control of 0.025 gr/dscf for grate kiln furnaces processing hematite as MACT for existing indurating furnaces.

5.3.2.5 Determination of MACT for New Sources

For the new source MACT analysis, the PM emissions test results were not adjusted for variability. The EPA believes that a variability adjustment is not necessary because new emission controls can be engineered to account for variability in process operation and control device performance, as well as measurement error.

As noted previously, both furnaces are ostensibly identical in design, operation, and control, with measured PM emissions based on one performance test per furnace of 0.017 and 0.018 gr/dscf. Given the similarities between the two furnaces and their demonstrated performance, EPA selected a PM emissions concentration of 0.018 gr/dscf as the new source MACT for grate kiln indurating furnaces when processing hematite.

5.4 Ore Dryers

The only two ore dryers in the source category are both rotary designs, and both are located at the Tilden plant in Michigan. One dryer measures 10 feet in diameter and 80 feet in length and has a rated capacity of 400 tons per hour. It is equipped with two cyclones and an impingement scrubber in series for PM emissions control. The other dryer is somewhat larger, measuring 12.5 feet in diameter and 100 feet in length with a rated capacity of 650 tons per hour. The exhaust gas from the second dryer is split into two streams, with each exhaust stream routed through two cyclones and an impingement scrubber in series before being discharged through a separate stack.

This section is organized into five subsections that discuss existing regulations, available PM emissions test data, our approach in determining the MACT floor, and our approach in establishing MACT for both existing and new sources.

5.4.1 Existing State and Federal Regulations

Both ore dryers are subject to Michigan's PM emission limit of 0.1 pound of PM per 1,000 pounds of exhaust gas (approximately 0.052 gr/dscf).

5.4.2 Particulate Matter Test Data

There is one valid PM emission test available for each ore dryer. Both ore dryers were tested in May 2002 while processing hematite. Tests were conducted at each of the three ore dryer stacks and included three 1-hour test runs per stack. In the case of the ore dryer with two stacks, the test results were calculated on a flow-weighted basis. The results, expressed in units of PM concentration, are 0.017 gr/dscf for the smaller dryer and 0.040 gr/dscf for the larger one.

The EPA has determined that the test conditions under which the smaller ore dryer was tested are not representative of normal long-term operations. Specifically, the ore dryer had been idle prior to testing and was brought back on-line, solely for the purpose of testing, only 2 hours ahead of commencing the performance test, which was 3 hours in duration. The EPA does not believe that a warm-up period of only a few hours is adequate to produce conditions representative of the worst-case circumstance reasonably expected to occur under normal long-term operations. Therefore, EPA has excluded these test data from further consideration in the MACT assessment.

5.4.3 Determination of the MACT Floor

Existing State PM emission limitations were evaluated as an option for establishing the MACT floor. A comparison of the State limit of 0.052 gr/dscf with the only credible data on actual PM emissions of 0.040 gr/dscf indicates that the State limit is a reasonable proxy of actual performance and, as such, is appropriate for establishing the MACT floor level. Consequently, EPA has determined the MACT floor for ore dryers to be the level of control indicated by the existing State limit of 0.052 gr/dscf.

5.4.4 Determination of MACT for Existing Sources

The next increment of control beyond the floor is the installation of venturi scrubbers capable of meeting a PM concentration limit of 0.025 gr/dscf, which is equivalent to the level of control required for new ore dryers (see Section 5.4.5). If the PM emission levels for grate kiln furnaces and straight grate furnaces are reduced from 0.052 gr/dscf to 0.025 gr/dscf, existing APCDs will need to be replaced on both stacks of the larger ore dryer (Tilden Dryer 2).

The costs of replacing the existing APCDs on these two stacks with venturi scrubbers are shown in Table 10 of Appendix C. Tables 12 and 13 of Appendix C show the venturi scrubber capital and annual costs, respectively, that were used in the ore dryer analysis. The additional capital cost of going from a level of 0.052 gr/dscf to a level of 0.025 gr/dscf was estimated to be $98,000, and the total increase in annual cost (including annualized capital costs) is estimated to be $256,000. This figure includes the cost of the projected additional 3,520 mega-watt hours per year needed to meet the increased energy requirements of the upgraded venturi scrubbers.

The incremental reduction in PM emissions achieved by reducing the PM concentration level from 0.052 gr/dscf to 0.025 gr/dscf represents a 52 percent PM emission reduction for each affected emission unit. Therefore, the PM emission reduction for each affected unit, measured in tons per year, was calculated by multiplying the PM emissions at MACT by 52 percent (Table 5.4-1).

Table 5.4-1: PM Emission Reduction Resulting from a Level of 0.025 gr/dscf for Ore Dryers

Plant	Unit	PM Emissions at MACT (tons/year)	Percent PM Emissions Reduction	PM Emissions Reduction at 0.025 gr/dscf (tons/year)
Tilden	Dryer #2 - North Stack	78	52%	40.4
	Dryer #2 - South Stack	71	52%	37.2
Total		149	52%	78

The incremental reduction in HAP emissions achieved by reducing the PM concentration level from 0.052 gr/dscf to 0.025 gr/dscf was determined as follows:

- The HAP emissions value at MACT for the affected plant was multiplied by the percent of the plant's total volumetric flow that the affected units represent. This provides an estimate of the total HAP emissions at MACT for the affected emission units.

- The total HAP emissions value at MACT for the affected emission units was then multiplied by the percent PM emissions reduction (52 percent) to yield the HAP emissions reduction.

The additional reduction in HAP emissions from ore dryers achieved with this above-the-floor alternative is estimated to be 0.32 tons. Therefore, the incremental cost per ton of HAP reduced for ore dryers is $790,000/ton [$255,915/year)/(0.32 tons/year) = $790,000/ton]. The EPA believes that the high cost, coupled with the small reduction in HAP emissions, does not justify this above-the-floor alternative at this time. No other above-the-floor alternatives could be identified. Consequently, the EPA chose the MACT floor level of control of 0.052 gr/dscf as MACT for existing ore dryers.

5.4.5 Determination of MACT for New Sources

For the new source MACT analysis, the PM emissions test results were not adjusted for variability. The EPA believes that a variability adjustment is not necessary because new emission controls can be engineered to account for variability in process operation and control device performance, as well as measurement error.

A PM outlet concentration of 0.025 gr/dscf was selected as new source MACT for ore dryers. The 0.025 gr/dscf level corresponds to the standard for dryers in the NSPS for calciners and dryers in mineral industries (40 CFR part 60, subpart UUU). The dryers used to develop the NSPS limit are very similar to the dryers that are used by the taconite source category. Specifically, many of the dryers studied in the NSPS were of the rotary design, were controlled by wet scrubbers, and processed material with a particle size distribution similar to that of taconite ore. Therefore, due to these similarities, the EPA believes that the level of 0.025 gr/dscf from the NSPS for calciners and dryers in mineral industries is a reasonable proxy of the performance that can be achieved by new ore dryers in the taconite industry.

5.5 REFERENCES

1. Fax from B. Anderson, EVTAC to C. Sarsony, AGTI. April 5, 2002. Re: Line 1 pellet plant waste gas stack test conducted November 21, 1997.

2. OAQPS Control Cost Manual (Fourth Edition), EPA 450/3-90-006. January 1990.

6.0 COSTS

This chapter presents the estimated industry costs resulting from the control of HAP emissions under the proposed standards. The EPA estimated the emission control, monitoring, recordkeeping, and reporting costs necessary to bring each facility into compliance with the proposed standards. Section 6.1 provides a summary of the overall costs anticipated to be incurred by the industry. Sections 6.2, 6.3, 6.4, and 6.5 of this chapter present the compliance costs for ore crushing and handling (OCH), indurating furnaces, finished pellet handling (PH), and ore dryers, respectively. Each of these sections presents the results of the cost analysis and describes the procedures that were used to determine the compliance costs.

6.1 SUMMARY OF COSTS

Table 6.1-1 provides a summary of the emission control costs and the monitoring, recordkeeping, and reporting costs for existing sources in the taconite iron ore processing source category. The EPA estimates that, for existing sources, the total capital cost of the proposed rule will be approximately $47.3 million, including emission control capital costs and monitoring, recordkeeping, and reporting (MRR) capital costs. Total annualized costs, including MRR costs, will be approximately $7.0 million per year. Approximately 83 percent of the total annualized costs are associated with the anticipated emission control upgrades for the indurating furnaces. The cost estimates, which were derived using procedures in the EPA's Control Technologies for Hazardous Air Pollutants Handbook,[1] are based on information gathered from industry representatives and vendors of industry-specific control equipment. All costs are presented in first quarter 1999 dollars (rounded to the nearest thousand) and are based on the proposed emission limits presented in Table 6.1-2.

Table 6.1-1: Overall Costs for Existing Sources in Taconite Iron Ore Processing Source Category

Cost Component	Total Capital Cost ($)	Annualized Capital Cost ($/yr)	O&M[a] Cost ($/yr)	MRR[b] Labor Cost ($/yr)	Annualized Total Cost ($/yr)
Emission Control Cost	$44,143,000	$3,788,000	$2,836,000	-	$6,624,000
Monitoring, Recordkeeping and Reporting Cost	$3,159,000	$271,000	$101,000	$29,000	$402,000
Total Cost	$47,302,000	$4,059,000	$2,937,000	$29,000	$7,026,000

[a] Operation and maintenance
[b] Monitoring, recordkeeping, and reporting

Table 6.1-2: Proposed PM Standards for Existing Affected Sources

Affected Source		Proposed PM Limit (gr PM/dscf)*
Ore crushing and handling		0.008
Indurating furnaces	Straight grate, processing magnetite	0.010
	Grate kiln, processing magnetite	0.011
	Grate kiln, processing hematite	0.025
Finished pellet handling		0.008
Ore dryers		0.052

* PM is being used as a surrogate for metallic HAP.

The emission control costs are based on the replacement of existing air pollution control devices (APCDs) that are anticipated not to meet the proposed MACT standards with new control equipment capable of meeting the standards. All emission units in the four affected sources subject to the proposed taconite rule are already equipped with some form of PM emission control. As discussed in Chapter 4 of this document, a total of 396 emission units within the taconite industry will be subject to the proposed standards. Sixty-five percent of these emission units are already equipped with a venturi or impingement wet scrubber, a baghouse, or an ESP–technologies reasonably expected to achieve compliance with the proposed standards, based on available test data (see Chapter 5). The remaining 35 percent of emission units are equipped with multiclones (dry) or low-energy wet scrubbers, such as rotoclones, wet multiclones, or marble-bed wet scrubbers. For the majority of emission units controlled by multiclones (dry) or low-energy wet scrubbers, emissions test data show an inability to meet the proposed MACT standards listed in Table 6.1-2.

The emission control costs presented in Table 6.1-1 are based on the cost of replacing APCDs incapable of meeting the proposed MACT standards (i.e., multiclones and low-energy wet scrubbers) with devices capable of achieving the standards (i.e., new wet scrubbers). Specifically, it was estimated that the following emission units will require replacement of existing APCDs with a new wet scrubber capable of meeting the proposed MACT standards:

- 54 ore crushing and handling emission units,
- 11 indurating furnace emission units (i.e., furnace stacks) on 4 indurating furnaces, and
- 11 pellet handling emission units.

It is anticipated that, in addition to installing any new APCDs that are required, the industry will install parametric monitoring equipment on 208 wet scrubbers, 24 ESPs, and 53 baghouses. The total capital cost of installing these devices, as well as the labor and operation and maintenance costs, are also summarized in Table 6.1-1.

Table 6.1-3 shows the EPA-estimated emission control costs and MRR costs for each of the eight taconite plants. Over 96 percent of the costs are incurred by four of the eight plants: Minntac (40.5%), National (24.5%), EVTAC (20.8%), and Northshore (10.5%). Inland, Tilden, and Empire are not projected to incur any emission control costs, although they are projected to incur MRR costs.

Table 6.1-3: Emission Control and MRR Costs for Each Taconite Plant

Plant	Emission Control Costs				Monitoring, Recordkeeping, and Reporting Costs [a]					
	(A) Total Capital Costs ($)	(B) Annualized Capital Costs [b] ($/yr)	(C) O&M Costs ($/yr)	(D) Total Annual Emission Control Costs (B + C)	(E) Total Capital Costs ($) [c]	(F) Annualized Capital Costs[b] ($/yr)	(G) Equipment O&M Costs ($/yr)	(H) MRR Labor Costs ($/yr) [d]	(I) Total Annual MRR Costs (F+G+H)	(J) Total Annual Costs (D+I)
Minntac	$19,384,350	$1,663,381	$1,177,661	$2,841,042	$ 27,901	$ 2,394	$ 1,545	$ 3,632	$ 7,571	$ 2,848,613
National	$ 9,546,810	$ 819,217	$ 879,525	$1,698,741	$ 188,180	$ 16,148	$ 0	$ 3,632	$ 19,779	$ 1,718,521
EVTAC	$11,078,935	$ 950,689	$ 470,903	$1,421,592	$ 326,346	$ 28,004	$ 5,150	$ 3,632	$ 36,785	$ 1,458,377
Northshore	$ 3,526,964	$ 302,651	$ 275,994	$ 578,645	$1,147,287	$ 98,449	$ 56,135	$ 3,632	$ 158,216	$ 736,860
Inland	$ 0	$ 0	$ 0	$ 0	$ 230,700	$ 19,797	$ 3,605	$ 3,632	$ 27,033	$ 27,033
Tilden	$ 0	$ 0	$ 0	$ 0	$ 523,395	$ 44,913	$ 22,660	$ 3,632	$ 71,204	$ 71,204
Hibbing	$ 605,990	$ 52,000	$ 32,117	$ 84,117	$ 270,979	$ 23,253	$ 0	$ 3,632	$ 26,884	$ 111,001
Empire	$ 0	$ 0	$ 0	$ 0	$ 444,375	$ 38,132	$ 12,360	$ 3,632	$ 54,124	$ 54,124
Total [e]	$44,143,050	$3,787,938	$2,836,199	$6,624,137	$3,159,163	$ 271,089	$ 101,455	$ 29,052	$ 401,596	$ 7,025,734

[a] Initial performance testing requirements are not included in these cost estimates. Performance testing will not begin until the fourth year after the MACT compliance date. However, we have estimated the initial performance testing burden to be approximately $1,256,000.

[b] Capital costs annualized over 25 years at 7%.

[c] The cost of monitoring devices is included in the capital cost of the new scrubbers for the indurating furnaces.

[d] The MRR labor cost is from the supporting statement for Standard Form 83-I. The total labor burden of $29,052 was divided by 8 to obtain the per facility cost of $3,632.

[e] Due to rounding, column totals may differ slightly from the sums of the individual line entries.

6.2 COSTS FOR ORE CRUSHING AND HANDLING EMISSION UNITS

Table 6.2-1 provides a summary of the emission control costs and the MRR costs for the ore crushing and handling (OCH) affected source. The EPA estimates that, for existing sources, the capital cost of the proposed rule for OCH emission units will be $6.3 million (includes emission control capital costs and MRR capital costs) and total annualized costs, including MRR costs, will be $951,000 per year. The costs for the OCH affected source represent approximately 13 percent of the total capital costs and 14 percent of the total annualized costs from the entire taconite iron ore processing source category. All costs are presented in first quarter, 1999 dollars and are based on the proposed MACT emission limits presented in Table 6.1-2. Ninety-nine percent of the OCH capital costs and 91 percent of the OCH total annual costs are incurred by three taconite plants: Minntac, EVTAC, and Northshore. Inland, Tilden, Hibbing, and Empire are not projected to incur any emission control costs, although they are projected to incur MRR costs.

The methodology EPA used to estimate the costs of the proposed standard for emission units within the OCH affected source is described in this section. Section 6.2.1 details the emission units that are expected to incur APCD replacement costs due to implementation of the proposed standards. Section 6.2.2 provides a detailed description of the methodology used to estimate control equipment replacement costs for emission units in the OCH affected source. Section 6.2.3 provides a description of the methodology used to estimate MRR costs for emission units in the OCH affected source.

6.2.1 Affected OCH Emission Units

The EPA anticipates that 54 of the total 264 OCH emission units will incur emission control costs as a result of the proposed rule (Table 1 of Appendix D). Of these 54 units, 17 are equipped with marble-bed scrubbers, 27 are equipped with multiclones, and 10 are equipped with rotoclones. Twenty-seven of the affected emission units are at Northshore, seventeen are at Minntac, nine are at EVTAC, and one unit is at National. Hibbing, Inland, Empire, and Tilden are not expected to incur emission control replacement costs for their ore crushing and handling units. All of the available PM emissions test data for emission units equipped with a venturi scrubber,

Table 6.2-1: Ore Crushing and Handling Emission Control and MRR Costs for Each Taconite Plant

	Emission Control Costs				Monitoring, Recordkeeping, and Reporting Costs [a]					
Facility	(A) Total Capital Costs ($)	(B) Annualized Capital Costs [b] ($/yr)	(C) O&M Costs ($/yr)	(D) Total Annual Emission Control Costs (B + C)	(E) Total Capital Costs ($)	(F) Annualized Capital Costs[b] ($/yr)	(G) Equipment O&M Costs ($/yr)	(H) MRR Labor Costs ($/yr) [c]	(I) Total Annual MRR Costs (F+G+H)	(J) Total Annual Costs (D+I)
Minntac	$1,298,682	$ 111,441	$ 102,322	$ 213,763	$ 27,901	$ 2,394	$ 1,545	$ 1,211	$ 5,150	$ 218,913
National	$ 41,878	$ 3,594	$ 4,241	$ 7,834	$ 120,435	$ 10,335	$ 0	$ 1,211	$ 11,546	$ 19,379
EVTAC	$ 715,596	$ 61,406	$ 56,369	$ 117,775	$ 273,656	$ 23,483	$ 5,150	$ 1,211	$ 29,844	$ 147,618
Northshore	$2,678,646	$ 229,856	$ 209,372	$ 439,228	$ 486,770	$ 42,027	$ 15,450	$ 1,211	$ 58,688	$ 497,916
Inland	$ 0	$ 0	$ 0	$ 0	$ 131,074	$ 11,247	$ 3,090	$ 1,211	$ 15,548	$ 15,548
Tilden	$ 0	$ 0	$ 0	$ 0	$ 221,970	$ 19,047	$ 7,210	$ 1,211	$ 27,468	$ 27,468
Hibbing	$ 0	$ 0	$ 0	$ 0	$ 112,908	$ 9,689	$ 0	$ 1,211	$ 10,900	$ 10,899
Empire	$ 0	$ 0	$ 0	$ 0	$ 143,017	$ 12,273	$ 0	$ 1,211	$ 13,484	$ 13,483
Total	$4,734,801	$ 406,296	$ 372,304	$ 778,599	$1,520,730	$ 130,495	$ 32,445	$ 9,688	$ 172,628	$ 951,227

[a] Initial performance testing requirements are not included in these estimates. Since there is a three-year compliance period, performance testing will not begin until the fourth year after the compliance date.

[b] Capital costs annualized over 25 years at 7%.

[c] The MRR labor cost is from the supporting statement for Standard Form 83-I. The total labor burden of $29,052 was divided by 8 to obtain the per facility cost of $3,632. Then $3,632 was divided by 3 to get the OCH costs.

impingement scrubber, or baghouse demonstrate that the existing controls could meet the proposed MACT standards for the OCH affected source. Therefore, no emission control costs were assigned to emission units equipped with these APCDs. Particulate matter emissions test data were not available for the two OCH emission units controlled by an ESP. The control efficiency of an ESP is expected to be the same or better than that of a venturi scrubber, impingement scrubber, or baghouse. This assumption is supported by PM emissions test data for indurating furnaces (see Chapter 5). Therefore, no emission control costs were assigned to emission units equipped with an ESP.

Particulate matter emissions data are available for 14 of the 78 OCH emission units equipped with marble-bed wet scrubbers (MBWS). The PM test data for 3 of the 14 tested emissions units (21.4%) demonstrate that the units would not meet the proposed MACT emission limits for OCH. Therefore, EPA anticipates that emission control costs for OCH emission units equipped with MBWS will be incurred by a proportional number, or 17, of the total 78 units [(78 units)*(0.214)=17 units].

Particulate matter emissions data are available for only 2 of the 28 OCH emission units equipped with multiclones. One of these is a primary crushing conveyor at National, which has been tested at 0.0783 gr PM/dscf, a value well above the proposed standard. Consequently, control equipment costs were assigned to this unit. The other multiclone-equipped OCH emission unit that has been tested is a tertiary storage bin at Northshore, which has been tested at 0.0058 gr/dscf. Because this value is below the proposed standard, control equipment costs were not assigned to this unit. The 26 other OCH emission units at Northshore that are equipped with multiclones include the primary crusher, four secondary crushers, and 21 storage bins for material at various stages of crushing. Due to differences in the types of emission units, it was determined that the PM emissions test results from the tested tertiary storage bin are not comparable to the other units. Therefore, in the absence of representative test data for these 26 OCH emission units at Northshore, EPA has chosen to take the conservative approach of assigning control equipment costs to all of them.

Particulate matter emissions data are available for 7 of the 23 OCH emission units equipped with rotoclones. The PM emission concentrations for the 16 emission units without test data were estimated using data from similar units within the tested units. Based on this data, EPA estimates that 10 of the 23 emission units equipped with rotoclones will incur emission control costs.

All 264 emission units in the OCH affected source are subject to the monitoring requirements in the proposed rule. Minntac is the only company that has already installed monitoring equipment capable of meeting the proposed MACT standards on its 84 wet scrubbers. Therefore, a total of 180 OCH emission units (264 - 84 = 180) are expected to incur monitoring equipment capital costs as a result of the proposed MACT standards (see Table 2, Appendix D).

6.2.2 Cost Methodology for OCH Control Equipment

As mentioned in Section 6.2.1, EPA anticipates that 54 OCH emission units will incur emission control costs as a result of the proposed rule (See Table 1, Appendix D). These costs will come from replacing existing PM emission control equipment that is incapable of meeting the proposed MACT standards with new emission control equipment that can meet the standards. To determine what type of emission control equipment should be installed, EPA contacted two principle vendors of PM control equipment to the taconite iron ore industry–Sly, Inc. and Ducon Technologies, Inc. Each vendor was asked to provide costs and operational data for air pollution control equipment capable of achieving an outlet loading of 0.005 gr PM/dscf with an inlet loading of 0.05 gr PM/dscf and a median inlet particle size (diameter) around 22 microns. A PM emissions level somewhat below the proposed MACT emission limit of 0.008 gr PM/dscf was chosen in order to provide a margin for fluctuations in performance. The vendors were asked to provide costs for emission controls capable of operating at a volumetric flow rate of 15,000 acfm, 30,000 acfm, and 70,000 acfm. Both companies provided equipment costs for venturi scrubbers and impingement scrubbers of the designated sizes. A summary of the vendor-supplied control costs is provided in Table 6.2-2.[3,4]

Table 6.2-2: Vendor-Supplied Control Equipment Costs for OCH Emission Units (2001 dollars)

Air Flow Rate (acfm)	Sly, Inc.		Ducon Technologies, Inc.		
	Impinjet wet scrubber	Venturi Rod wet scrubber	UW-4 Impingement wet scrubber	VVO Venturi wet scrubber	A33 Venturi Rod wet scrubber
15,000	$ 22,500	$ 18,300	$26,000*	$ 10,000	$ 18,100
30,000	$41,700*	$ 30,700	$ 36,000	$ 16,000	$ 25,000
70,000	$79,300*	$ 58,400	$ 68,000	$ 24,000	$ 48,000

* Values selected for use in the cost estimates.

In general, the equipment cost of impingement type scrubbers is higher than that of venturi type scrubbers. However, the venturi type scrubbers have higher operational costs as a result of operating the fan to maintain a higher pressure drop across the equipment and a higher water-to-gas ratio for scrubbing water. The EPA selected the highest control equipment costs for all three sizes (note the values marked with an asterisk in Table 6.2-2). Due to this costing strategy, which is designed to provide a conservatively high estimate of control equipment costs, all OCH control equipment costs are anticipated to result from equipping emission units with impingement scrubbers. However, facilities are free to choose to install the less-expensive venturi type scrubbers in accordance with their compliance plans.

The total capital investment (i.e., equipment costs plus installation costs) for each of the selected impingement scrubbers was calculated using the procedures in the EPA's "Control Technologies for Hazardous Air Pollutants Handbook".[1] The factors listed in Table 6.2-3 were applied to account for direct and indirect installation costs based on the purchased equipment cost (the equipment cost adjusted to include the costs of sales tax and shipping). As noted, these factors apply to wet scrubbers in general, not just impingement scrubbers.

Table 6.2-3: Capital Cost Factors for Wet Scrubbers [1]

Cost Item	EPA Installation Factor
Purchased Equipment Costs (PEC)	1.08 of equipment cost
Sales tax	0.03 of equipment cost
Freight	0.05 of equipment cost
Direct Installation Costs	0.66 of PEC
Removal of old equipment	0.10 of PEC
Foundation and supports	0.06 of PEC
Erection and handling	0.40 of PEC
Electrical	0.01 of PEC
Piping	0.05 of PEC
Insulation	0.03 of PEC
Painting	0.01 of PEC
Indirect Installation Costs	0.35 of PEC
Engineering	0.10 of PEC
Construction	0.10 of PEC
Contractor fee	0.10 of PEC
Start-up	0.01 of PEC
Performance test	0.01 of PEC
Contingency	0.03 of PEC
Total Capital Investment	2.01 of PEC (1 + 0.66 + 0.35)

The baseline year chosen for the cost analysis is 1999. Therefore, the total capital costs, which were derived from purchased equipment costs in 2001 dollars, were adjusted downward to 1999 dollars. The EPA's Vatavuk Air Pollution Control Cost Indexes (VAPCCI)[5] are not available for years after 1999. Thus, it was assumed that environmental control costs have increased by 3 percent per year. The resulting capital costs adjusted to 1999 dollars are shown in Table 6.2-4, column B for all three models.

Table 6.2-4: Capital Costs and Cost-per-unit-flow for Selected Impingement Scrubber Models

Model Control Equipment Used as Basis of Costs	(A) Air Flow Rate (acfm)	(B) Adjusted Capital Cost (1999 dollars)	(C) Cost per unit flow ($/acfm) [B/A]	(D) Flow Range (acfm)
Model 1: Ducon UW-4 Impingement	15,000	$53,105	$3.54	0 to 22,500
Model 2: Sly Impinjet	30,000	$85,172	$2.84	22,501 to 50,000
Model 3: Sly Impinjet	70,000	$161,971	$2.31	50,001 or greater

To apply the vendor-supplied cost estimates to all emission points in the OCH affected source, EPA assumed a direct relationship between the volumetric flow rate of an emission unit and the capital cost of an impingement scrubber. For each of the three control equipment sizes, the capital cost was divided by the corresponding volumetric flow rate (acfm) to yield a cost-per-unit-flow in dollars per acfm (see Table 6.2-4, column C).

The volumetric flow rate for the exhaust of each emission unit in the OCH affected source was obtained either from Title V operating permit applications or from available source test reports. To account for the maximum possible volumetric flow rate from each emission unit, the reported volumetric flow rate was increased by a factor of 20 percent. This adjusted volumetric flow rate was used as the design flow rate for the new impingement scrubber. The capital cost of installing a new impingement scrubber on each affected emission unit was calculated by multiplying the adjusted volumetric flow rate by the cost-per-unit-flow for the appropriate scrubber model. Column D of Table 6.2-4 shows the range of volumetric flow rates to which each cost-per-unit-flow was applied. The impingement scrubber capital costs were annualized based on an interest rate of 7 percent and an equipment lifetime of 25 years, yielding a capital recovery factor (CRF) of 0.086. A summary of the total capital investment and annualized capital costs for each affected emission unit in the OCH affected source is provided in Table 1 of Appendix D.

Using the procedures in the EPA's "Control Technologies for Hazardous Air Pollutants Handbook,"[1] direct and indirect annual O&M costs were calculated for each of the three model impingement scrubbers. All of the assumptions and values used to determine the annual costs are provided in Table 3 of Appendix D. Since each of the affected emission units was already equipped with an emission control device (i.e., a rotoclone, multiclone, or wet scrubber), each facility with an affected emission unit was already incurring a baseline level of O&M costs. Therefore, the annual O&M cost impacts are based only on the incremental change in annual O&M costs resulting from the installation of new impingement scrubbers. Each existing APCD was assumed to be operating 8,760 hours per year (24 hours per day for 365 days per year) at a baseline pressure drop of 3.0 inches of water.

Direct annual costs include utility costs, operating labor costs, maintenance costs, and wastewater treatment costs. It is expected that the proposed rule will result in a small increase in electricity usage corresponding to the operation of larger fans in the new impingement scrubbers. Larger fans are required to maintain a higher pressure drop (around 4.5 to 5.5 inches of water) across an impingement scrubber compared to the pressure drop (around 3.0 inches of water) for the rotoclones and multiclones currently used. Thus, the additional electricity required to operate impingement scrubbers is based on the net pressure drop differences of 2.0, 1.5, and 2.5 inches of water for scrubber models 1, 2 and 3, respectively. Additional water consumption and wastewater treatment will not result in any costs incurred because the scrubbing water is obtained from and returned to ore tailings basins. No additional operating or supervisory labor costs are expected above those currently associated with existing APCDs. In addition, no additional maintenance labor or material costs are anticipated to result from the proposed rule.

Indirect annual costs include overhead costs, administrative costs, insurance costs, and property taxes. Overhead costs are calculated as 60 percent of the operating labor and maintenance costs. Since the operating labor and maintenance costs are zero, the overhead costs are also zero. The other indirect annual costs were calculated as a percent of the total capital costs, as indicated in Table 3 of Appendix D.

The total annual O&M costs for each model scrubber were divided by the model's flow rate to yield a total annual cost-per-unit-flow in dollars per acfm. The adjusted flow rate of each emission unit of the OCH affected source was multiplied by the total annual cost-per-unit-flow of the appropriate scrubber model to estimate the annual O&M costs. The results are shown in column C of Table 6.2-1.

6.2.3 Cost Methodology for Monitoring Equipment

The proposed standards require continuous monitoring of all applicable control equipment. For wet scrubbers, the proposed standards require a continuous parameter monitoring system (CPMS) for the following operating parameters: volumetric flow rate of exhaust gas (acfm), pressure drop across the device (inches of water), and volumetric flow rate of scrubbing liquid (gallons per minute). For baghouses, the proposed standards require a bag leak detector system. For ESPs, the proposed standards require a continuous opacity monitoring system (COMS). As stated earlier, 264 OCH emission units are subject to the monitoring requirements in the proposed rule, and only Minntac has already installed monitoring equipment on 84 wet scrubbers. Therefore, of the total 264 OCH emission units, 180 are expected to incur monitoring equipment capital costs.

The EPA prepared estimates of capital and O&M costs associated with the required monitoring equipment on wet scrubbers, baghouses, and ESPs. The number of affected devices was multiplied by the unit capital cost of each monitoring device to obtain the total capital costs. The annualized capital cost is based on an interest rate of 7 percent and an equipment lifetime of 25 years, which yields a capital recovery factor (CRF) of 0.086. The number of affected control devices was multiplied by the unit O&M costs of each monitoring device to obtain the total monitoring equipment O&M costs. The total annualized monitoring costs for OCH are shown in

Table 6.2-5. This cost does not include the recordkeeping and reporting labor. The total MRR costs are shown in column H of Table 6.2-1.

Table 6.2-5: Monitoring Equipment Costs for Emission Units in the OCH Affected Source

Type of Control Device	Type of Monitoring Equipment	(A) Number of Monitors[a]	(B) Capital Cost per Monitor ($)	(C) O & M Costs per Monitor ($/yr)	(D) Total Capital Cost (A x B)	(E) Total Annualized Capital Cost (D x 0.086[a])	(F) Total O&M Costs[c] (A x C)	(G) Total Annual Cost for Monitoring (E + F)
Scrubber	CPMS[d]	127	$7,527	$0	$955,955	$82,030	$0	$82,030
Baghouse	Bag leak Detector[e]	51	$9,300	$515	$474,314	$40,701	$26,265	$66,966
ESP	COMS[f]	2	$45,231	$3,090	$90,461	$7,764	$6,180	$13,944
Total		180			$1,520,730	$130,495	$32,445	$162,940

[a] The number of monitors excludes the monitors already in place on wet scrubbers at Minntac.

[b] Cost recovery factor (CRF) of annualizing capital costs at 7% over 25 years.

[c] O&M costs based on 1998 estimates from coke ovens, scaled to 1999 using a 3% increase.

[d] Continuous Parameter Monitoring System (CPMS) which monitors water flow rate and pressure drop. Cost information provided by Ducon, a control device vendor. Scaled from 2001 dollars to 1999 dollars assuming a 3 % annual increase.

[e] Bag leak detector cost based on Coke Ovens BID. Originally in 1998 dollars, scaled to 1999 dollars using the VAPCCI average for fabric filters for the first quarter of 1998 and the first quarter of 1999.

[f] Continuous Opacity Monitoring System based on Section 114 response from coke ovens. Originally 1998 dollars, scaled to 1999 dollars using the VAPCCI factor for average ESP.

6.3 COSTS FOR INDURATING FURNACES

Table 6.3-1 provides a summary of the emission control costs and the monitoring, recordkeeping, and reporting costs for the indurating furnace affected source. The EPA estimates that, for existing sources, the capital cost of the proposed rule for indurating furnaces will be $39.4 million (includes emission control capital costs and MRR capital costs); the total annualized costs, including monitoring, recordkeeping, and reporting (MRR) costs, will be $5,830,687 per year. The costs from indurating furnaces represent approximately 83 percent of the total capital costs and 83 percent of the total annualized costs from the entire industry. All costs are presented in first quarter, 1999 dollars and are based on the proposed limits presented in Table 6.1-2.

Ninety-nine percent of the indurating furnace capital costs and 96 percent of the indurating furnace annualized costs are incurred by Minntac, National, and EVTAC. Northshore, Inland, Tilden, and Empire are not projected to incur any emission control costs, although they are projected to incur MRR costs. Hibbing is projected to incur minimal indurating-furnace-related emission control costs compared to Minntac, National, and EVTAC.

The methodology used to estimate the costs of the proposed standard for emission units within the indurating furnace affected source is described in this section. Section 6.3.1 identifies the number of emission units that are expected to incur costs due to implementation of the proposed standards. Section 6.3.2 provides a detailed description of the methodology used to estimate control costs for emission units in the indurating furnace affected source. Finally, Section 6.3.3 provides a description of the methodology used to estimate monitoring costs for emission units in the indurating furnace affected source.

Table 6.3-1: Indurating Furnace Emission Control and MRR Costs for Each Taconite Plant

	Emission Control Costs				Monitoring, Recordkeeping, and Reporting Costs [a]					
Facility	(A) Total Capital Costs ($)	(B) Annualized Capital Costs[b] ($/yr)	(C) O&M Costs ($/yr)	(D) Total Annual Emission Control Costs (B + C)	(E) Total Capital Costs[c] ($)	(F) Annualized Capital Costs[b] ($/yr)	(G) Equipment O&M Costs ($/yr)	(H) MRR Labor Costs[d] ($/yr)	(I) Total Annual MRR Costs (F+G+H)	(J) Total Annual Costs (D+I)
Minntac	$18,085,668	$1,551,941	$1,075,338	$2,627,279	$ 0	$ 0	$ 0	$ 1,211	$ 1,211	$ 2,628,490
National	$9,420,072	$ 808,341	$ 866,691	$1,675,033	$ 0	$ 0	$ 0	$ 1,211	$ 1,211	$ 1,676,244
EVTAC	$10,363,340	$ 889,284	$ 414,534	$1,303,817	$ 7,527	$ 646	$ 0	$ 1,211	$ 1,857	$ 1,305,674
Northshore	$ 0	$ 0	$ 0	$ 0	$ 587,999	$ 50,456	$ 40,170	$ 1,211	$ 91,837	$ 91,837
Inland	$ 0	$ 0	$ 0	$ 0	$ 30,109	$ 2,584	$ 0	$ 1,211	$ 3,795	$ 3,795
Tilden	$ 0	$ 0	$ 0	$ 0	$ 226,153	$ 19,406	$ 15,450	$ 1,211	$ 36,067	$ 36,067
Hibbing	$ 401,576	$ 34,459	$ 16,063	$ 50,522	$ 90,326	$ 7,751	$ 0	$ 1,211	$ 8,962	$ 59,484
Empire	$ 0	$ 0	$ 0	$ 0	$ 180,923	$ 15,525	$ 12,360	$ 1,211	$ 29,096	$ 29,096
Total	$38,270,656	$3,284,025	$2,372,626	$5,656,651	$1,123,037	$ 96,368	$ 67,980	$ 9,688	$ 174,036	$ 5,830,687

[a] Initial performance testing requirements are not included in these estimates. Since there is a three-year compliance period, performance testing will not begin until the fourth year after the compliance date.

[b] Capital costs annualized over 25 years at 7%.

[c] The cost of monitoring devices is included in the capital cost of the new scrubbers for the indurating furnaces.

[d] The MRR labor cost is from the supporting statement for Standard Form 83-1. The total labor burden of $29,052 was divided by 8 to obtain the per facility cost of $3,632.Then $3,632 was divided by 3 to get the indurating costs.

6.3.1 Affected Emission Units

It is anticipated that six indurating furnaces will incur emission control costs as a result of the proposed rule (see Table 4, Appendix D). These six are Minntac Line 3, Minntac Line 6, Minntac Line 7, EVTAC Line 2, Hibbing Line 3, and National Line 2. Empire, Inland, Northshore, and Tilden are not expected to incur emission control costs related to their indurating furnaces. Since some of the affected furnaces have multiple stacks and controls, a total of 11 control devices will have to be replaced or upgraded to comply with the proposed rule. Included in these 11 control devices are three multiclones and eight venturi scrubbers. Three of the affected control devices are at Minntac, two are at EVTAC, four are at Hibbing, and two are at National.

Actual PM emissions test data are available for each indurating furnace used in the taconite industry (21 indurating furnaces total). Therefore, the actual PM emissions test data were used for each furnace to determine whether or not the furnace was capable of meeting the proposed MACT standards.

6.3.2 Cost Methodology for Control Equipment

As mentioned in Section 6.3.1, EPA anticipates that 11 indurating furnace emission control devices will need to be replaced or upgraded as a result of the proposed rule (see Table 4, Appendix D). The emission control costs for the seven affected devices on Minntac Line 3, Minntac Line 6, Minntac Line 7, EVTAC Line 2, and National Line 2 were based on the installation of new venturi wet scrubbers. Based on written comments received from Hibbing, the costs for the four affected devices on Hibbing Line 3 were based on upgrading rather than replacing the existing equipment.[6]

The capital costs of a new venturi scrubber were based on cost estimates provided by Minntac.[7] The cost estimates represent equipment costs and both direct and indirect installation costs incurred by Minntac in 1991 for two new venturi scrubbers, one each for furnace lines 4 and 5. This cost estimate included the cost of removing the existing control equipment. Minntac's costs were divided by two to estimate the capital costs of installing one scrubber (Table 6.3-2). Initially, the total capital investment was adjusted from first quarter 1991 dollars to first quarter 1994 dollars using the average annual percent increase from 1994 to 1999, as determined using the Vatavuk Air Pollution Control

Cost Indexes (VAPCCI) for large wet scrubbers. The figure was then scaled from first quarter 1994 dollars to first quarter 1999 dollars using the VAPCCI factor for large wet scrubbers.

Table 6.3-2: Capital Costs for One Venturi Scrubber

Cost Item	Cost
A. Equipment Cost (1991 dollars)	$1,100,400
B. Direct Installation Cost (1991 dollars)	$3,972,250
C. Total Direct Cost (A+B) (1991 dollars)	$5,072,650
D. Indirect Installation Cost (1991 dollars)	$756,500
E. Total Capital Investment (C+D) (1991 dollars)	$5,829,150
F. Total Capital Investment (1999 dollars)	$6,714,378

The capital costs for installing a new venturi scrubber for the seven affected emission units on Minntac Line 3, Minntac Line 6, Minntac Line 7, EVTAC Line 2, and National Line 2 were estimated by scaling the Minntac scrubber costs up or down based on the ratio of the exhaust gas volume of the indurating furnaces. A power of six scaling assumption was used in scaling the costs. The upgrade costs for Hibbing Line 3 were based on estimates provided by the plant for replacing the following items: pre-demist panels, de-mist panels, venturi rod deck, spray padding, and spray nozzles.[6] The upgrade also included the addition of upper and lower distribution baffles. The total annual capital costs for all affected units were annualized based on an interest rate of 7 percent and an equipment lifetime of 25 years. The total capital costs and annualized capital costs are shown in columns A and B of Table 6.3-1.

Annual operation and maintenance (O&M) costs were calculated for each of the new venturi scrubbers using the procedures in the EPA's "Control Technologies for Hazardous Air Pollutants Handbook"[1]. The only exception was for Minntac Line 3; in this case, Minntac provided an estimate of the total O&M labor costs.[8] All of the assumptions and values used to determine the annual costs are provided in Table 5 of Appendix D. Since each of the affected emission units was already equipped with an emission control device (i.e., a multiclone or venturi scrubber), each facility was already incurring a baseline level of O&M costs. Therefore, the annual O&M cost impacts were based only on the incremental change in annual O&M costs resulting from the installation of new venturi scrubbers. Each existing multiclone was assumed to be operating at a baseline pressure drop of 4 inches of water, and each existing venturi scrubber was assumed to be operating at a baseline pressure drop of 10 inches of water. The new venturi scrubbers are assumed to have a pressure drop of 10 inches of water. The operating hours for Minntac Line 3 and for National Line 2 were based on estimates provided by the plants. All other affected emission units were assumed to operate 8,760 hours per year.

It is expected that, for stacks currently equipped with a multiclone, the proposed rule will result in an increase in electricity usage–an increase directly related to the operation of larger fans for the new venturi scrubbers. Larger fans are needed to maintain a higher pressure drop (around 10 inches of water) across a venturi scrubber compared to the pressure drop typically associated with the currently used multiclones (around 4 inches of water). Since both existing and new venturi scrubbers have an estimated pressure drop of 10 inches of water, there is no anticipated increase in energy requirements for emission units already equipped with venturi scrubbers.

It was assumed that no additional water consumption costs or wastewater treatment costs will be incurred because all the scrubbing water will be taken from and returned to tailings basins. Additional operating or supervisory labor costs, as well as maintenance labor or material costs, are anticipated only for those units currently equipped with multiclones. Indirect annual costs, which include administrative costs, insurance costs, and property taxes, were calculated as a percent of the total capital costs, as shown in Table 5 of Appendix D. All of the affected emission units are expected to incur indirect annual costs. The estimated annual operation and maintenance costs are presented in column C of Table 6.3-1.

6.3.3 Cost Methodology for Monitoring Equipment

The proposed standards require continuous monitoring of all applicable control equipment. For wet scrubbers, the proposed standards require a continuous parameter monitoring system (CPMS) for the following operating parameters: volumetric flow rate of exhaust gas (acfm), pressure drop across the device (inches of water), and volumetric flow rate of scrubbing liquid (gallons per minute). For ESPs, the proposed standards require a continuous opacity monitoring system (COMS). All 47 indurating furnace emission units (stacks) are subject to the monitoring requirements in the proposed rule. Minntac has already installed monitoring equipment on its five units. Also, EPA assumes that the costs of the new venturi scrubbers that are replacing the three multiclones (discussed in Section 6.3.1) include the costs of associated monitoring equipment. Therefore, it is anticipated that a total of 39 indurating furnace emission units will incur monitoring equipment capital costs.

Next, the EPA prepared estimates of capital and O&M costs associated with the required monitoring equipment on wet scrubbers and ESPs. The number of controls were multiplied by the capital cost of each monitoring device to obtain the total capital costs. The annualized capital cost is based on an interest rate of 7 percent and an equipment lifetime of 25 years. The number of controls were multiplied by the O&M costs of each monitoring device to obtain the monitoring equipment O&M costs. The total annual monitoring costs for indurating furnaces are shown in Table 6.3-3 and are summarized by plant in columns E, F, and G of Table 6.3-2. These costs do not include the recordkeeping and reporting labor costs. The MRR labor costs are presented in column H of Table 6.2-1.

Table 6.3-3: Monitoring Costs for Indurating Furnaces

Type of Control Device	Type of Monitoring Equipment	(A) Number of Monitors[a]	(B) Capital Cost per Monitor ($)	(C) O & M Costs per Monitor ($/yr)	(D) Total Capital Cost (A x B)	(E) Total Annualized Capital Cost (D x 0.086[b])	(F) Total O&M Costs[c] (A x C)	(G) Total Annual Cost for Monitoring (E + F)
Scrubber	CPMS[d]	17	$7,527.20	$0	$127,962	$10,980	$0	$10,980
ESP	COMS[e]	22	$45,230.67	$3,090	$995,075	$85,388	$67,980	$153,368
Total		39			$1,123,037	$96,368	$67,980	$164,348

[a] The number of monitors does not include the monitors already in place at Minntac.

[b] Cost recovery factor (CRF) of annualizing capital costs at 7% over 25 years.

[c] O&M costs based on 1998 dollar estimates from coke ovens, scaled to 1999 dollars using a 3% annual increase.

[d] Continuous Parameter Monitoring System (CPMS,) which monitors water flow rate and pressure drop. Cost information provided by Ducon, a control device vendor. Scaled from 2001 dollars to 1999 dollars assuming a 3% annual increase.

[e] Continuous Opacity Monitoring System (COMS) based on Section 114 response from coke ovens. Originally 1998 dollars, scaled to 1999 dollars using the VAPCCI factor for average ESP.

6.4 COSTS FOR FINISHED PELLET HANDLING EMISSION UNITS

Table 6.4-1 provides a summary of the emission control costs and the monitoring, recordkeeping, and reporting costs for the finished pellet handling (PH) affected source. The EPA estimates that, for existing sources, the capital cost of the proposed rule for PH emission units will be $1.6 million (includes emission control capital costs and MRR capital costs) and total annualized costs, including monitoring, recordkeeping, and reporting (MRR) costs, will be $241,893 per year. The costs associated with PH emission units represent approximately 3 percent of the total capital costs and 4 percent of the total annualized costs from the entire industry. All costs are presented in first quarter 1999 dollars and are based on the proposed limits presented in Table 6.1-2. All of the PH emission unit capital costs and 90 percent of the PH emission unit annual costs are incurred by National, Northshore, and Hibbing. Minnac, EVTAC, Inland, Tilden, and Empire are not projected to incur any PH emission control costs associated with the proposed rule, although they are projected to incur associated MRR costs.

The methodology used to estimate the costs of the proposed standard for emission units within the PH affected source is described in this section. Section 6.4.1 identifies the PH emission units that are expected to incur costs due to implementation of the proposed standards. Section 6.4.2 provides a detailed description of the methodology used to estimate control equipment costs for emission units in the PH affected source. Finally, Section 6.4.3 provides a description of the methodology used to estimate monitoring, recordkeeping, and reporting costs for emission units in the PH affected source.

6.4.1 Affected Emission Units

It is anticipated that 11 PH emission units will incur emission control costs as a result of the proposed rule (see Table 1, Appendix D). Included in these 11 emission units are eight rotoclones and three impingement scrubbers. Eight of the affected units are at Northshore, two are at Hibbing, and one is at National. Finished pellet handling emission units at Inland, Empire, EVTAC, Minntac, and Tilden are not expected to incur emission control costs.

Only one PM emissions test is available for a PH emission unit controlled by a venturi scrubber. The emissions from this unit are at the proposed PH emission limit of 0.008 gr PM/dscf. For additional data, we looked at the 14 PM emissions tests available for OCH units controlled by a venturi scrubber. All 14 of these tests showed emission rates at or below the proposed limit. Based on these 15 data points, we concluded that emission units controlled by a venturi scrubber will be able to comply with the standard, and therefore, will not incur emission control costs. Eleven PM emissions tests are available for PH emission units equipped with impingement scrubbers; eight of these tests demonstrate the capability of meeting the proposed standards. Based on this data and the fact that all OCH emission units equipped with impingement scrubbers could meet the standards, all of the impingement scrubbers were considered to be capable of meeting the standards, except for the three units whose test data indicated otherwise. Particulate matter emissions tests were not available for the two PH emission units equipped with a baghouse. The control efficiency of a baghouse would be expected to be the same as or better than that of a venturi scrubber. This assumption is supported by the PM emissions test data for OCH. Therefore, no emission control costs were assigned to the two PH emission units equipped with baghouses.

Table 6.4-1: Pellet Handling Emission Control and MRR Costs for Each Taconite Plant

	Emission Control Costs				Monitoring, Recordkeeping, and Reporting Costs [a]					
Facility	(A) Total Capital Costs ($)	(B) Annualized Capital Costs[b] ($/yr)	(C) O&M Costs ($/yr)	(D) Total Annual Emission Control Costs (B + C)	(E) Total Capital Costs ($)	(F) Annualized Capital Costs[b] ($/yr)	(G) Equipment O&M Costs ($/yr)	(H) MRR Labor Costs[c] ($/yr)	(I) Total Annual MRR Costs (F+G+H)	(J) Total Annual Costs (D+I)
Minntac	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 1,211	$ 1,211	$ 1,211
National	$ 84,861	$ 7,282	$ 8,593	$ 15,875	$ 67,745	$ 5,813	$ 0	$ 1,211	$ 7,024	$ 22,899
EVTAC	$ 0	$ 0	$ 0	$ 0	$ 45,163	$ 3,876	$ 0	$ 1,211	$ 5,087	$ 5,087
Northshore	$ 848,318	$ 72,795	$ 66,623	$ 139,417	$ 69,518	$ 5,966	$ 515	$ 1,211	$ 7,692	$ 147,109
Inland	$ 0	$ 0	$ 0	$ 0	$ 69,518	$ 5,965	$ 515	$ 1,211	$ 7,691	$ 7,691
Tilden	$ 0	$ 0	$ 0	$ 0	$ 52,690	$ 4,521	$ 0	$ 1,211	$ 5,732	$ 5,732
Hibbing	$ 204,414	$ 17,541	$ 16,054	$ 33,594	$ 67,745	$ 5,813	$ 0	$ 1,211	$ 7,024	$ 40,618
Empire	$ 0	$ 0	$ 0	$ 0	$ 120,435	$ 10,335	$ 0	$ 1,211	$ 11,546	$ 11,546
Total	$1,137,592	$ 97,617	$ 91,269	$ 188,887	$ 492,814	$ 42,289	$ 1,030	$ 9,688	$ 53,007	$ 241,893

[a] Initial performance testing requirements are not included in these estimates. Since there is a three-year compliance period, performance testing will not begin until the fourth year after the compliance date.

[b] Capital costs annualized over 25 years at 7%.

[c] The MRR labor cost is from the supporting statement for Standard Form 83-I. The total labor burden of $29,052 was divided by 8 to obtain the per facility cost of $3,632. Then $3,632 was divided by 3 to get the PH costs.

Of the nine PH emission units equipped with rotoclones, particulate matter emissions test data are available for only one. This emission unit has PM emissions of 0.0092 gr PM/dscf, which is above the proposed MACT level of 0.008 gr PM/dscf. Based on this data and the fact that rotoclones are low-energy devices, it was assumed that all PH emission units equipped with rotoclones will be unable to comply with the standard and will incur emission control costs.

All 82 PH emission units are subject to the monitoring requirements in the proposed rule. However, Minntac already has monitoring equipment installed on its 17 wet scrubbers. Therefore, 65 PH emission units (82 - 17 = 65) are expected to incur monitoring equipment capital costs as a result of the rule (see Table 2, Appendix D).

6.4.2 Cost Methodology for Control Equipment

As mentioned in Section 6.4.1, EPA anticipates that 11 PH emission units will incur emission control costs as a result of the proposed rule (see Table 1, Appendix D). These emission control costs will result from replacing existing PM emission control equipment that is incapable of meeting the proposed standards with new emission control equipment that can meet the standards. To determine what type of emission control equipment should be installed, EPA contacted the two principle vendors of wet scrubbers to the taconite iron ore industry - Sly, Inc. and Ducon Technologies, Inc. Each vendor was asked to provide costs and operational data for air pollution control equipment capable of achieving an outlet loading of 0.005 gr PM/dscf with an inlet loading of 0.05 gr PM/dscf and a median inlet particle size (diameter) around 22 microns. A PM emissions level somewhat below the proposed MACT emission limit of 0.008 gr PM/dscf was chosen in order to provide a margin for fluctuations in performance. The vendors were asked to provide costs for emission control equipment capable of operating at a volumetric flow rate of 15,000 acfm, 30,000 acfm, and 70,000 acfm. Both companies provided equipment costs for three sizes of venturi scrubbers and three sizes of impingement scrubbers. A summary of the vendor-supplied control costs is provided in Table 6.4-2.[3,4]

Table 6.4-2: Vendor-Supplied Control Equipment Costs for PH Emission Units (2001 dollars)

Air Flow Rate (acfm)	Sly, Inc.		Ducon Technologies, Inc.		
	Impinjet wet scrubber	Venturi Rod wet scrubber	UW-4 Impingement wet scrubber	VVO Venturi wet scrubber	A33 Venturi Rod wet scrubber
15,000	$ 22,500	$ 18,300	$26,000*	$ 10,000	$ 18,100
30,000	$41,700*	$ 30,700	$ 36,000	$ 16,000	$ 25,000
70,000	$79,300*	$ 58,400	$ 68,000	$ 24,000	$ 48,000

* Values selected for use in the cost estimates.

In general, the equipment cost of impingement type scrubbers is higher than that of venturi type scrubbers. However, the venturi type scrubbers have higher operational costs as a result of operating the fan to maintain a higher pressure drop across the equipment and a higher water-to-gas ratio for scrubbing water. The EPA selected the highest control equipment costs for all three sizes (note the values marked with an asterisk in Table 6.4-2). Due to this costing strategy, which is designed to provide a conservatively high estimate of control equipment costs, all PH control equipment costs are anticipated to result from equipping emission units with impingement scrubbers. However, facilities are free to choose to install the less-expensive venturi type scrubbers in accordance with their compliance plans.

The total capital investment (i.e., equipment costs plus installation costs) for each of the selected impingement scrubbers was calculated using the procedures in the EPA's "Control Technologies for Hazardous Air Pollutants Handbook".[1] See Table 6.2-3 for a list of the factors that were applied to account for direct and indirect installation costs.

The baseline year chosen for the cost analysis is 1999. Therefore, the total capital costs, which were derived from purchased equipment costs provided in 2001 dollars, were adjusted downward to 1999 dollars. The EPA's Vatavuk Air Pollution Control Cost Indexes (VAPCCI)[5] are not available for years after 1999. Thus, it was assumed that environmental control costs have increased by only 3 percent per year. The resulting capital costs adjusted to 1999 dollars are shown in Table 6.2-4, column B for all three models.

To apply the vendor-supplied cost estimates to all affected emission points in the PH affected source, EPA assumed a direct relationship between the volumetric flow rate of an emission unit and the capital cost of an impingement scrubber. For each of the three control equipment sizes, the capital cost was divided by the corresponding volumetric flow rate (acfm) to yield a cost-per-unit-flow in dollars per acfm (see Table 6.2-4, column C).

The volumetric flow rate for the exhaust of each affected emission unit in the PH affected source was obtained either from Title V operating permit applications or from available source test reports. To account for the maximum possible volumetric flow rate from each emission point, the reported volumetric flow rate was increased by a factor of 20 percent. This adjusted volumetric flow rate was used as the design flow rate for the new impingement scrubber. The capital cost of installing a new impingement scrubber on each affected emission unit was calculated by multiplying the adjusted volumetric flow rate by the cost-per-unit-flow for the appropriate scrubber model. Column D of Table 6.2-4 shows the range of volumetric flow rates to which each cost-per-unit-flow was applied. The impingement scrubber capital costs were annualized based on an interest rate of 7 percent and an equipment lifetime of 25 years, yielding a capital recovery factor (CRF) of 0.086. A summary of the total capital investment and annualized capital costs for each affected emission unit in the PH affected source is provided in Table 1 of Appendix D.

Annual operation and maintenance (O&M) costs were calculated for each of the model impingement scrubbers using the procedures in the EPA's "Control Technologies for Hazardous Air Pollutants Handbook".[1] All of the assumptions and values used to determine the annual costs are provided in Table 3 of Appendix D. Since each of the affected emission units was already equipped with an emission control device (i.e., a rotoclone, multiclone, or wet scrubber) each facility with an affected emission unit was already incurring a baseline level of O&M costs. Therefore, the annual O&M cost impacts were based only on the incremental change in annual O&M costs resulting from the installation of new impingement scrubbers. Each existing APCD was assumed to be operating 8,760 hours per year (24 hours per day for 365 days per year) at a baseline pressure drop of 3 inches of water.

Direct annual costs include utility costs, operating labor costs, maintenance costs, and wastewater treatment costs. It is expected that the proposed rule will result in a small increase in electricity usage corresponding to the operation of larger fans in the new impingement scrubbers. Larger fans are required to maintain a higher pressure drop (around 4.5 to 5.5 inches of water) across an impingement scrubber compared to the pressure drop (around 3.0 inches of water) for the rotoclones and multiclones currently used. Thus, the additional electricity required to operate impingement scrubbers is based on the net pressure drop differences of 2.0, 1.5, and 2.5 inches of water for scrubber models 1, 2 and 3, respectively. Additional water consumption and wastewater treatment will not result in any costs incurred because the scrubbing water is obtained from and returned to ore tailings basins. No additional operating or supervisory labor costs are expected above those currently associated with existing APCDs. In addition, no additional maintenance labor or material costs are anticipated to result from the proposed rule.

Indirect annual costs include overhead costs, administrative costs, insurance costs, and property taxes. Overhead costs are calculated as 60 percent of the operating labor and maintenance costs. Since the operating labor and maintenance costs are zero, the overhead costs are also zero. The other indirect annual costs were calculated as a percent of the total capital costs, as indicated in Table 3 of Appendix D.

The total annual O&M costs for each model scrubber were divided by the model's flow rate to yield a total annual cost-per-unit-flow in dollars per acfm. The adjusted flow rate of each affected emission unit of the PH affected source was multiplied by the total annual cost-per-unit-flow of the appropriate scrubber model to estimate the annual O&M costs. The total annual O&M costs for the PH affected source are shown in column C of Table 6.4-1.

6.4.3 Cost Methodology for Monitoring Equipment

The proposed standards require continuous monitoring of all applicable control equipment. For wet scrubbers, the proposed standards require continuous parameter monitoring system (CPMS) for the following operating parameters: volumetric flow rate of exhaust gas (acfm), pressure drop across the device (inches of water), and volumetric flow rate of scrubbing liquid (gallons per minute). For baghouses, the proposed standards require a bag leak detector system. All 82 PH emission units are subject to the monitoring requirements in the proposed rule. However, Minntac already has monitoring equipment installed on its 17 wet scrubbers. Therefore, 65 PH emission units (82 units - 17 units = 65 units) are expected to incur monitoring equipment capital costs.

The EPA prepared estimates of capital and O&M costs associated with the required monitoring equipment on wet scrubbers and baghouses. The number of affected devices was multiplied by the unit capital cost of each monitoring device to obtain the total capital costs. The annualized capital cost is based on an interest rate of 7 percent and an equipment lifetime of 25 years, which yields a capital recovery factor (CRF) of 0.086. The number of affected control devices was multiplied by the unit O&M costs of each monitoring device to obtain the total monitoring equipment O&M costs. The total annualized monitoring costs for PH are shown in Table 6.4-3. This cost does not include the recordkeeping and reporting labor. The total MRR costs are shown in column H of Table 6.4-1.

Table 6.4-3: Monitoring Equipment Costs for Emission Units in the Finished Pellet Handling (PH) Affected Source

Type of Control Device	Type of Monitoring Equipment	(A) Number of Monitors[a]	(B) Capital Cost per Monitor ($)	(C) O & M Costs per Monitor ($/yr)	(D) Total Capital Cost (A x B)	(E) Total Annualized Capital Cost (D x 0.086[b])	(F) Total O&M Costs[c] (A x C)	(G) Total Annual Cost for Monitoring (E + F)
Scrubber	CPMS[d]	63	$7,527.20	$0	$474,213	$40,693	$0	$40,693
Baghouse	Bag leak Detector[e]	2	$9,300.28	$515	$18,601	$1,596	$1,030	$2,626
Total		65			$492,814	$42,289	$1,030	$43,319

[a] The number of monitors does not include the monitors already in place at Minntac.

[b] Cost recovery factor (CRF) of annualizing capital costs at 7% over 25 years.

[c] O&M costs based on 1998 estimates from coke ovens, scaled to 1999 using a 3% increase.

[d] Continuous Parameter Monitoring System (CPMS) which monitors water flow rate and pressure drop. Cost information provided by Ducon, a control device vendor. Scaled from 2001 to 1999 using 3% annual interest.

[e] Bag leak detector cost based on Coke Ovens BID. Originally in 1998 dollars, scaled to 1999 dollars using the VAPCCI average for fabric filters for the first quarter of 1998 and the first quarter of 1999.

6.5 ORE DRYERS

There are only two ore dryers used in the taconite industry, both of which are located at Tilden. One ore dryer has two stacks and the other has one stack. Each of these three stacks is controlled by a cyclone and an impingement scrubber connected in series. Particulate emissions data are available for each stack. These test data indicate that both ore dryers are capable of meeting the proposed PM emission limit of 0.052 gr PM/dscf. Based on this data, no emission control costs were assigned to these ore dryers.

However, the proposed standards require continuous monitoring of all applicable control equipment. For wet scrubbers, the proposed standards require continuous parameter monitoring system (CPMS) for the following operating parameters: volumetric flow rate of exhaust gas (acfm), pressure drop across the device (inches of water), and volumetric flow rate of scrubbing liquid (gallons per minute). The EPA prepared estimates of capital and O&M costs associated with the required monitoring equipment on wet scrubbers. The number of emission control devices was multiplied by the capital cost of each monitoring device to obtain the total capital costs. The annualized capital is based on an interest rate of 7 percent and an equipment lifetime of 25 years. Also, the number of emission control devices was multiplied by the O&M costs of each monitoring device to obtain the total monitoring equipment O&M costs. The total annual monitoring costs for ore dryers are shown in Table 6.5-1.

Table 6.5-1: Monitoring Costs for Ore Dryers

Type of Control Device	Type of Monitoring Equipment	(A) Number of Monitors	(B) Capital Cost per Monitor ($)	(C) O & M Costs per Monitor ($/yr)	(D) Total Capital Cost (A x B)	(E) Total Annualized Capital Cost (D x 0.086[a])	(F) Total O&M Costs[b] (A x C)	(G) Total Annual Cost for Monitoring (E + F)
Scrubber	CPMS[c]	3	$7,527	$0	$22,582	$1,938	$0	$1,938

[a] Cost recovery factor (CRF) of annualizing capital costs at 7% over 25 years.

[b] O&M costs based on 1998 dollar estimates from coke ovens, scaled to 1999 dollars using a 3% increase.

[c] Continuous Parameter Monitoring System (CPMS) which monitors water flow rate and pressure drop. Cost information provided by Ducon, a control device vendor. Scaled from 2001dollars to 1999 dollars assuming a 3% annual increase.

6.6 REFERENCES

1. U.S. EPA, Handbook: Control Techniques for Hazardous Air Pollutants. EPA 625/6-91/014. Washington, D.C., June 1991.

2. National Emission Standards for Hazardous Air Pollutants (NESHAP) for Coke Ovens: Pushing, Quenching, and Battery Stacks–Background Information Document for Proposed Standards.

3. Letter from T.B. Kurtz, Sly Inc., to Chuck Zukor, Alpha-Gamma Technologies, Inc, October 12, 2001. Re: Scrubber pricing.

4. Fax from George Massoud, Ducon Technologies, Inc., to Conrad Chin, U.S. EPA, October 12, 2001. Re: Scrubber cost proposal.

5. "Escalation Indexes for Pollution Control Costs," EPA 452/R-95-006. Updates of the VAPCCI are available at: www.epa.gov/ttncatc1/products.html#cccinfo.

6. Fax from Andrea Hayden, Hibbing Taconite Company, to Conrad Chin, U.S. EPA, May 5, 2002. Re: Revised cost estimate for rebuilding furnace line #3.

7. Letter from Larry C. Salmela, U.S. Steel Minntac, to Conrad Chin, U.S. EPA, November 23, 1999. Re: Costs for installation of multiple venturi rod deck wet scrubbers on lines 4 and 5 in mid-1991.

8. E-mail from Larry C. Salmela, U.S. Steel Minntac, to Conrad Chin, U.S. EPA, July 18, 2001. Re: Required cost information from Minntac.

7.0 ENVIRONMENTAL AND ENERGY IMPACTS

This chapter presents the air, non-air environmental, and energy impacts resulting from the control of PM and HAP emissions under the proposed rule. The impacts are based on the replacement of poorly performing emission control devices at existing plants with new control devices capable of meeting the emission limits in the proposed rule. There are no environmental or energy impacts associated with a plant or emission unit that is already in compliance with the proposed standards. No impacts associated with new sources have been estimated since we do not anticipate any new or reconstructed affected sources becoming subject to the new source MACT requirements in the foreseeable future.

To meet the ore crushing and handling (OCH) PM emission limit, it is anticipated that four plants will install new impingement scrubbers on 54 of the 264 total OCH emission units. The EPA anticipates that four plants will install new venturi rod wet scrubbers or will upgrade existing wet scrubbers on at least one of their indurating furnaces. In total, the EPA expects that existing controls will be replaced with new venturi rod wet scrubbers on 7 of the 49 indurating furnace stacks. It is estimated that three plants will install new impingement scrubbers on 11 of the 82 total finished pellet handling (PH) emission units to meet the PH PM emission limit.

Section 7.1 presents the anticipated PM and HAP air emissions reductions corresponding to the proposed rule for each taconite plant. The secondary air and other environmental impacts of the proposed regulation are summarized in Section 7.2. The energy impacts associated with the proposed rule are discussed in Section 7.3.

7.1 REDUCTIONS IN AIR EMISSIONS

Air emissions from the taconite iron ore processing source category include PM and the following three types of HAP:

- Metallic HAP (primarily manganese, arsenic, lead, nickel, and chromium) are intrinsic components of the taconite ore and are borne in the PM released to the atmosphere during all phases of the process--ore crushing, indurating, ore drying, and pellet handling.

- Products of incomplete combustion, or PIC, (primarily formaldehyde) result from the burning of fuel in the indurating furnaces.
- Acid gases (hydrochloric acid and hydrofluoric acid) derive primarily from the volatilization of chloride and fluoride compounds in the fluxstone material that is added during the indurating process.

The proposed standards control PM emissions as a surrogate for HAP emissions. Baseline PM and HAP emissions (i.e., emissions that would occur in absence of the standard) were calculated for each emission unit in the four affected sources as described in Chapter 3. The second columns of Tables 7.1-1 and 7.1-2 summarize the baseline PM and HAP emissions by affected source. A total of approximately 14,500 tons of PM and 935 tons of HAP are emitted by the taconite iron ore processing industry each year.

It is estimated that the proposed standards will reduce PM emissions by approximately 9,400 tons per year, or 65 percent. It is estimated that the proposed standards will reduce HAP emissions by 370 tons per year, or 40 percent. As shown in Tables 7.1-1 and 7.1-2, the vast majority of the PM and HAP reductions result from the indurating furnace affected source. Table 7.1-3 shows the PM and HAP emission reductions by plant and by affected source. Over 95 percent of the PM emissions and HAP emissions reductions result from improved controls at Minntac and National. No PM or HAP emissions reductions are expected for Inland, Empire, and Tilden. Table 7.1-3 also shows that incidental control of acid gas emissions accounts for 96 percent of the total HAP emission reductions.

7.1.1 Emission Reductions from OCH Emission Units

The PM emissions at the MACT level of performance were estimated assuming that each APCD would be operating at an emission rate of 0.008 gr/dscf, which is equivalent to the MACT level of performance. The PM emissions at MACT and the PM emission reductions for each OCH emission unit are shown in Table 2 of Appendix A. The PM emission reduction percentage for each plant was used to calculate the expected reduced emissions for each metallic HAP.

Table 7.1-1: PM Emission Reductions by Affected Source

Affected Source	(A) Baseline PM Emissions (tons/year)	(B) PM Emissions after Compliance (tons/year)	(C) PM Emission Reduction (tons/year)	(D) Percent PM Reduction from Affected Source (C/A x 100)	(E) Percent of Overall PM Reduction
Ore Crushing and Handling	2,130	1,865	264	12.4 %	2.8 %
Indurating Furnaces	11,441	2,335	9,106	79.6 %	96.5 %
Finished Pellet Handling	654	586	67	10.3 %	0.7 %
Ore Dryers	259	259	0	0 %	0 %
Total	14,483	5,045	9,438	65.2 %	100 %

Table 7.1-2: HAP Emission Reductions by Affected Source

Affected Source	(A) Baseline HAP Emissions (tons/year)	(B) HAP Emissions after Compliance (tons/year)	(C) HAP Emission Reduction (tons/year)	(D) Percent HAP Reduction from Affected Source (C/A x 100)	(E) Percent of Overall HAP Reduction
Ore Crushing and Handling	8.9	7.5	1.1	12.9 %	0.3 %
Indurating Furnaces	924.3	555.7	368.6	39.9 %	99.68 %
Finished Pellet Handling	0.6	0.5	0.1	13.3 %	0.02 %
Ore Dryers	1	1	0	0 %	0 %
Total	934.8	564.7	369.8	39.6 %	100 %

Table 7.1-3: HAP and PM Emission Reductions by Plant and Affected Source

Plant	Affected Source[a]	PM Emission Reductions (tons/year)	HAP Emission Reductions (tons/year)			
			Metallic HAP	Acid Gases	PIC	Total HAP
Minntac	OCH	32.5	0.169	0	0	0.2
	PH	0	0	0	0	0
	FURN	8,336.8	<8.4	145.9	0	154.4
	TOTAL	8,369.3	8.569	145.9	0	154.5
EVTAC	OCH	201.8	0.818	0	0	0.8
	PH	0	0	0	0	0
	FURN	39.3	0.1	10	0	10.1
	TOTAL	241.1	0.919	10	0	10.9
Northshore	OCH	0	0	0	0	0
	PH	62.7	0.076	0	0	0.1
	FURN	0	0	0	0	0
	TOTAL	62.7	0.076	0	0	0.1
National	OCH	30.1	0.156	0	0	0.2
	PH	4.6	0.005	0	0	0
	FURN	696.3	3.7	193.9	0	197.6
	TOTAL	730.9	3.861	193.9	0	197.8
Hibbing	OCH	0	0	0	0	0
	PH	0	0	0	0	0
	FURN	33.6	0.2	6.3	0	6.5
	TOTAL	33.6	0.2	6.3	0	6.5
Inland	OCH	0	0	0	0	0
	PH	0	0	0	0	0
	FURN	0	0	0	0	0
	TOTAL	0	0	0	0	0
Empire	OCH	0	0	0	0	0
	PH	0	0	0	0	0
	FURN	0	0	0	0	0
	TOTAL	0	0	0	0	0
Tilden	OCH	0	0	0	0	0
	PH	0	0	0	0	0
	FURN	0	0	0	0	0
	DRYERS	0	0	0	0	0
	TOTAL	0	0	0	0	0
TOTAL	OCH	264.3	1.14	0	0	1.1
	PH	67.2	0.081	0	0	0.08
	FURN	9,106	12.5	356.1	0	368.6
	DRYERS	0	0	0	0	0
	TOTAL	9,437.6	13.7	356.1	0	369.8

[a] OCH=Ore crushing and handling; PH=Pellet handling; FURN=Indurating furnace; DRYERS=Ore drying

As shown in Table 7.1-4 the proposed standard is projected to reduce PM emissions from OCH emission units by 264.3 tons per year, or 12.4 percent. Over 75 percent of the PM emission reductions from OCH emission units result from EVTAC. Reductions in PM at Minntac and National make up the remaining 25 percent. No reductions in PM emissions are expected for OCH emission units at Northshore, Hibbing, Inland, Empire, and Tilden.

Table 7.1-5 shows the HAP emission reductions from OCH emission units by pollutant and plant. Emission reductions of HAP from all OCH emission units is estimated to be only 1.14 tons per year. Reductions in the emissions of manganese accounts for nearly all of the OCH HAP emission reductions.

Table 7.1-4: PM Baseline Emissions and Emission Reductions for OCH Emission Units

Plant	Baseline PM Emissions (tons/year)	Emissions After MACT (tons/year)	Emission Reduction (tons/year)	Percent Reduction
Minntac	606.6	574.0	32.5	5.4 %
EVTAC	518.5	316.7	201.8	38.9 %
Northshore	564.8	564.8	0	0 %
National	96.5	66.5	30.1	31.1 %
Hibbing	93.8	93.8	0	0 %
Inland	109.1	109.1	0	0 %
Empire	101.3	101.3	0	0 %
Tilden	38.9	38.9	0	0 %
Total	2,129.5	1,865.1	264.3	12.4 %

Table 7.1-5: Emission Reductions of HAP from OCH Emission Units by Pollutant and Plant

Element	Plant								Total
	Minntac	EVTAC	Northshore	National	Hibbing	Inland	Empire	Tilden	
Antimony, Sb	2.63e-04	2.42e-03	0	2.43e-04	0	0	0	0	2.93e-03
Arsenic, As	4.78e-04	3.03e-03	0	4.42e-04	0	0	0	0	3.95e-03
Beryllium, Be	6.90e-05	1.01e-03	0	6.37e-05	0	0	0	0	1.14e-03
Cadmium, Cd	3.42e-05	< 1.01e-04	0	3.16e-05	0	0	0	0	1.67e-04
Chromium, Cr	7.64e-04	4.84e-03	0	7.06e-04	0	0	0	0	6.31e-03
Cobalt, Co	3.25e-04	9.68e-03	0	3.01e-04	0	0	0	0	1.03e-02
Lead, Pb	4.26e-04	4.04e-03	0	3.94e-04	0	0	0	0	4.86e-03
Manganese, Mn	1.66e-01	7.87e-01	0	1.53e-01	0	0	0	0	1.11e+00
Mercury, Hg	1.65e-04	< 2.02e-03	0	1.52e-04	0	0	0	0	2.34e-03
Nickel, Ni	2.29e-04	2.62e-03	0	2.12e-04	0	0	0	0	3.06e-03
Selenium, Se	3.51e-04	< 1.01e-03	0	3.25e-04	0	0	0	0	1.69e-03
Total	1.69e-01	8.18e-01	0	1.56e-01	0	0	0	0	1.14e+00

7.1.2 Emission Reductions from Indurating Furnaces

The PM emissions at the MACT level of performance were estimated assuming that each APCD would be operating at an emission rate equivalent to the appropriate MACT level:

- 0.011 gr/dscf for grate kiln furnaces processing magnetite,
- 0.010 gr/dscf for straight grate furnaces processing magnetite, and
- 0.025 gr/dscf for grate kiln furnaces processing hematite).

The PM emissions at MACT and the PM emission reductions for each indurating furnace stack are shown in Table 3 of Appendix A. The PM emission reduction percentage for each plant was used to calculate the expected reduced emissions for each metallic HAP. The acid gas emission reduction estimate was based on an engineering test from Northshore. The test indicated that 74 percent to 97 percent reduction in hydrochloric acid and hydrofluoric acid emissions was achieved with a wet-ESP. Considering the hydroscopic nature of acid gases, a conservative estimate of 74 percent was used for the analysis.

As shown in Table 7.1-6 the proposed standard is projected to reduce PM emissions from indurating furnaces by 9,106 tons per year, or 79.6 percent. Ninety-two percent of the PM emission reductions from indurating furnaces result from improved controls at Minntac. Reductions in PM at National, Hibbing, and EVTAC make up the remaining 8 percent. No reductions in PM emissions are expected for furnaces at Northshore, Empire, Inland, and Tilden.

Table 7.1-6: PM Baseline Emissions and Emission Reductions for Indurating Furnaces

Plant	Baseline PM Emissions (tons/year)	Emissions After MACT (tons/year)	Emission Reduction (tons/year)	Percent Reduction
Minntac	9,097.4	760.7	8,336.8	91.6 %
EVTAC	283.9	244.6	39.3	13.8 %
Northshore	171.8	171.8	0	0 %
National	801.5	105.2	696.3	86.9
Hibbing	202.7	169.0	33.6	16.6 %
Inland	54.4	54.4	0	0 %
Empire	609.4	609.4	0	0 %
Tilden	259.0	259.0	0	0 %
Total	11,440.5	2,334.5	9,106.0	79.6 %

Table 7.1-7 shows the HAP emission reductions from indurating furnaces by pollutant and plant. Emission reductions from all indurating furnaces is estimated to be 368.6 tons per year. Reductions in the emissions of acid gases account for almost 97 percent of the HAP emission reductions from indurating furnaces.

Table 7.1-7: Emission Reductions of HAP from Indurating Furnaces by Pollutant and Plant

Pollutant	Plant								Total
	Minntac	EVTAC	Northshore	National	Hibbing	Inland	Empire	Tilden	
PIC Total	0.0	0.0	0	0.0	0.0	0	0	0	0.0
Hydrogen									
Hydrogen									
Acid Gas Total	145.9	10.0	0	193.9	6.3	0	0	0	356.1
Antimony, Sb	<0.2	0.0	0	0.1	0.0	0	0	0	0.3
Arsenic, As	2.8	0.1	0	1.0	0.1	0	0	0	3.9
Beryllium, Be	0.0	0.0	0	0.0	0.0	0	0	0	0.0
Cadmium, Cd	0.0	0.0	0	0.0	0.0	0	0	0	0.0
Chromium, Cr	0.9	0.0	0	0.3	0.0	0	0	0	1.2
Cobalt, Co	0.0	0.0	0	0.0	0.0	0	0	0	0.0
Lead, Pb	2.0	0.0	0	0.2	0.1	0	0	0	2.2
Manganese, Mn	1.5	0.0	0	1.8	0.1	0	0	0	3.4
Mercury, Hg	0.0	0.0	0	0.0	0.0	0	0	0	0.0
Nickel, Ni	0.8	0.0	0	0.1	0.0	0	0	0	0.9
Selenium, Se	0.2	0.0	0	0.3	0.0	0	0	0	0.5
Metals Total	<8.4	0.1	0	3.7	0.2	0	0	0	<12.5
Grand Total	<154.4	10.1	0	<197.6	6.5	0	0	0	<368.6

7.1.3 Emission Reductions from Finished Pellet Handling Emission Units

The PM emissions at the MACT level of performance were estimated assuming that each APCD would be operating at an emission rate of 0.008 gr/dscf, which is equivalent to the MACT level of performance. The PM emissions at MACT and the PM emission reductions for each PH emission unit are shown in Table 2 of Appendix A. The PM emission reduction percentage for each plant was used to calculate the expected reduced emissions for each metallic HAP.

As shown in Table 7.1-8, the proposed standard is projected to reduce PM emissions from PH emission units by 67.2 tons per year, or 10.3 percent. Ninety-three percent of the PM emission reductions from PH emission units result from improved controls at Northshore. Reductions in PM at National make up the remaining 7 percent. No reductions in PM emissions are expected for PH emission units at Minntac, EVTAC, Hibbing, Inland, Empire, and Tilden.

Table 7.1-8: PM Baseline Emissions and Emission Reductions for PH Emission Units

Plant	(A) Baseline PM Emissions (tons/year)	(B) Emissions After MACT (tons/year)	(C) Emission Reduction (tons/year)	(D) Percent Reduction (C/A x 100)
Minntac	168.8	168.8	0	0 %
EVTAC	30.5	30.5	0	0 %
Northshore	132.2	69.5	62.7	47.4 %
National	58.8	54.2	4.6	7.8 %
Hibbing	108.1	108.1	0	0 %
Inland	79.1	79.1	0	0 %
Empire	54.1	54.1	0	0 %
Tilden	22.0	22.0	0	0 %
Total	653.6	586.3	67.2[a]	10.3 %

[a] Total differs from the sum of column values due to rounding.

Table 7.1-9 shows the HAP emission reductions from PH emission units by pollutant and plant. Emission reductions from all PH emission units is estimated to be 0.08 tons per year. Reductions in the emissions of manganese accounts for almost 96 percent of the HAP emission reductions from PH emission units.

Table 7.1-9: Emission Reductions of HAP from PH Emission Units by Pollutant and Plant

Metallic HAP	Plant								Total
	Minntac	EVTAC	Northshore	National	Hibbing	Inland	Empire	Tilden	
Antimony, Sb	0	0	3.05e-05	1.89e-06	0	0	0	0	3.24e-05
Arsenic, As	0	0	1.35e-04	2.23e-05	0	0	0	0	1.58e-04
Beryllium, Be	0	0	3.76e-05	3.39e-06	0	0	0	0	4.10e-05
Cadmium, Cd	0	0	1.88e-06	1.28e-07	0	0	0	0	2.01e-06
Chromium, Cr	0	0	1.82e-03	1.08e-04	0	0	0	0	1.93e-03
Cobalt, Co	0	0	6.39e-04	3.23e-05	0	0	0	0	6.72e-04
Lead, Pb	0	0	2.51e-05	2.65e-06	0	0	0	0	2.77e-05
Manganese, Mn	0	0	7.33e-02	4.43e-03	0	0	0	0	7.77e-02
Mercury, Hg	0	0	1.25e-07	9.15e-09	0	0	0	0	1.34e-07
Nickel, Ni	0	0	4.69e-04	2.58e-05	0	0	0	0	4.85e-04
Selenium, Se	0	0	1.69e-05	1.28e-06	0	0	0	0	1.82e-05
Total	0	0	7.64e-02	4.63e-03	0	0	0	0	8.11e-02

7.1.4 Emission Reductions from Ore Dryers

No PM or HAP emissions reductions are expected for the existing ore dryers at Tilden. Both ore dryers can currently meet the 0.052 gr/dscf MACT standard for ore dryers.

7.2 SECONDARY ENVIRONMENTAL IMPACTS

This section presents the estimated wastewater and solid waste impacts of implementing the proposed standards.

7.2.1 Wastewater Impacts

The EPA projects that the implementation of the proposed standards will increase water usage in the taconite processing industry by 8.4 billion gallons per year (Appendix E, Table 1). This represents only a 2-percent increase over the industry's baseline use of approximately 370 billion gallons of water (see Appendix E, Table 2). The increased water usage results from the installation of new wet scrubbers needed for compliance. Much of this water will be discharged as scrubber blowdown to the tailings basin(s) located at each plant and will then be recycled.

7.2.2 Solid Waste Impacts

The PM material collected in wet scrubbers, baghouses, or ESP can be recycled or returned to the ore concentration process. Therefore, the proposed standard is not expected to generate any appreciable amount of solid waste from the operation of new control devices.

7.3 ENERGY IMPACTS

The proposed standards are expected to increase energy usage by 15,298 megawatt-hours per year. This increase will result primarily from the higher energy requirements of new control devices required by the proposed standards (see Appendix E, Table 1).

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Appendix A

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Appendix A, Table 1: Ore Crushing & Handling and Finished Pellet Handling Emission Units

Affected Source	Unit Type	Emission Unit	Control Description	SV ID
US Steel Minntac				
OCH	Primary Crushing	Step 1 Coarse	Baghouse	13
OCH	Primary Crushing	Step 1 metal conveyor (pan feeders)	Venturi scrubber	16
OCH	Primary Crushing	Step 2 Coarse	Baghouse	14
OCH	Primary Crushing	Step 2 metal conveyor (pan feeders)	Venturi scrubber	17
OCH	Primary Crushing	Step 3 Coarse	Baghouse	15
OCH	Primary Crushing	Step 3 metal conveyor (pan feeders)	Venturi scrubber	18
OCH	Conveying	Turn bin conveyor transfer	Marble bed wet scrubber	21
OCH	Conveying	Turn bin conveyor transfer	Marble bed wet scrubber	22
OCH	Conveying	Turn bin conveyor transfer	Marble bed wet scrubber	23
OCH	Conveying	Turn bin conveyor transfer	Marble bed wet scrubber	24
OCH	Conveying	Turn bin conveyor transfer	Marble bed wet scrubber	25
OCH	Miscellaneous	Surge pile/Reclaim	Marble bed wet scrubber	26
OCH	Conveying	Conveyor transfer	Marble bed wet scrubber	27
OCH	Conveying	Conveyor transfer	Marble bed wet scrubber	28
OCH	Conveying	Conveyor transfer	Marble bed wet scrubber	30
OCH	Secondary Crushing	Secondary crushing(fine)	Marble bed wet scrubber	31
OCH	Secondary Crushing	Secondary crushing(fine)	Marble bed wet scrubber	32
OCH	Secondary Crushing	Secondary crushing(fine)	Marble bed wet scrubber	33
OCH	Secondary Crushing	Secondary crushing(fine)	Marble bed wet scrubber	34
OCH	Conveying	Conveyor transfer	Marble bed wet scrubber	35
OCH	Conveying	Conveyor transfer	Marble bed wet scrubber	36
OCH	Secondary Crushing	Secondary crushing(fine)	Marble bed wet scrubber	62
OCH	Secondary Crushing	Secondary crushing(fine)	Marble bed wet scrubber	55
OCH	Secondary Crushing	Secondary crushing(fine)	Marble bed wet scrubber	56
OCH	Secondary Crushing	Secondary crushing(fine)	Marble bed wet scrubber	57
OCH	Secondary Crushing	Secondary crushing(fine)	Marble bed wet scrubber	58
OCH	Secondary Crushing	Secondary crushing(fine)	Marble bed wet scrubber	59
OCH	Secondary Crushing	Secondary crushing(fine)	Marble bed wet scrubber	64
OCH	Secondary Crushing	Secondary crushing(fine)	Marble bed wet scrubber	65
OCH	Secondary Crushing	Secondary crushing(fine)	Marble bed wet scrubber	66
OCH	Secondary Crushing	Secondary crushing(fine)	Marble bed wet scrubber	67
OCH	Secondary Crushing	Secondary crushing(fine)	Marble bed wet scrubber	68
OCH	Conveying	Conveyor transfer	Marble bed wet scrubber	60
OCH	Conveying	Conveyor transfer	Marble bed wet scrubber	63
OCH	Miscellaneous	Conveyor transfer bin	Marble bed wet scrubber	69
OCH	Conveying	Conveyor transfer	Marble bed wet scrubber	70
OCH	Conveying	Conveyor transfer	Marble bed wet scrubber	71
OCH	Miscellaneous	Tertiary storage bin	Marble bed wet scrubber	37
OCH	Miscellaneous	Tertiary storage bin	Marble bed wet scrubber	54
OCH	Miscellaneous	Tertiary storage bin	Marble bed wet scrubber	61
OCH	Miscellaneous	Tertiary storage bin	Marble bed wet scrubber	72
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	38
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	39

Appendix A, Table 1: Ore Crushing & Handling and Finished Pellet Handling Emission Units (Cont.)

Affected Source	Unit Type	Emission Unit	Control Description	SV ID
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	40
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	41
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	42
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	43
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	44
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	45
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	46
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	47
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	48
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	49
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	50
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	51
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	52
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	53
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	73
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	74
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	75
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	76
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	77
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	78
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	79
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	80
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	81
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	82
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	83
OCH	Tertiary Crushing	Tertiary crushing(fine)	Marble bed wet scrubber	84
OCH	Conveying	Conveyor transfer	Marble bed wet scrubber	85
OCH	Conveying	Conveyor transfer	Marble bed wet scrubber	85
OCH	Miscellaneous	Storage Bin for ore transfer	Marble bed wet scrubber	87
OCH	Miscellaneous	Storage Bin for ore transfer	Marble bed wet scrubber	88
OCH	Miscellaneous	Storage Bin for ore transfer	Marble bed wet scrubber	89
OCH	Miscellaneous	Storage Bin for ore transfer	Marble bed wet scrubber	90
OCH	Miscellaneous	Storage Bin for ore transfer	Marble bed wet scrubber	91
OCH	Miscellaneous	Storage Bin for ore transfer	Marble bed wet scrubber	92
OCH	Miscellaneous	Storage Bin for ore transfer	Marble bed wet scrubber	93
OCH	Conveying	Conveyor transfer	Marble bed wet scrubber	94
OCH	Miscellaneous	Storage Bin for ore transfer	Marble bed wet scrubber	95
OCH	Miscellaneous	Storage Bin for ore transfer	Marble bed wet scrubber	96
OCH	Miscellaneous	Storage Bin for ore transfer	Marble bed wet scrubber	97
PH	Grate Feed	Grate feed	Ducon UW-4 imping. scrubber	101
PH		Grate discharge	Ducon UW-4 imping. scrubber	102
PH		Pellet cooler discharge	Ducon UW-4 imping. scrubber	105
PH		Conveyor Transfer Feeder (pellet cooling)	Ducon UW-4 imping. scrubber	106
PH		Pellet conveyor Transfer	Ducon UW-4 imping. scrubber	109

Appendix A, Table 1: Ore Crushing & Handling and Finished Pellet Handling Emission Units (Cont.)

Affected Source	Unit Type	Emission Unit	Control Description	SV ID
PH		Pellet conveyor Transfer	Ducon UW-4 imping. scrubber	108
PH	Grate Feed	Grate feed	Rod scrubber (new)	116
PH		Grate discharge	Rod scrubber (converted)	117
PH		Conveyor Transfer Feeder (pellet cooling)	Rod scrubber (converted)	120
PH		Pellet cooler discharge	Ducon UW-4 imping. scrubber	121
PH		Pellet conveyor Transfer	Ducon UW-4 imping. scrubber	122
PH	Grate Feed	Grate feed	Rod scrubber (converted)	125
PH		Grate discharge	Rod scrubber (new)	126
PH		Pellet cooler discharge	Ducon UW-4 imping. scrubber	130
PH		Conveyor Transfer Feeder (pellet cooling)	Rod scrubber (converted)	129
PH		Pellet conveyor Transfer	Ducon UW-4 imping. scrubber	131
PH	Grate Feed	Grate feed	Rod scrubber (converted)	142
PH		Grate discharge	Rod scrubber (converted)	143
PH		Pellet cooler discharge	Rod scrubber (converted)	145
PH		Pellet conveyor Transfer	Rod scrubber (converted)	146
PH	Grate Feed	Grate feed	Rod scrubber (converted)	149
PH		Grate discharge	Rod scrubber (converted)	150
PH		Pellet cooler discharge	Rod scrubber (converted)	153
EVTAC (Thunderbird Mine)				
OCH	Primary Crushing	North primary crusher	Buell HE-350 Baghouse	1
OCH	Secondary Crushing	3 North secondary crushers	Buell HE-154 Baghouse	2
OCH	Miscellaneous	North loadout tunnel	Buell HE-224 Baghouse	3
OCH	Primary Crushing	3 South primary crushers	Wheelabrator #108Baghouse	4
OCH	Secondary Crushing	South secondary crusher	Wheelabrator #108Baghouse	5
OCH	Miscellaneous	South loadout tunnel	Wheelabrator #108Baghouse	6
EVTAC (Fairlane Plant)				
OCH	Miscellaneous	Unloading pan feeders	Wheelabrator Baghouse	7
OCH	Miscellaneous	Ore unloading pocket A and B side	Wheelabrator Baghouse	8,9
OCH	Miscellaneous	Ore Surge	Wheelabrator Baghouse	10
OCH	Tertiary Crushing	3rd stage	Am. A F Type N Rotoclone WS	11
OCH	Tertiary Crushing	3rd stage	Am. A F Type N Rotoclone WS	12
OCH	Tertiary Crushing	3rd stage	Am. A F Type N Rotoclone WS	13
OCH	Tertiary Crushing	3rd stage	Am. A F Type N Rotoclone WS	14
OCH	Tertiary Crushing	3rd stage	Am. A F Type N Rotoclone WS	15
OCH	Miscellaneous	Third stage bins conveyor	Am. A F Type N Rotoclone WS	16
OCH	4° Crushing	4th stage	Am. A F Type N Rotoclone WS	17
OCH	4° Crushing	4th stage	Am. A F Type N Rotoclone WS	18
OCH	4° Crushing	4th stage	Am. A F Type N Rotoclone WS	19
OCH	4° Crushing	4th stage	Am. A F Type N Rotoclone WS	20
OCH	4° Crushing	4th stage	Am. A F Type N Rotoclone WS	21
OCH	4° Crushing	4th stage	Am. A F Type N Rotoclone WS	22
OCH	4° Crushing	4th stage	Am. A F Type N Rotoclone WS	23
OCH	4° Crushing	4th stage	Am. A F Type N Rotoclone WS	24
OCH	Conveying	Fourth stage trip/bin/conveyor	Am. A F Type N Rotoclone WS	25

Appendix A, Table 1: Ore Crushing & Handling and Finished Pellet Handling Emission Units (Cont.)

Affected Source	Unit Type	Emission Unit	Control Description	SV ID
OCH	Conveying	Transfer house (north)	Am. A F Type N Rotoclone WS	26
OCH	Conveying	Transfer house (south)	Am. A F Type N Rotoclone WS	28
OCH	Fine Crushing	Rod mill	Am. A F Type N Rotoclone WS	29
OCH	Fine Crushing	Rod mill	Am. A F Type N Rotoclone WS	30
OCH	Fine Crushing	Rod mill	Am. A F Type N Rotoclone WS	31
OCH	Fine Crushing	Rod mill	Am. A F Type N Rotoclone WS	32
OCH	Fine Crushing	Rod mill	Am. A F Type N Rotoclone WS	33
OCH	Grate Feed	Grate feed	Ducon Type UW-4 Imping. WS	39
OCH		Grate discharge	Ducon Type UW-4 Imping. WS	40
PH		Kiln cooler discharge	Ducon Type UW-4 Imping. WS	41
OCH	Grate Feed	Grate feed	Ducon Type UW-4 Imping. WS	43
OCH		Grate discharge	Ducon Type UW-4 Imping. WS	44
PH		Kiln cooler discharge	Ducon Type UW-4 Imping. WS	45
PH		Line 1 Pellet Transfer	Ducon Type UW-4 Imping. WS	50
PH		Pellet loadout conveyor South	Ducon venturi scrubber	111
PH		Pellet Loadout Bin 3 Vent	Ducon venturi scrubber	111
PH		Pellet Loadout Bins Venting	Ducon venturi scrubber	111
Northshore (Babbitt) mine				
OCH	Primary Crushing	Primary Crusher	Baghouse	
OCH	Primary Crushing	Primary Crusher	Multiclone	
OCH	Secondary Crushing	Secondary Crusher	Baghouse	
OCH	Secondary Crushing	Secondary Crusher	Baghouse	
OCH	Secondary Crushing	Secondary Crusher	Baghouse	
OCH	Secondary Crushing	Secondary Crusher	Baghouse	
OCH	Secondary Crushing	Secondary Crusher	Multiclone	
OCH	Secondary Crushing	Secondary Crusher	Multiclone	
OCH	Secondary Crushing	Secondary Crusher	Multiclone	
OCH	Secondary Crushing	Secondary Crusher	Multiclone	
Northshore (Sil. Bay)				
OCH	Miscellaneous	West car Dump	Flex Kleen Baghouse (PJet)	7
OCH	Miscellaneous	East Car Dump	Flex Kleen Baghouse (PJet)	8
OCH	Miscellaneous	West Crusher Storage Bins	Flex Kleen Baghouse (PJet)	9
OCH	Miscellaneous	East Crusher Storage Bins	Flex Kleen Baghouse (PJet)	10
OCH	Fine Crushing	Fine cone crusher W	Flex Kleen Baghouse (PJet)	14
OCH	Fine Crushing	Fine cone crusher W	Flex Kleen Baghouse (PJet)	13
OCH	Fine Crushing	Fine cone crusher W	Flex Kleen Baghouse (PJet)	12
OCH	Fine Crushing	Fine cone crusher W	Flex Kleen Baghouse (PJet)	11
OCH	Conveying	Conveyor	Flex Kleen Baghouse (PJet)	15
OCH	Conveying	Conveyor	Flex Kleen Baghouse (PJet)	16
OCH	Fine Crushing	Fine cone crusher E	Flex Kleen Baghouse (PJet)	17
OCH	Fine Crushing	Fine cone crusher E	Flex Kleen Baghouse (PJet)	18
OCH	Fine Crushing	Fine cone crusher E	Flex Kleen Baghouse (PJet)	19
OCH	Fine Crushing	Fine cone crusher E	Flex Kleen Baghouse (PJet)	20
OCH	Miscellaneous	Dry cobbing	Flex Kleen Baghouse (PJet)	21

Appendix A, Table 1: Ore Crushing & Handling and Finished Pellet Handling Emission Units (Cont.)

Affected Source	Unit Type	Emission Unit	Control Description	SV ID
OCH	Miscellaneous	Dry cobbing	Flex Kleen Baghouse (PJet)	22
OCH	Miscellaneous	Dry cobbing	Flex Kleen Baghouse (PJet)	23
OCH	Miscellaneous	Conveyor	Flex Kleen Baghouse (PJet)	24
OCH	Miscellaneous	Dry cobbing	Flex Kleen Baghouse (PJet)	25
OCH	Conveying/Misc	Coarse Tails Conveying	Flex Kleen Baghouse (PJet)	26
OCH	Conveying/Misc	Coarse Tails Conveying	Flex Kleen Baghouse (PJet)	27
OCH	Conveying/Misc	Coarse Tails Transfer	Flex Kleen Baghouse (PJet)	28
OCH	Conveying/Misc	Coarse Tails Loadout	Flex Kleen Baghouse (PJet)	29
OCH	Conveying/Misc	West Transfer Bin	Flex Kleen Baghouse (PJet)	30
OCH	Conveying/Misc	East Transfer Bin	Flex Kleen Baghouse (PJet)	31
OCH	Conveying/Misc	Storage Bins (West)	Multiclone	32-43
OCH	Conveying/Misc	Storage Bins (East)	Multiclone	44-53
PH		Pellet Hearth Layer (East)	Baghouse	97
PH		Furnace discharge	Am. Air F. type N Rotoclone WS	120
PH		Furnace discharge	Am. Air F. type N Rotoclone WS	121
PH		East furnaces discharge	Am. Air F. type N Rotoclone WS	122
PH		East furnaces screening	Am. Air F. type N Rotoclone WS	123
PH		Pellet conveying	Am. Air F. type N Rotoclone WS	124
PH		Pellet Screen House	Am. Air F. type N Rotoclone WS	125
PH		Furnace feed (west)	Am. Air F. type N Rotoclone WS	260
PH		Furnace discharge	Am. Air F. type N Rotoclone WS	255
PH		Furnace discharge end	Am. Air F. type N Rotoclone WS	265
National				
OCH	Primary Crushing	Primary	Wet multiclone	1
OCH	Conveying	Drive House No. 1Primary Conveyor	Multiclone	3
OCH	Primary Crushing	Primary	Venturi Rod WS	2
OCH	Conveying	Drive House No. 2Primary Conveyor	Ducon A-33 Venturi Rod	4
OCH	Conveying	Crude ore feed (conveyor transfer)	Ducon UW-4 imping. scrubber	5
OCH	Conveying	Crude ore feed (conveyor transfer)	Ducon UW-4 imping. scrubber	6
OCH	Conveying	Crude ore feed (conveyor transfer)	Ducon UW-4 imping. scrubber	7
OCH	Conveying	Crude ore feed (conveyor transfer)	Ducon UW-4 imping. scrubber	8
OCH	Conveying	Crude ore feed (conveyor transfer)	Ducon UW-4 imping. scrubber	9
OCH	Conveying	Crude ore feed (conveyor transfer)	Ducon UW-4 imping. scrubber	10
OCH	Conveying	Crude ore feed (conveyor transfer)	Ducon A-33 Venturi Rod	11
OCH	Conveying	Crude ore feed (conveyor transfer)	Ducon A-33 Venturi Rod	12
OCH	Conveying	Crude ore feed (conveyor transfer)	Ducon A-33 Venturi Rod	13
OCH	Conveying	Crude ore feed (conveyor transfer)	Ducon A-33 Venturi Rod	14
OCH	Grate Feed	Grate feed	National Hydro Marble bed wet scrubber	19
OCH	Grate Feed	Grate feed	Ducon UW-4 imping. scrubber	20
PH		Grate discharge	Ducon UW-4 imping. scrubber	21
PH		Grate discharge	Ducon UW-4 imping. scrubber	22
PH		Cooler dump zone	Ducon UW-4 imping. scrubber	23
PH		Cooler vibrating feeder	Ducon UW-4 imping. scrubber	24
PH		Pellet Cooler, Phase II		26

Appendix A, Table 1: Ore Crushing & Handling and Finished Pellet Handling Emission Units (Cont.)

Affected Source	Unit Type	Emission Unit	Control Description	SV ID
PH		Cooler vibrating feeder	Am. Air Filter R rotoclone WS	27
PH		Pellet product conveyor	Am. Air Filter R rotoclone WS	28
PH		Pellet cooler product belts	Ducon UW-4 scrubber	32
PH		Pellet loadout drive house	National Hydro Marble bed wet scrubber	34
PH		Pellet screening	Ducon UW-4 imping. scrubber	37
PH		Conveyor drop	Ducon A-33 Venturi Rod	38
Hibbing				
OCH	Primary Crushing	Apron feeder from primary crusher	Ducon venturi Rod WS	1
OCH	Conveying	Ore feed conveyor	Enviro. venturi Rod WS	3
OCH	Primary Crushing	Apron feeder from primary crusher	Ducon venturi Rod WS	2
OCH	Conveying	Ore feed conveyor	Enviro. venturi Rod WS	3
OCH	Conveying	Mill feed conveyor	Ducon Oriclone Venturi	101
OCH	Conveying	Mill feed conveyor	Ducon Oriclone Venturi	102
OCH	Conveying	Mill feed conveyor	Ducon Oriclone Venturi	103
OCH	Conveying	Mill feed conveyor	Ducon Oriclone Venturi	104
OCH	Conveying	Mill feed conveyor	Ducon Oriclone Venturi	105
OCH	Conveying	Mill feed conveyor	Ducon Oriclone Venturi	106
OCH	Conveying	Mill feed conveyor	Ducon Oriclone Venturi	107
OCH	Conveying	Mill feed conveyor	Ducon Oriclone Venturi	108
OCH	Conveying	Mill feed conveyor	Ducon Oriclone Venturi	109
OCH	Secondary Crushing	Secondary (pebble) crusher	CGS venturi WS	110
OCH	Secondary Crushing	Secondary (pebble) crusher	CGS venturi WS	111
OCH	Miscellaneous	Hearth layer bin	Ducon UW-4 imping. scrubber	203
OCH	Miscellaneous	Hearth layer bin	Ducon UW-4 imping. scrubber	204
OCH	Miscellaneous	Hearth layer feed (furnaces 1and 2)	Ducon UW-4 imping. scrubber	205
OCH	Miscellaneous	Hearth layer feed (furnace 3)	Ducon UW-4 imping. scrubber	206
PH		Pellet discharge	Ducon UW-4 imping. scrubber	219
PH		Pellet discharge	Ducon UW-4 imping. scrubber	220
PH		Pellet discharge	Ducon UW-4 imping. scrubber	221
PH		Hearth layer screening	Ducon UW-4 imping. scrubber	222
PH		Pellet transfer house	Ducon UW-4 imping. scrubber	223
Inland				
OCH	Primary Crushing	Primary Crusher	Venturi Scrubber	1
OCH			Envirotech Buell Baghouse	2
OCH	Conveying	Coarse ore pile conveyor	Flex Kleen Baghouse	3
OCH	Secondary Crushing	Secondary crusher & conveyor	Venturi Scrubber	4,5
OCH	Secondary Crushing	Secondary crusher & conveyor	Venturi Scrubber	4,5
OCH	Secondary Crushing	Secondary crusher & conveyor	Venturi Scrubber	4,5
OCH	Conveying	Outside ore Transfer	Flex Kleen Baghouse	9,10
OCH	Tertiary Crushing	Tertiary crusher & conveyor	Venturi Scrubber	6,7,8
OCH	Tertiary Crushing	Tertiary crusher & conveyor	Venturi Scrubber	6,7,8
OCH	Tertiary Crushing	Tertiary crusher & conveyor	Venturi Scrubber	6,7,8
OCH	Tertiary Crushing	Tertiary crusher & conveyor	Venturi Scrubber	6,7,8
OCH	Miscellaneous	Fine ore underfeeds	Flex Kleen Baghouse	9,10

Appendix A, Table 1: Ore Crushing & Handling and Finished Pellet Handling Emission Units (Cont.)

Affected Source	Unit Type	Emission Unit	Control Description	SV ID
OCH	Miscellaneous	Fine ore conveyor	Flex Kleen Baghouse	9,10
OCH	Miscellaneous	Pellet drop internal hearth layer conveyor	Ducon UW-4 imping. scrubber	19
OCH	Miscellaneous	Drop into hearth layer bin	Ducon UW-4 imping. scrubber	19
OCH	Grate Feed	Grate feed	Ducon UW-4 imping. scrubber	19
PH		Drop into hearth layer screen	Ducon UW-4 imping. scrubber	20
PH		Drop onto conveyor to hearth layer bin	Ducon UW-4 imping. scrubber	20
PH		Machine discharge	Ducon UW-4 imping. scrubber	18
PH		Drop onto conveyor to pellet splitter bin	Ducon UW-4 imping. scrubber	18
PH		Drop into pellet splitter bin	Ducon UW-4 imping. scrubber	21
PH		Drop onto pellet splitter bin conveyors	Ducon UW-4 imping. scrubber	21
PH		Drop in transfer house	Ducon UW-4 imping. scrubber	24
PH		Drop onto pellet pile underfeed conveyor	Mikropul Baghouse	22
PH		Drop into pellet loadout bin	Venturi Rod Scrubber	23
Empire				
OCH	Primary Crushing	Primary Crusher	Venturi Rod Scrubber	
OCH	Conveying	Conveyor	Venturi Rod Scrubber	
OCH	Primary Crushing	Primary Crusher	Sly Imping. Scrubber	
OCH	Secondary Crushing	Secondary crusher	High eff dry cartridge collector	
OCH	Tertiary Crushing	Pebble crushers	High eff dry cartridge collector	
OCH	Conveying / Misc	Transfer Tower (1B and 2A conveyer)	Sly Imping. Scrubber	
OCH	Conveying / Misc	Ore feed conveyor	Venturi Scrubber	
OCH	Conveying / Misc	Ore feed conveyor	Venturi Scrubber	
OCH	Conveying / Misc	Ore feed conveyor	Impingment Scrubber	
OCH	Conveying / Misc	Ore feed conveyor	Impingment Scrubber	
OCH	Conveying / Misc	Ore feed conveyor	Impingment Scrubber	
OCH	Conveying / Misc	Ore feed conveyor	Impingment Scrubber	
OCH	Conveying / Misc	Ore feed conveyor	Impingment Scrubber	
OCH	Conveying / Misc	Ore feed conveyor	Impingment Scrubber	
OCH	Conveying / Misc	Ore feed conveyor	Impingment Scrubber	
OCH	Conveying / Misc	Ore feed conveyor	Impingment Scrubber	
OCH	Conveying / Misc	Ore feed conveyor	Impingment Scrubber	
OCH	Conveying / Misc	Ore feed conveyor	Venturi Scrubber	
OCH	Conveying / Misc	Ore feed conveyor	Impingment Scrubber	
OCH	Conveying / Misc	Ore feed conveyor	Venturi Scrubber	
PH	Conveying / Misc	Cooler discharge	Impingment Scrubber	
PH	Conveying / Misc	Pellet loadout transfer conveyor	Venturi Scrubber	
PH	Conveying / Misc	Grate stripping	Venturi Scrubber	
PH	Conveying / Misc	Cooler discharge	Impingment Scrubber	
PH		Pellet loadout transfer conveyor	Venturi Scrubber	
PH		Grate stripping	Venturi Scrubber	
PH		Cooler discharge	Venturi Scrubber	
PH		Pellet loadout transfer conveyor	Venturi Scrubber	
PH		Conveyor 31-4 discharge end	Venturi Scrubber	
PH		Grate stripping	Venturi Scrubber	

Appendix A, Table 1: Ore Crushing & Handling and Finished Pellet Handling Emission Units (Cont.)

Affected Source	Unit Type	Emission Unit	Control Description	SV ID
PH		Pan Conveyor	Venturi Scrubber	
OCH	Grate Feed	Grate feed	Venturi Scrubber	
PH		Cooler discharge	Venturi Scrubber	
PH		Pellet loadout transfer conveyor	Venturi Scrubber	
PH		Grate stripping	Venturi Scrubber	
PH		Conveyor 31-5 discharge end	Venturi Scrubber	
PH		Conveyor 32-1 discharge end	Venturi Scrubber	
Tilden				
OCH	Primary Crushing	Primary crusher apron feeder	Peabody venturi scrubber	
OCH	Conveying	Conveyor	Peabody venturi scrubber	
OCH		Intermediate crusher	Unknown	
OCH	Conveying	Transfer from conveyor	Baghouse	
OCH	Conveying	Transfer from conveyor	Unknown	
OCH	Conveying	Transfer from conveyor	Sly impingement wet scrubber	
OCH	Conveying	Transfer from conveyor	Sly impingement wet scrubber	
OCH	Conveying	Transfer from conveyor	Scrubber	
OCH	Conveying	Transfer from conveyor	Scrubber	
OCH	Conveying	Transfer from conveyor	Scrubber	
OCH	Conveying	Transfer from conveyor	Scrubber	
OCH	Conveying	Transfer from conveyor	Scrubber	
OCH	Conveying	Transfer from conveyor	Scrubber	
OCH	Conveying	Transfer from conveyor	Scrubber	
OCH	Conveying	Transfer from conveyor	Scrubber	
OCH	Conveying	Transfer from conveyor	Scrubber	
OCH	Conveying	Transfer from conveyor	Scrubber	
OCH	Conveying	Transfer from conveyor	Scrubber	
OCH	Conveying	Transfer from balling area to grate	Scrubber	
OCH	Grate Feed	Grate feed	ESP	
OCH	Grate Feed	Grate feed	ESP	
PH		Cooler discharge	Sly Imping. Scrubber	
PH		Cooler discharge	Sly Imping. Scrubber	
PH		Low head feeder	Sly Imping. Scrubber	
PH		Low head feeder	Sly Imping. Scrubber	
PH		Cooler and Product conveyors	Sly Imping. Scrubber	
PH		Transfer for pellet conveyors 31.4 to 31.7	Sly Imping. Scrubber	
PH		Pellet loadout transfer conveyor 31.1&31.2 to 32	Sly Imping. Scrubber	
PH		Pellet loadout transfer conveyor31.5 & 31.7 to 32	Sly Imping. Scrubber	

Appendix A, Table 2: Ore Crushing & Handling and Finished Pellet Handling Particulate Matter Emissions and Emission Reductions

Type	SV ID	Flow rate (dcfm)	Lowest Test data (gr/dscf)	Assigned Emissions (gr/dscf)	Basis for Assigned Emissions	Base Emis. (T/Y)	Basis for Baseline Emis.	Emis. After MACT (T/Y)	Basis for MACT Emissions
US Steel Minntac									
OCH	13	66,108		0.0015	SV16, 17, 18	20	MACT	20	MACT
OCH	16	30,579	0.0019	0.0019	Test	9	MACT	9	MACT
OCH	14	66,108		0.0015	SV16, 17, 18	20	MACT	20	MACT
OCH	17	30,022	0.0014	0.0014	Test	9	MACT	9	MACT
OCH	15	31,275	0.0129	0.0129	SV16, 17, 18	9	MACT	9	MACT
OCH	18	27,699	0.0012	0.0012	Test	8	MACT	8	MACT
OCH	21	22,884		0.0047	SV24	7	SV 24	7	MACT
OCH	22	11,188		0.0047	SV24	3	SV 24	3	MACT
OCH	23	16,273		0.0047	SV24	5	SV 24	5	MACT
OCH	24	32,925	0.0047	0.0047	Test	10	MACT	10	MACT
OCH	25	15,256		0.0047	SV24	5	SV 24	5	MACT
OCH	26	6,427	0.0060	0.0060	Test	2	MACT	2	MACT
OCH	27	14,899	0.0035	0.0035	Test	4	MACT	4	MACT
OCH	28	15,674	0.0041	0.0041	Test	5	MACT	5	MACT
OCH	30	13,984		0.0038	SV 27, 28	4	SV 27,28	4	MACT
OCH	31	22,884		0.0105	SV 62, 68	9	SV 62, 68	7	MACT
OCH	32	22,884		0.0105	SV 62, 68	9	SV 62, 68	7	MACT
OCH	33	22,884		0.0105	SV 62, 68	9	SV 62, 68	7	MACT
OCH	34	22,884		0.0105	SV 62, 68	9	SV 62, 68	7	MACT
OCH	35	22,884		0.0053	SV36 Test	7	SV 36	7	MACT
OCH	36	14,600	0.0053	0.0053	Test	4	MACT	4	MACT
OCH	62	20,300	0.0097	0.0097	Test	7	Test	6	MACT
OCH	55	21,765		0.0105	SV 62, 68	9	SV 62, 68	7	MACT
OCH	56	21,256		0.0105	SV 62, 68	8	SV 62, 68	6	MACT
OCH	57	21,256		0.0105	SV 62, 68	8	SV 62, 68	6	MACT
OCH	58	21,663		0.0105	SV 62, 68	9	SV 62, 68	7	MACT
OCH	59	21,256		0.0105	SV 62, 68	8	SV 62, 68	6	MACT
OCH	64	26,697		0.0105	SV 62, 68	10	SV 62, 68	8	MACT
OCH	65	26,697		0.0105	SV 62, 68	10	SV 62, 68	8	MACT
OCH	66	26,697		0.0105	SV 62, 68	10	SV 62, 68	8	MACT
OCH	67	26,697		0.0105	SV 62, 68	10	SV 62, 68	8	MACT
OCH	68	24,867	0.0111	0.0111	Test	10	Test	7	MACT
OCH	60	20,341		0.0051	SV 63, 70	6	SV 63, 70	6	MACT
OCH	63	14,033	0.0053	0.0053	Test	4	MACT	4	MACT
OCH	69	12,200	0.0051	0.0051	Test	4	MACT	4	MACT
OCH	70	16,733	0.0050	0.0050	Test	5	MACT	5	MACT
OCH	71	16,527		0.0051	SV 63, 70	5	SV 63, 70	5	MACT
OCH	37	9,333	0.0070	0.0070	Test	3	MACT	3	MACT
OCH	54	19,070		0.0040	SV 37, 72	6	SV 37, 72	6	MACT
OCH	61	11,188		0.0040	SV 37, 72	3	SV 37, 72	3	MACT

Appendix A, Table 2: Ore Crushing & Handling and Finished Pellet Handling Particulate Matter Emissions and Emission Reductions (Cont.)

Type	SV ID	Flow rate (dcfm)	Lowest Test data (gr/dscf)	Assigned Emissions (gr/dscf)	Basis for Assigned Emissions	Base Emis. (T/Y)	Basis for Baseline Emis.	Emis. After MACT (T/Y)	Basis for MACT Emissions
OCH	72	37,900	0.0032	0.0032	Test	11	MACT	11	MACT
OCH	38	19,070		0.0038	SV 45, 73	6	SV 45, 73	6	MACT
OCH	39	19,070		0.0038	SV 45, 73	6	SV 45, 73	6	MACT
OCH	40	19,070		0.0038	SV 45, 73	6	SV 45, 73	6	MACT
OCH	41	19,070		0.0038	SV 45, 73	6	SV 45, 73	6	MACT
OCH	42	19,070		0.0038	SV 45, 73	6	SV 45 , 73	6	MACT
OCH	43	19,070		0.0038	SV 45, 73	6	SV 45 , 73	6	MACT
OCH	44	19,070		0.0038	SV 45, 73	6	SV 45 , 73	6	MACT
OCH	45	13,000	0.0021	0.0021	Test	4	MACT	4	MACT
OCH	46	19,070		0.0038	SV 45, 73	6	SV 45 , 73	6	MACT
OCH	47	19,070		0.0038	SV 45, 73	6	SV 45 , 73	6	MACT
OCH	48	19,070		0.0038	SV 45, 73	6	SV 45 , 73	6	MACT
OCH	49	19,070		0.0038	SV 45, 73	6	SV 45 , 73	6	MACT
OCH	50	19,070		0.0038	SV 45, 73	6	SV 45 , 73	6	MACT
OCH	51	19,070		0.0038	SV 45, 73	6	SV 45 , 73	6	MACT
OCH	52	19,070		0.0038	SV 45, 73	6	SV 45 , 73	6	MACT
OCH	53	19,070		0.0038	SV 45, 73	6	SV 45 , 73	6	MACT
OCH	73	23,733	0.0048	0.0048	Test	7	MACT	7	MACT
OCH	74	26,697		0.0038	SV 45, 73	8	SV 45 , 73	8	MACT
OCH	75	26,697		0.0038	SV 45, 73	8	SV 45 , 73	8	MACT
OCH	76	26,697		0.0038	SV 45, 73	8	SV 45 , 73	8	MACT
OCH	77	26,697		0.0038	SV 45, 73	8	SV 45 , 73	8	MACT
OCH	78	26,697		0.0038	SV 45, 73	8	SV 45 , 73	8	MACT
OCH	79	26,697		0.0038	SV 45, 73	8	SV 45 , 73	8	MACT
OCH	80	26,697		0.0038	SV 45, 73	8	SV 45 , 73	8	MACT
OCH	81	26,697		0.0038	SV 45, 73	8	SV 45 , 73	8	MACT
OCH	82	26,697		0.0038	SV 45, 73	8	SV 45 , 73	8	MACT
OCH	83	26,697		0.0038	SV 45, 73	8	SV 45 , 73	8	MACT
OCH	84	26,697		0.0038	SV 45, 73	8	SV 45 , 73	8	MACT
OCH	85	16,273		0.0087	SV 85	5	SV 85	5	MACT
OCH	85	13,033	0.0087	0.0087	Test	4	MACT	4	MACT
OCH	87	13,984		0.0023	SV 97	4	SV 97	4	MACT
OCH	88	26,697		0.0023	SV 97	8	SV 97	8	MACT
OCH	89	26,697		0.0023	SV 97	8	SV 97	8	MACT
OCH	90	31,783		0.0023	SV 97	10	SV 97	10	MACT
OCH	91	23,087		0.0023	SV 97	7	SV 97	7	MACT
OCH	92	27,155		0.0023	SV 97	8	SV 97	8	MACT
OCH	93	32,240		0.0023	SV 97	10	SV 97	10	MACT
OCH	94	18,567	0.0030	0.0030	Test	6	MACT	6	MACT
OCH	95	43,224		0.0023	SV 97	13	SV 97	13	MACT
OCH	96	43,224		0.0023	SV 97	13	SV 97	13	MACT

Appendix A, Table 2: Ore Crushing & Handling and Finished Pellet Handling Particulate Matter Emissions and Emission Reductions (Cont.)

Type	SV ID	Flow rate (dcfm)	Lowest Test data (gr/dscf)	Assigned Emissions (gr/dscf)	Basis for Assigned Emissions	Base Emis. (T/Y)	Basis for Baseline Emis	Emis. After MACT (T/Y)	Basis for MACT Emissions
OCH	97	32,100	0.0023	0.0023	Test	10	MACT	10	MACT
PH	101	15,256				5	MACT	5	MACT
PH	102	15,256				5	MACT	5	MACT
PH	105	24,409				7	MACT	7	MACT
PH	106	15,256				5	MACT	5	MACT
PH	109	15,256				5	MACT	5	MACT
PH	108	15,256				5	MACT	5	MACT
PH	116	14,239				4	MACT	4	MACT
PH	117	14,239				4	MACT	4	MACT
PH	120	28,833				9	MACT	9	MACT
PH	121	21,866				7	MACT	7	MACT
PH	122	8,136				2	MACT	2	MACT
PH	125	14,239				4	MACT	4	MACT
PH	126	14,239				4	MACT	4	MACT
PH	130	21,866				7	MACT	7	MACT
PH	129	28,833				9	MACT	9	MACT
PH	142	15,256				5	MACT	5	MACT
PH	143	15,256				5	MACT	5	MACT
PH	145	115,929				35	MACT	35	MACT
PH	146	38,667	0.0083	0.0083	Test	12	MACT	12	MACT
PH	149	15,256				5	MACT	5	MACT
PH	150	47,394				14	MACT	14	MACT
PH	153	39,000				12	MACT	12	MACT
						775		743	
				OCH		607		574	
				PH		169		169	
				TOTAL		775		743	
							Emission Reduction	33	
EVTAC (Thunderbird Mine)									
OCH	1	59,000	0.0017	0.0017	Test	18	MACT	18	MACT
OCH	2	27,000	0.0017	0.0017	Test	8	MACT	8	MACT
OCH	3	39,190				12	MACT	12	MACT
OCH	4	76,278				23	MACT	23	MACT
OCH	5	25,426				8	MACT	8	MACT
OCH	6	62,713				19	MACT	19	MACT
EVTAC (Fairlane Plant)									
OCH	7	22,734	0.0079	0.0079	Test	7	MACT	7	MACT
OCH	8,9	42,818	0.0231	0.0231	Test	13	MACT	13	MACT

Appendix A, Table 2: Ore Crushing & Handling and Finished Pellet Handling Particulate Matter Emissions and Emission Reductions (Cont.)

Type	SV ID	Flow rate (dcfm)	Lowest Test data (gr/dscf)	Assigned Emissions (gr/dscf)	Basis for Assigned Emissions	Base Emis. (T/Y)	Basis for Baseline Emis.	Emis. After MACT (T/Y)	Basis for MACT Emissions
OCH	10	17,107	0.1291	0.1291	Test	5	MACT	5	MACT
OCH	11	33,000	0.0060	0.0060	Test	10	MACT	10	MACT
OCH	12	40,993		0.0060	SV 11	9	SV 11	12	MACT
OCH	13	40,993		0.0060	SV 11 test	9	SV 11	12	MACT
OCH	14	40,993		0.0060	SV 11 test	9	SV 11	12	MACT
OCH	15	40,993		0.0060	SV 11 test	9	SV 11	12	MACT
OCH	16	27,333	0.0030	0.0030	Test	8	MACT	8	MACT
OCH	17	22,280	0.0387	0.0387	Test	32	Test	7	MACT
OCH	18	22,314		0.0357	SV 17,19,22	31	SV 17, 19, &22	7	MACT
OCH	19	19,000	0.0659	0.0659	Test	47	Test	6	MACT
OCH	20	19,550		0.0357		27	SV 17, 19, &22	6	MACT
OCH	21	20,341		0.0357		28	SV 17, 19, &22	6	MACT
OCH	22	21,640	0.0060	0.0060	Test	6	MACT	6	MACT
OCH	23	30,920		0.0357		43	SV 17, 19, &22	9	MACT
OCH	24	30,920		0.0357		43	SV 17, 19, &22	9	MACT
OCH	25	22,000	0.0040	0.0040	Test	7	SV 31	7	MACT
OCH	26	26,056		0.0162	SV11, 16, 17, 19, 22, 25, 31	16	SV 11, 16, 17, 19, 22, 25, and 31	8	MACT
OCH	28	15,256		0.0162	SV11, 16, 17, 19, 22, 25, and 31	9	SV 11, 16, 17, 19, 22, 25, and 31	5	MACT
OCH	29			0.0050	SV 31	7	SV 31	7	MACT
OCH	30			0.0050	SV 31	7	SV 31	7	MACT
OCH	31	23,667	0.0050	0.0050	Test	7	SV 31	7	MACT
OCH	32			0.0050	SV 31	7	SV 31	7	MACT
OCH	33			0.0050	SV 31	7	SV 31	7	MACT
OCH	39	27,300	0.0046	0.0046	Test	8	MACT	8	MACT
OCH	40	26,300	0.0072	0.0072	Test	8	MACT	8	MACT
PH	41	41,300	0.0027	0.0027	Test	12	MACT	12	MACT
OCH	43	20,775		0.0046	SV 39	6	MACT	6	MACT
OCH	44	14,861		0.0072	SV 40	4	MACT	4	MACT
PH	45	21,636		0.0027	SV 41	6	MACT	6	MACT
PH	50	6,509				2	MACT	2	MACT
PH	111	11,500	0.0056	0.0056	Test	3	MACT	3	MACT
PH	111	1,600	0.0480	0.0480	Test	0	MACT	0	MACT
PH	111	19,000	0.0647	0.0647	Test	6	MACT	6	MACT
				OCH		518		317	
				PH		30		30	
				Total		549		347	
							Emis. Red.	202	

Appendix A, Table 2: Ore Crushing & Handling and Finished Pellet Handling Particulate Matter Emissions and Emission Reductions (Cont.)

Type	SV ID	Flow rate (dcfm)	Lowest Test data (gr/dscf)	Assigned Emissions (gr/dscf)	Basis for Assigned Emissions	Base Emis. (T/Y)	Basis for Baseline Emis	Emis. After MACT (T/Y)	Basis for MACT Emissions
Northshore mine (Babbitt)									
OCH	No ID	61,023		0.0016		18	MACT	18	MACT
OCH	No ID					0		0	Not operating
OCH	No ID					18	MACT, flow- primary	18	MACT, flow- primary
OCH	No ID					18	MACT, flow- primary	18	MACT, flow- primary
	No ID								MACT, flow- primary
	No ID								MACT, flow- primary
OCH	No ID					0	Not operating	0	Not operating
OCH	No ID					0	Not operating	0	Not operating
OCH	No ID					0	Not operating	0	Not operating
OCH	No ID					0	Not operating	0	Not operating
Northshore (Sil. Bay)									
OCH	7	63,565				19	MACT	19	MACT
OCH	8	63,565				19	MACT	19	MACT
OCH	9	91,534				27	MACT	27	MACT
OCH	10	91,534				27	MACT	27	MACT
OCH	14	15,256		0.0043	SV 12, 11	5	MACT	5	MACT
OCH	13	15,256		0.0043	SV 12, 11	5	MACT	5	MACT
OCH	12	15,820	0.0043	0.0043	Test	5	MACT	5	MACT
OCH	11	15,393	0.0042	0.0042	Test	5	MACT	5	MACT
OCH	15	32,545				10	MACT	10	MACT
OCH	16	32,545				10	MACT	10	MACT
OCH	17	15,595	0.0021	0.0021	Test	5	MACT	5	MACT
OCH	18	15,256		0.0021	SV 17	5	MACT	5	MACT
OCH	19	15,256		0.0021	SV 17	5	MACT	5	MACT
OCH	20	15,256		0.0021	SV 17	5	MACT	5	MACT
OCH	21	69,687		0.0048	SV 22	21	MACT	21	MACT
OCH	22	64,555	0.0048	0.0048	Test	19	MACT	19	MACT
OCH	23	69,687		0.0048	SV 22t	21	MACT	21	MACT
OCH	24	69,687				21	MACT	21	MACT
OCH	25	69,687		0.0048	SV 22	21	MACT	21	MACT
OCH	26	9,153				3	MACT	3	MACT
OCH	27	9,153				3	MACT	3	MACT
OCH	28	9,153				3	MACT	3	MACT
OCH	29	3,560				1	MACT	1	MACT
OCH	30	14,800				4	MACT	4	MACT
OCH	31	19,120				6	MACT	6	MACT
OCH	32-43	29,901		0.0058	SV 44-53	108	MACT	108	MACT
OCH	44-53	29,732	0.0058	0.0058	Test	89	MACT	89	MACT
PH	97	12,551		0.0207		4	MACT	4	MACT

Appendix A, Table 2: Ore Crushing & Handling and Finished Pellet Handling Particulate Matter Emissions and Emission Reductions (Cont.)

Type	SV ID	Flow rate (dcfm)	Lowest Test data (gr/dscf)	Assigned Emissions (gr/dscf)	Basis for Assigned Emissions	Base Emis. (T/Y)	Basis for Baseline Emis.	Emis. After MACT (T/Y)	Basis for MACT Emissions
PH	120	28,925				17	EVTAC SV 11, 16, 17, 19, 22, 25, 31, NS SV 124	9	MACT
PH	121	28,925				17	EVTAC SV 11, 16, 17, 19, 22, 25, 31, NS SV 124	9	MACT
PH	122	28,925				17	EVTAC SV 11, 16, 17, 19, 22, 25, 31, NS SV 124	9	MACT
PH	123	28,925				17	EVTAC SV 11, 16, 17, 19, 22, 25, 31, NS SV 124	9	MACT
PH	124	14,481	0.0092	0.0092	Test	5	TEST	4	MACT
PH	125					8	EVTAC SV 11, 16, 17, 19, 22, 25, 31, NS SV 124; SV 124 flow	4	MACT, flow - SV 124
PH	260	28,925				17	EVTAC SV 11, 16, 17, 19, 22, 25, 31, NS SV 124	9	MACT
PH	255	28,925				17	EVTAC SV 11, 16, 17, 19, 22, 25, 31, NS SV 124	9	MACT
PH	265					17	EVTAC SV 11, 16, 17, 19, 22, 25, 31, NS SV 124; SV 255 flow	9	MACT, flow - SV255
						697		634	
				OCH		565		565	
				PH		132		70	
				Total		697		634	
							Emis. Red.	63	
National									
OCH	1	17,633	0.0053	0.0053	Test	5	MACT	5	MACT
OCH	3	11,387	0.0783	0.0783	Test	33	Test	3	MACT
OCH	2	22,543	0.0019	0.0019	Test	7	MACT	7	MACT
OCH	4	13,067	0.0032	0.0032	Test	4	MACT	4	MACT
OCH	5	9,647	0.0057	0.0057	Test	3	MACT	3	MACT
OCH	6	11,500		0.0057	SV 5	3	MACT	3	MACT
OCH	7	11,500		0.0057	SV 5	3	MACT	3	MACT
OCH	8	11,500		0.0057	SV 5	3	MACT	3	MACT
OCH	9	11,500		0.0057	SV 5	3	MACT	3	MACT
OCH	10	11,500		0.0057	SV 5	3	MACT	3	MACT
OCH	11	12,400				4	MACT	4	MACT
OCH	12	13,400				4	MACT	4	MACT

Appendix A, Table 2: Ore Crushing & Handling and Finished Pellet Handling Particulate Matter Emissions and Emission Reductions (Cont.)

Type	SV ID	Flow rate (dcfm)	Lowest Test data (gr/dscf)	Assigned Emissions (gr/dscf)	Basis for Assigned Emissions	Base Emis. (T/Y)	Basis for Baseline Emis.	Emis. After MACT (T/Y)	Basis for MACT Emissions
OCH	13	13,400				4	MACT	4	MACT
OCH	14	13,400				4	MACT	4	MACT
OCH	19	11,700				4	MACT	4	MACT
OCH	20	25,200	0.0020	0.0020	Test	8	MACT	8	MACT
PH	21	12,600		0.0035	SV 22	4	MACT	4	MACT
PH	22	28,000		0.0035	Test	8	MACT	8	MACT
PH	23	20,200				6	MACT	6	MACT
PH	24	51,160				15	MACT	15	MACT
PH	26	65,690		0.1683		0	Assumed NR	0	Assumed NR
PH	27	16,000				9	EVTAC SV 11, 16, 17, 19, 22, 25, 31, NS SV 124	5	MACT
PH	28	9,300				0	Not operating.	0	Not operating.
PH	32	25,333	0.0130	0.0130	Test	8	MACT	8	MACT
PH	34	11,500				3	MACT	3	MACT
PH	37	12,633	0.0035	0.0035	Test	4	MACT	4	MACT
PH	38	3,100	0.0025	0.0025	Test	1	MACT	1	MACT
						155		121	
				OCH		97		66	
				PH		59		54	
				Total		155		121	
							Emis. Red.	35	
Hibbing									
OCH	1	14,090	0.0036	0.0036	Test	4	MACT	4	MACT
OCH	3	31,233	0.0019	0.0019	Test	9	MACT	9	MACT
OCH	2	14,137				4	MACT	4	MACT
OCH	3	15,945		0.0010		5	MACT	5	MACT
OCH	101	12,220	0.0013	0.0013	Test	4	MACT	4	MACT
OCH	102	10,800	0.0016	0.0016	Test	3	MACT	3	MACT
OCH	103	13,868				4	MACT	4	MACT
OCH	104	13,868				4	MACT	4	MACT
OCH	105	13,868				4	MACT	4	MACT
OCH	106	13,868				4	MACT	4	MACT
OCH	107	13,868				4	MACT	4	MACT
OCH	108	13,868				4	MACT	4	MACT
OCH	109	13,868				4	MACT	4	MACT
OCH	110	4,577				1	MACT	1	MACT
OCH	111	5,594				2	MACT	2	MACT
OCH	203	34,400	0.0072	0.0072	Test	10	MACT	10	MACT

Appendix A, Table 2: Ore Crushing & Handling and Finished Pellet Handling Particulate Matter Emissions and Emission Reductions (Cont.)

Type	SV ID	Flow rate (dcfm)	Lowest Test data (gr/dscf)	Assigned Emissions (gr/dscf)	Basis for Assigned Emissions	Base Emis. (T/Y)	Basis for Baseline Emis.	Emis. After MACT (T/Y)	Basis for MACT Emissions
OCH	204	19,324		0.0072	SV 203	6	MACT	6	MACT
OCH	205	29,533	0.0029	0.0029	Test	9	MACT	9	MACT
OCH	206	23,392		0.0029	SV 205	7	MACT	7	MACT
PH	219	94,033	0 0024	0.0024	Test	28	MACT	28	MACT
PH	220	105,000		0.0024	SV 219	32	MACT	32	MACT
PH	221	105,000		0.0024	SV 219	32	MACT	32	MACT
PH	222	30,700	0.0176	0.0176	Test	9	MACT	9	MACT
PH	223	21,500	0.0148	0.0148	Test	6	MACT	6	MACT
						202		202	
				OCH		94		94	
				PH		108		108	
				TOTAL		202		202	
							Emis. Red.	0	
Inland									
OCH	1	12,205	0.0008	0.0008	Test	4	MACT	4	MACT
OCH	2	20,341				6	MACT	6	MACT
OCH	3	12,205				4	MACT	4	MACT
OCH	4,5	26,443				8	MACT	8	MACT
OCH	4,5	26,443				8	MACT	8	MACT
OCH	4,5	26,443				8	MACT	8	MACT
OCH	9,10	32,545				10	MACT	10	MACT
OCH	6,7,8	30,180				9	MACT	9	MACT
OCH	6,7,8	27,460				8	MACT	8	MACT
OCH	6,7,8	27,460				8	MACT	8	MACT
OCH	6,7,8	27,460				8	MACT	8	MACT
OCH	9,10	32,545				10	MACT	10	MACT
OCH	9,10	32,545				10	MACT	10	MACT
OCH	19	9,662				3	MACT	3	MACT
OCH	19					3	MACT, flow- EUID 21	3	MACT
OCH	19					3	MACT, flow- EUID 21	3	MACT
PH	20	22,782				7	MACT	7	MACT
PH	20					7	MACT, flow- EUID 24	7	MACT, flow-EUID 24
PH	18	65,091				20	MACT	20	MACT
PH	18					20	MACT, flow- EUID 27	20	MACT, flow- EUID 27
PH	21	20,595				6	MACT	6	MACT
PH	21					6	MACT, flow- EUID 27	6	MACT, flow- EUID 27
PH	24	15,256				5	MACT	5	MACT
PH	22	14,900				4	MACT	4	MACT
PH	23	16,273				5	MACT	5	MACT
						188		188	

Appendix A, Table 2: Ore Crushing & Handling and Finished Pellet Handling Particulate Matter Emissions and Emission Reductions (Cont.)

Type	SV ID	Flow rate (dcfm)	Lowest Test data (gr/dscf)	Assigned Emissions (gr/dscf)	Basis for Assigned Emissions	Base Emis. (T/Y)	Basis for Baseline Emis.	Emis. After MACT (T/Y)	Basis for MACT Emissions
				OCH		109		109	
				PH		79		79	
				Total		188		188	
							Emis. Red.	0	
Empire									
OCH		13,730				4	MACT	4	MACT
OCH		7,119				2	MACT	2	MACT
OCH		28,477				9	MACT	9	MACT
OCH				No emis.		0	No Ambient Emis.	0	No emissions
OCH				No emis.		0	No Ambient Emis.	0	No emissions
OCH		25,426				8	MACT	8	MACT
OCH		15,256				5	MACT	5	MACT
OCH		15,256				5	MACT	5	MACT
OCH		15,256				5	MACT	5	MACT
OCH		15,256				5	MACT	5	MACT
OCH		15,256				5	MACT	5	MACT
OCH		15,256				5	MACT	5	MACT
OCH		15,256				5	MACT	5	MACT
OCH		15,256				5	MACT	5	MACT
OCH		15,256				5	MACT	5	MACT
OCH		15,256				5	MACT	5	MACT
OCH		15,256				5	MACT	5	MACT
OCH		29,494				9	MACT	9	MACT
OCH		17,290				5	MACT	5	MACT
OCH		29,494				9	MACT	9	MACT
PH		15,256				5	MACT	5	MACT
PH		6,102				2	MACT	2	MACT
PH		15,256				5	MACT	5	MACT
PH		18,307				5	MACT	5	MACT
PH		12,205				4	MACT	4	MACT
PH		15,256				5	MACT	5	MACT
PH		5,085				2	MACT	2	MACT
PH		6,285				2	MACT	2	MACT
PH		6,285				2	MACT	2	MACT
PH		15,256				5	MACT	5	MACT
PH		6,102				2	MACT	2	MACT
OCH		18,510				6	MACT	6	MACT
PH		13,888				4	MACT	4	MACT
PH		5,085				2	MACT	2	MACT

Appendix A, Table 2: Ore Crushing & Handling and Finished Pellet Handling Particulate Matter Emissions and Emission Reductions (Cont.)

Type	SV ID	Flow rate (dcfm)	Lowest Test data (gr/dscf)	Assigned Emissions (gr/dscf)	Basis for Assigned Emissions	Base Emis. (T/Y)	Basis for Baseline Emis.	Emis. After MACT (T/Y)	Basis for MACT Emissions
PH		18,510				6	MACT	6	MACT
PH		9,153				3	MACT	3	MACT
PH		12,205				4	MACT	4	MACT
				OCH		101		101	
				PH		54		54	
				Total		155		155	
							Emis. Red.	0	
Tilden									
OCH		19,430		0.0120		6	MACT	6	MACT
OCH	36					2	MACT	2	MACT
OCH									
OCH						1	MACT, flow- 13-17.1	1	MACT, flow- 13-17.1
OCH						1	MACT, flow-13-17.1	1	MACT, flow- 13-17.1
OCH		3,947		0.018		1	MACT	1	MACT
OCH						1	MACT, flow- 13-17.1	1	MACT, flow- 13-17.1
OCH						1	MACT, flow- 13-17.1	1	MACT, flow- 13-17.1
OCH						1	MACT, flow- 13-17.1	1	MACT, flow- 13-17.1
OCH						1	MACT, flow- 13-17.1	1	MACT, flow- 13-17.1
OCH						1	MACT, flow- 13-17.1	1	MACT, flow- 13-17.1
OCH						1	MACT, flow- 13-17.1	1	MACT, flow- 13-17.1
OCH						1	MACT, flow- 13-17.1	1	MACT, flow- 13-17.1
OCH						1	MACT, flow 13-17.1	1	MACT, flow- 13-17.1
OCH						1	MACT, flow 13-17.1	1	MACT, flow- 13-17.1
OCH						1	MACT, flow 13-17.1	1	MACT, flow- 13-17.1
OCH						1	MACT, flow 13-17.1	1	MACT, flow- 13-17.1
OCH						1	MACT, flow 13-17.1	1	MACT, flow- 13-17.1
OCH						1	MACT, flow 13-17.1	1	MACT, flow- 13-17.1
OCH						6	MACT, flow- primary crusher	6	MACT, flow- primary crusher
OCH						6	MACT, flow primary crusher	6	MACT, flow- primary crusher
PH		30,511				0	NR	0	NR
PH		30,511				0	NR	0	NR
PH						4	MACT, flow- pellet loadout	4	MACT, flow- pellet loadout
PH						4	MACT, flow- pellet loadout	4	MACT, flow- pellet loadout
PH						4	MACT, flow- pellet loadout	4	MACT, flow- pellet loadout
PH						4	MACT, flow- pellet loadout	4	MACT, flow- pellet loadout

Appendix A, Table 2: Ore Crushing & Handling and Finished Pellet Handling Particulate Matter Emissions and Emission Reductions (Cont.)

Type	SV ID	Flow rate (dcfm)	Lowest Test data (gr/dscf)	Assigned Emissions (gr/dscf)	Basis for Assigned Emissions	Base Emis. (T/Y)	Basis for Baseline Emis.	Emis. After MACT (T/Y)	Basis for MACT Emissions
PH		12,205				4	MACT	4	MACT
PH		12,205				4	MACT	4	MACT
						61		61	
				OCH		39		39	
				PH		22		22	
				Total		61		61	
							Emis. Red.	0	

Appendix A, Table 3: Indurating Particulate Matter Emission Reductions

Plant	*Test Date*	*Line/stack* tested	*Run #*	*Flow Rate* (dscfm)	*Mass Conc.* (gr/dscf)		*Adjusted* Furnace Average	*Baseline* Emissions (tons/year)	*Basis* for Baseline	*Proposed* MACT Emis. (lb/hr)	*Proposed* MACT Emis. (tons/year)	*Basis* for MACT Emis.	*Emission* Reduction (tons/year)
					stack	*avg.*							
Minntac	*01-Feb-01*	*Line 7*	*1*	*359,004*	*0.009*								
			2	*363,977*	*0.008*								
			3	*357,544*	*0.007*								
			ave	*360,175*		*0.008*							
							0.011	*149*	*MACT*	*33.96*	*149*	*MACT*	*0*
	Jun-00	*Line 5*	*1*	*432,000*	*0.008*								
			2	*423,000*	*0.005*								
			3	*415,000*	*0.006*								
			ave	*423,333*		*0.006*							
							0.008	*175*	*MACT*	*39.91*	*175*	*MACT*	*0*
	Jun-00	*Line 4*	*1*	*401,000*	*0.006*								
			2	*401,000*	*0.006*								
			3	*406,000*	*0.007*								
			ave	*402,667*		*0.006*							
							0.008	*166*	*MACT*	*37.97*	*166*	*MACT*	*0*
	22-Jun-00	*Line 6*	*1*	*355,000*	*0.018*								
			2	*351,000*	*0.015*								
			3	*347,000*	*0.017*								
			ave	*351,000*		*0.017*							
							0.023	*301*	*TEST*	*33.09*	*145*	*MACT*	*156*
	Mar-94	*Line 3*	*1*	*295,837*	*0.617*								
			2	*315,600*	*0.498*								
			3	*302,731*	*0.475*								
			ave	*304,723*		*0.530*							
							0.726	*8307*	*TEST*	*28.73*	*126*	*MACT*	*8181*
						Facility Total		*9097*			*761*		*8337*

Appendix A, Table 3: Indurating Particulate Matter Emission Reductions (Cont.)

Plant	*Test Date*	*Line/stack* tested	*Run #*	*Flow Rate* (dscfm)	*Mass Conc.* (gr/dscf)		*Adjusted* Furnace Average	*Baseline* Emissions (tons/year)	*Basis* for Baseline	*Proposed* MACT Emis. (lb/hr)	*Proposed* MACT Emis. (tons/year)	*Basis* for MACT Emis.	*Emission* Reduction (tons/year)
					stack	*avg.*							
EVTAC	*21-Nov-97*	*Line 1 (gas fuel)*	*1*	*284,000*	*0.005*								
	21-Nov-97		*2*	*282,000*	*0.004*								
	21-Nov-97		*3*	*283,000*	*0.004*								
	21-Nov-97		*ave*	*283,000*		*0.004*							
							0.006	*117*	*MACT*	*26.68*	*117*	*MACT*	*0*
	Apr-01	*Line 2 Stack 2A*	*1*	*317,000*	*0.011*								
	Apr-01	*(coal/coke fuel)*	*2*	*317,000*	*0.011*								
	Apr-01		*3*	*319,000*	*0.012*								
	Apr-01		*ave*	*317,667*		*0.011*							
	Apr-01	*Line 2*	*1*	*300,000*	*0.009*								
	Apr-01	*Stack 2B*	*2*	*304,000*	*0.010*								
	Apr-01	*(coal/coke fuel)*	*3*	*299,000*	*0.010*								
	Apr-01		*ave*	*301,000*		*0.010*							
		Furnace Average		*309,333*			*0.014*	*167*	*TEST*	*29.17*	*128*	*MACT*	*39*
						Facility Total		*284*			*245*		*39*
Inland	*17-Jun-97*	*Stack A*	*1*	*148,009*	*0.014*								
	17-Jun-97		*2*	*147,135*	*0.008*								
	17-Jun-97		*3*	*145,207*	*0.008*								
	17-Jun-97		*ave*	*146,784*		*0.010*							
	17-Jun-97	*Stack B*	*1*	*144,969*	*0.007*								
	17-Jun-97		*2*	*143,473*	*0.008*								
	17-Jun-97		*3*	*144,634*	*0.005*								
	17-Jun-97		*ave*	*144,359*		*0.007*							
	17-Jun-97	*Stack C*	*1*	*150,321*	*0.007*								
	17-Jun-97		*2*	*149,600*	*0.005*								
	17-Jun-97		*3*	*145,900*	*0.005*								
	17-Jun-97		*ave*	*148,607*		*0.006*							
	17-Jun-97	*Stack D*	*1*	*138,928*	*0.005*								
	17-Jun-97		*2*	*140,090*	*0.005*								
	17-Jun-97		*3*	*141,327*	*0.005*								
	17-Jun-97		*ave*	*140,115*		*0.005*							
		Furnace Average		*144,966*			*0.010*	*54*	*MACT*	*12.43*	*54*	*MACT*	*0*
						Facility Total		*54*			*54*		*0*

Appendix A, Table 3: Indurating Particulate Matter Emission Reductions (Cont.)

Plant	*Test Date*	*Line/stack* tested	*Run #*	*Flow Rate* (dscfm)	*Mass Conc.* (gr/dscf)		*Adjusted* Furnace Average	*Baseline* Emissions (tons/year)	*Basis* for Baseline	*Proposed* MACT Emis. (lb/hr)	*Proposed* MACT Emis. (tons/year)	*Basis* for MACT Emis.	*Emission* Reduction (tons/year)
					stack	*avg.*							
Hibbing	*10-May-94*	*Furnace 1 Stack A*	*1*	*125,200*	*0.005*								
	10-May-94		*2*	*118,800*	*0.009*								
	10-May-94		*3*	*117,600*	*0.009*								
	10-May-94		*ave*	*120,533*		*0.008*							
	10-May-94	*Furnace 1 Stack B*	*1*	*137,200*	*0.007*								
	10-May-94		*2*	*116,900*	*0.013*								
	10-May-94		*3*	*132,700*	*0.004*								
	10-May-94		*ave*	*128,933*		*0.008*							
	10-May-94	*Furnace 1 Stack C*	*1*	*126,300*	*0.003*								
	10-May-94		*2*	*126,200*	*0.004*								
	10-May-94		*3*	*139,000*	*0.002*								
	10-May-94		*ave*	*130,500*		*0.003*							
	10-May-94	*Furnace 1 Stack D*	*1*	*129,400*	*0.003*								
	10-May-94		*2*	*124,500*	*0.003*								
	10-May-94		*3*	*137,000*	*0.007*								
	10-May-94		*ave*	*130,300*		*0.004*							
		Furnace Average		*127,567*			*0 008*	*48*	*MACT*	*10 93*	*48*	*MACT*	*0*
	Jul-99	*Furnace 2 Stack E*	*1*	*149,000*	*0.007*								
	Jul-99		*2*	*152,000*	*0.005*								
	Jul-99		*3*	*150,000*	*0.005*								
	Jul-99		*ave*	*150,333*		*0.006*							
	Jul-99	*Furnace 2 Stack F*	*1*	*154,000*	*0.006*								
	Jul-99		*2*	*155,000*	*0.004*								
	Jul-99		*3*	*154,000*	*0.004*								
	Jul-99		*ave*	*154,333*		*0.005*							
	Jul-99	*Furnace 2 Stack G*	*1*	*172,000*	*0.003*								
	Jul-99		*2*	*174,000*	*0.003*								
	Jul-99		*3*	*173,000*	*0.005*								
	Jul-99		*ave*	*173,000*		*0.004*							

Appendix A, Table 3: Indurating Particulate Matter Emission Reductions (Cont.)

Plant	*Test Date*	*Line/stack* tested	*Run #*	*Flow Rate* (dscfm)	*Mass Conc.* (gr/dscf)		*Adjusted* Furnace Average	*Baseline* Emissions (tons/year)	*Basis* for Baseline	*Proposed* MACT Emis. (lb/hr)	*Proposed* MACT Emis. (tons/year)	*Basis* for MACT Emis.	*Emission* Reduction (tons/year)
					stack	*avg.*							
Hibbing (Cont.)	*Jul-99*	*Furnace 2 Stack H*	*1*	*169,000*	*0.003*								
	Jul-99		*2*	*166,000*	*0.003*								
	Jul-99		*3*	*166,000*	*0.003*								
	Jul-99		*ave*	*167,000*		*0.003*							
		Furnace Average		*161,167*			*0.006*	*61*	*MACT*	*13.81*	*61*	*MACT*	*0*
	27-Sep-94	*Furnace 3 Stack J*	*1*	*149,200*	*0.012*								
	27-Sep-94		*2*	*153,800*	*0.017*								
	27-Sep-94		*3*	*151,700*	*0.012*								
	27-Sep-94		*ave*	*151,567*		*0.014*							
	27-Sep-94	*Furnace 3 Stack K*	*1*	*179,000*	*0.009*								
	27-Sep-94		*2*	*175,200*	*0.007*								
	27-Sep-94		*3*	*165,400*	*0.007*								
	27-Sep-94		*ave*	*173,200*		*0.008*							
	27-Sep-94	*Furnace 3 Stack L*	*1*	*146,900*	*0.016*								
	27-Sep-94		*2*	*150,400*	*0.013*								
	27-Sep-94		*3*	*143,700*	*0.013*								
	27-Sep-94		*ave*	*147,000*		*0.014*							
	27-Sep-94	*Furnace 3 Stack M*	*1*	*175,000*	*0.012*								
	27-Sep-94		*2*	*171,300*	*0.010*								
	27-Sep-94		*3*	*176,000*	*0.008*								
	27-Sep-94		*ave*	*174,100*		*0.010*							
		Furnace Average		*161,467*			*0.016*	*94*	*TEST*	*13.84*	*61*	*MACT*	*34*
							Facility Total	*203*			*169*		*34*

Appendix A, Table 3: Indurating Particulate Matter Emission Reductions (Cont.)

Plant	*Test Date*	*Line/stack* tested	*Run #*	*Flow Rate* (dscfm)	*Mass Conc.* (gr/dscf)		*Adjusted* Furnace Average	*Baseline* Emissions (tons/year)	*Basis* for Baseline	*Proposed* MACT Emis. (lb/hr)	*Proposed* MACT Emis. (tons/year)	*Basis* for MACT Emis.	*Emission* Reduction (tons/year)
					stack	*avg.*							
National	*Jul-00*	*Stack 2A*	*1*	*246,553*	*0.058*								
			2	*248,218*	*0.074*								
			3	*244,867*	*0.078*								
			ave	*246,546*		*0.070*							
	Jul-00	*Stack 2B*	*1*	*268,870*	*0.055*								
			2	*259,641*	*0.057*								
			3	*260,378*	*0.045*								
			ave	*262,963*		*0.052*							
		Furnace Average		*254,755*			*0.084*	*801*	*TEST*	*24.02*	*105*	*MACT*	*696*
						Facility Total		*801*			*105*		*696*
Northshore	*Jul-96*	*Furnace 11*	*1*	*62,176*	*0.011*								
	Jul-96	*Waste Gas*	*2*	*60,661*	*0.006*								
	Jul-96		*3*	*61,312*	*0.005*								
	Jul-96		*ave*	*61,383*		*0.007*							
	Jul-96	*Furnace 11*	*1*	*62,573*	*0.006*								
	Jul-96	*Waste Gas*	*2*	*60,998*	*0.006*								
	Jul-96		*3*	*61,764*	*0.006*								
	Jul-96		*ave*	*61,778*		*0.006*							
		Furnace Average		*61,581*			*0.009*	*58*	*MACT*	*5.28*	*58*	*MACT*	*0*
	Jul-96	*Furnace 12*	*1*	*58,484*	*0.009*								
	Jul-96	*Waste Gas*	*2*	*60,125*	*0.006*								
	Jul-96		*3*	*60,740*	*0.006*								
	Jul-96		*ave*	*59,783*		*0.007*							
	Jul-96	*Furnace 12*	*1*	*56,746*	*0.005*								
	Jul-96	*Waste Gas*	*2*	*56,129*	*0.007*								
	Jul-96		*3*	*56,134*	*0.007*								
	Jul-96		*ave*	*56,336*		*0.006*							
		Furnace Average		*58,060*			*0.009*	*54*	*MACT*	*4.98*	*54*	*MACT*	*0*

Appendix A, Table 3: Indurating Particulate Matter Emission Reductions (Cont.)

Plant	*Test Date*	*Line/stack* tested	*Run #*	*Flow Rate* (dscfm)	*Mass Conc.* (gr/dscf)		*Adjusted* Furnace Average	*Baseline* Emissions (tons/year)	*Basis* for Baseline	*Proposed* MACT Emis. (lb/hr)	*Proposed* MACT Emis. (tons/year)	*Basis* for MACT Emis.	*Emission* Reduction (tons/year)
					stack	*avg.*							
Northshore	*10-Oct-95*	*Furnace 6*	*1*	*52,507*	*0.009*								
(Cont)	*10-Oct-95*	*Waste Gas*	*2*	*52,961*	*0.005*								
	10-Oct-95		*3*	*52,937*	*0.009*								
	10-Oct-95		*ave*	*52,802*		*0.008*							
							0.010	*59*	*MACT*	*4.53*	*59*	*MACT*	*0*
						Facility Total		*172*			*172*		*0*
Empire	*20-May-00*	*Kiln 1*	*1*	*272,105*	*0.006*								
	20-May-00	*coal/gas*	*2*	*272,786*	*0.005*								
	20-May-00		*3*	*274,174*	*0.003*								
	20-May-00		*ave*	*273,022*		*0.005*							
							0.006	*113*	*MACT*	*25.74*	*113*	*MACT*	*0*
	Aug-00	*Kiln 2*	*1*	*330,256*	*0.001*								
	Aug-00	*gas*	*2*	*318,569*	*0 001*								
	Aug-00		*3*	*321,935*	*0.001*								
	Aug-00		*ave*	*324,413*		*0.001*							
							0.001	*134*	*MACT*	*30.59*	*134*	*MACT*	*0*
	Aug-00	*Kiln 3*	*1*	*307,502*	*0.002*								
	Aug-00	*coal*	*2*	*287,201*	*0.002*								
	Aug-00		*3*	*294,649*	*0.002*								
	Aug-00		*ave*	*296,451*		*0.002*							
							0 003	*122*	*MACT*	*27.95*	*122*	*MACT*	*0*
	Aug-00	*Kiln 4*	*1*	*582,259*	*0*								
	Aug-00	*gas*	*2*	*583,960*	*0.001*								
	Aug-00		*3*	*579,074*	*0.001*								
	Aug-00		*ave*	*581,764*		*0 001*							
							0.001	*240*	*MACT*	*54.85*	*240*	*MACT*	*0*
						Facility Total		*609*			*609*		*0*

Appendix A, Table 3: Indurating Particulate Matter Emission Reductions (Cont.)

Plant	*Test Date*	*Line/stack* tested	*Run #*	*Flow Rate* (dscfm)	*Mass Conc.* (gr/dscf) *stack*	*Mass Conc.* (gr/dscf) *avg.*	*Adjusted* Furnace Average	*Baseline* Emissions (tons/year)	*Basis* for Baseline	*Proposed* MACT Emis. (lb/hr)	*Proposed* MACT Emis. (tons/year)	*Basis* for MACT Emis.	*Emission* Reduction (tons/year)
Tilden	*03-May-00*	*Unit 1 Stack 2A*	*1*	*361,597*	*0.054*								
	03-May-00		*2*	*360,140*	*0.014*								
	03-May-00		*3*	*356,228*	*0.025*								
	03-May-00		*ave*	*359,322*		*0.031*							
	03-May-00	*Unit 1 Stack 2B*	*1*	*277,572*	*0.01*								
	03-May-00		*2*	*278,539*	*0.005*								
	03-May-00		*3*	*279,603*	*0.004*								
	03-May-00		*ave*	*278,571*		*0.006*							
	03-May-00	*Unit 1 Stack 2C*	*1*	*237,680*	*0.009*								
	03-May-00		*2*	*218,411*	*0.005*								
	03-May-00		*3*	*227,611*	*0.005*								
	03-May-00		*ave*	*227,901*		*0.006*							
		Furnace average		*288,598*			*0.015*	*119*	*MACT*	*27.21*	*119*	*MACT*	*0*
	May-94	*Unit 2 Stack 2A*	*1*	*246,774*	*0.007*								
	May-94		*2*	*242,397*	*0.005*								
	May-94		*3*	*240,661*	*0.005*								
	May-94		*ave*	*243,277*		*0.006*							
	May-94	*Unit 2 Stack 2B*	*1*	*264,878*	*0.002*								
	May-94		*2*	*264,268*	*0.003*								
	May-94		*3*	*245,946*	*0.002*								
	May-94		*ave*	*258,364*		*0.002*							
	May-94	*Unit 2 Stack 2C*	*1*	*303,634*	*0.004*								
	May-94		*2*	*298,345*	*0.004*								
	May-94		*3*	*296,227*	*0.004*								
	May-94		*ave*	*299,402*		*0.004*							
		Furnace average		*267,014*			*0.005*	*100*	*MACT*	*22.89*	*100*	*MACT*	*0*
						Facility Total		*219*			*219*		*0*
						GRAND TOTAL		*11441*			*2335*		

a Northshore furnace 6 test represents only 1 out of 3 stacks. It is assumed that the test values are not representative and it is included just for getting a baseline value. Therefore, furnace is considered to incur no emission reductions.

Appendix A, Table 4: Ore Dryer Particulate Matter Baseline Emissions

Plant	Process	Emission Unit	Control Description	Flow rate (acfm)	Flow rate (dcfm)	Test data or Assigned Test data (gr/dscf)	Adjusted Flow rate (acfm)[a]	PM MACT Base. Emis. (tons/year)
Tilden	Ore Dryer	Dryer # 2 North Stack	Impingement Scrubber	39,138	39,805	0.0280	46,966	77.71
	Ore Dryer	Dryer # 2 South Stack	Impingement Scrubber	36,069	36,684	0.0520	43,283	71.62
	Ore Dryer	Dryer # 1	Impingement Scrubber	55,251	56,193	0.0170	66,301	109.70
							Tilden - Ore Dryers	259.03

[a] Element compositions for Tilden were not available.

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Appendix B

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Appendix B, Table 1a: Operating and Design Parameters of Scrubbers for Indurating Furnaces

Line	Stack #	Flow (acfm)	Inlet temp. (°F)	Inlet air velocity (ft/sec)	Water flow (gpm)	Pressure drop (inches water)	Gas pre-treatment	# of rods in rod deck	Rod diameter (inches)	Rod length (feet)	Width of rod bed (feet)	Type of mist eliminator
EVTAC VENTURI SCRUBBERS DATA (GRATE-KILNS)												
1	2	420,000	250	62	3,700	8	No					Chevron blade
2	2A	415,000	230	47	3,850	8	No					Chevron blade
2	2B	415,000	230	47	3,850	8	No					Chevron blade
HIBBING VENTURI ROD SCRUBBERS DATA (TRAVEL GRATES)												
1	1A, 1B, 1C, 1D	200,000 per scrubber	200-350	unknown	1,000 - 1,150	6	multiclones* (see multiclones section)	89	0.75	18	3.5	Chevron blade
2	2E,, 2F, 2G, 2H	200,000 per scrubber	200-350	unknown	1,000 - 1,150	6	multiclones* (see multiclones section)	89	0.75	18	3.5	Chevron blade
3	3J, 3K, 3L, 3M	200,000 per scrubber	200-350	unknown	1,000 - 1,150	6	multiclones* (see multiclones section)	89	0.75	18	3.5	Chevron blade
ISPAT INLAND VENTURI ROD SCRUBBERS DATA (TRAVEL GRATE)												
1	1a, 1b, 1c, 1d	184,000	210-320	49	1,000	4-9	multiclones	100	1.1	17		Chevron blade

Appendix B, Table 1a: Operating and Design Parameters of Scrubbers for Indurating Furnaces (Cont.)

Line	Stack #	Flow (acfm)	Inlet temp. (°F)	Inlet air velocity (ft/sec)	Water flow (gpm)	Pressure drop (inches water)	Gas pre-treatment	# of rods in rod deck	Rod diameter (inches)	Rod length (feet)	Width of rod bed (feet)	Type of mist eliminator
US STEEL MINNTAC VENTURI ROD SCRUBBERS DATA (LINES 4 - 7 GRATE-KILNS)												
4	n/a	860,000	250	85	3,000	6	cyclones and washed (impingement) plate	190	1.1	20	2.1	Chevron blade
5	n/a	860,000	250	85	3,000	6	cyclones and washed (impingement) plate	190	1.1	20	2.1	Chevron blade
6	n/a	590,000	250	57	3,000	7	cyclones and washed (impingement) plate	296	1	22	2.25	Chevron blade
7	n/a	590,000	250	57	3,000	7	cyclones and washed (impingement) plate	296	1	22	2.25	Chevron blade

Appendix B, Table 1b: Operating and Design Parameters of ESP for Indurating Furnaces

EMPIRE DRY ESPS DATA (GRATE-KILNS)																
Line /unit	EU #	Flow. (acfm)	Inlet temp (°F)	Inlet air velocity (ft/sec)	Pressure drop (inches water)	Cross sectional area (ft^2)	Specific collection area (ft^2/1000 acfm)	No. of plates per field	No of chambers, No. of fields	Distance between plate and electrode (inches)	No. of T/R sets	Plate area per T/R set (ft^2)	Primary current (amperes)/ Secondary current (milli-amperes)	Primary voltage (volts)/ Secondary voltage (kilovolts)	Spark rate (sparks per min)	Rapping mechanism
1	141	385,000	230-290	6	unk.	990	171	34	1, 3	6	3	set 1: 24,007 set 2: 24,007 set 3: 17,985	set 1: 161/656 set 2: 268/588 set 3: 187/865	set 1: 335/46 set 2: 275/49 set 3:293/unknown	set 1: 0 set 2: 0 set 3: 0	electromagnetic gravity
2	143	420,000	230-290	6	unk.	1,110	174	38	1, 3	6	3	set 1: 26,640 set 2: 26,640 set 3: 19,980	set 1: 200/1220 set 2: 190/1080 set 3: 208/1240	set 1: 412/52 set 2: 400/52 set 3: 404/54	set 1: 0 set 2: 0 set 3: 0	electromagnetic gravity
3	145	382,700	200-240	5	unk.	1,190	222	36	1, 4	6	4	set 1: 19,648 set 2: 19,648 set 3: 19,648 set 4: 26,196	set 1: 136/640 set 2: 206/980 set 3: 209/1000 set 4: 286/970	set 1: 238/41 set 2: 349/47 set 3: 210/42 set 4: 293/unknown	set 1: 0 set 2: 0 set 3: 1 set 4: 0	electromagnetic gravity
4	147	769,000	230-290	6	0.5	2,233	176	31	2, 3	6	7	set 1: 20,367 set 2: 20,367 set 3: 20,367 set 4: 20,367 set 5: 27,063 set 6: 13,531 set 7: 13,531	set 1: unknown set 2: 112/730 set 3: 110/630 set 4: 85/690 set 5: 127/840 set 6: 122/870 set 7: 123/750	set 1: unknown set 2: 420/43 set 3: 464/42 set 4: 443/43 set 5: 401/40 set 6: 444/42 set 7: 442/43	set 1: unk. set 2: 0 set 3: 0 set 4: 0 set 5: 0 set 6: 0 set 7: 0	electromagnetic gravity

Appendix B, Table 1b: Operating and Design Parameters of ESP for Indurating Furnaces (Cont.)

NORTHSHORE WET ESPS DATA (TRAVEL GRATES)

Line/ Unit	EU # (CE#)	Flow (acfm)	Inlet temp (°F)	Rate of water spray for moisture control (gpm)	Inlet air velocity (ft/sec)	Pressure drop (inches water)	Cross sectional area (ft²)	Specific collection area (ft²/1000 acfm)	No. of chambers; No. of fields	Distance between plate and electrode (inches)	No. of T/R sets	Plate area per T/R set (ft²)	Primary current (amperes)/ Secondary current (milliamperes)	Primary voltage (volts)/ Secondary voltage (kilovolts)	Spark rate (sparks per minute)	Rate of water irrigation (gpm)	Duration of irrigation (minutes)
6	601 (95) 602 (96) 603 (97)	100,000	<165	variable	55	1.5	115	25	6, 6	2	1 per cylinder	1,200	set 1: 0-54/400 set 2: variable	480/0-54 (all sets)	10 (all sets)	160	continuous
11	1101 (98) 1102 (99) 1103 (100) 1104 (104) 1105 (105)	100,000	<165	variable	55	1.5	115	25	6, 6	2	1 per cylinder	1,200	set 1: 0-54/400 set 2: variable	480/0-54 (all sets)	10 (all sets)	160	continuous
12	1201 (101) 1202 (102) 1203 (103) 1204 (106) 1205 (107)	100,000	<165	variable	55	1.5	115	25	6,6	2	1 per cylinder	1,200	set 1: 0-54/400 set 2: variable	480/0-54 (all sets)	10 (all sets)	160	continuous

TILDEN WET ESP DATA (GRATE-KILN)

Line/ Unit	EU #	Flow (acfm)	Inlet temp (°F)	Rate of water spray for moisture control (gpm)	Inlet air velocity (ft/sec)	Pressure drop (inches water)	Cross sectional area (ft²)	Specific collection area (ft²/1000 acfm)	No. of plates per field	No. of chambers; No. of fields	Distance between plate and electrode (inches)	No. of T/R sets	Plate area per T/R set (ft²)	Primary current (amperes)/ Secondary current (milliamperes)	Primary voltage (volts)/ Secondary voltage (kilovolts)	Spark rate, (sparks per minute)	Rate of water irrigation (gpm)	Duration of irrigation (minutes)
1	2A	446,700	180	480	5	unk.	1,500	123	1st - 60 2nd - 44 3rd- 44	2, 3	1st - 6 2nd - 8 3rd - 8	4	set 1: 8640 set 2: 8640 set 3: 19,000 set 4: 12,672	set 1: 130/660 set 2: 130/660 set 3: 90/420 set 4: 60/220	400 (primary) for all sets/ no data for secondary	set 1: 8 - 30 set 2:8 - 30 set 3: 0 set 4: 0	60	10-20

Appendix B, Table 1b: Operating and Design Parameters of ESP for Indurating Furnaces (Cont.)

TILDEN DRY ESP DATA (GRATE-KILN)

Line/ Unit	EU #	Flow (acfm)	Inlet temp (°F)	Rate of water spray for moisture control (gpm)	Inlet air velocity (ft/sec)	Pressure drop (inches water)	Cross sectional area (ft^2)	Specific collection area (ft^2/1000 acfm)	No. of plates per field	No. of chambers; No. of fields	Distance between plate and electrode (inches)	No. of T/R sets	Plate area per T/R set (ft^2)	Primary current (amperes)/ Secondary current (milliamperes)	Primary voltage (volts)/ Secondary voltage (kilovolts)	Spark rate (sparks per minute)	Rapping mechanism	Rapping frequency
1	2B	433,100	340	n/a	4	1-2	1,670	358	80	2, 4	4.5	4	set 1: 43,200 set 2: 28,800 set 3: 43,200 set 4: 28,800	240/1500 (all sets)	400 (primary) for all sets	varies	drop of weight onto anvil	varies
1	2C	433,100	340	n/a	4	1-2	1,670	358	80	2, 4	4.5	4	set 1: 43,200 set 2: 28,800 set 3: 43,200 set 4: 28,800	240/1500 (all sets)	400 (primary) for all sets	varies	drop of weight onto anvil	varies
2	2A	446,700	230-300	n/a	5	1-2	1,800	322	80	2, 4	4.5	4	set 1: 43,200 set 2: 28,800 set 3: 43,200 set 4: 28,800	240/1500 (all sets)	400 (primary) for all sets	varies	drop of weight onto anvil	varies
2	2B	402,200	230-300	n/a	4	1-2	1,800	358	80	2, 4	4.5	4	set 1: 43,200 set 2: 28,800 set 3: 43,200 set 4: 28,800	240/1500 (all sets)	400 (primary) for all sets	varies	drop of weight onto anvil	varies
2	2C	402,200	230-300	n/a	4	1-2	1,800	358	80	2, 4	4.5	4	set 1: 43,200 set 2: 28,800 set 3: 43,200 set 4: 28,800	240/1500 (all sets)	400 (primary) for all sets	varies	drop of weight onto anvil	varies

Appendix B, Table 1c: Operating and Design Parameters of Multiclones for Indurating Furnaces

Line	CE#	Stack #	EU#	Flow (acfm)	Inlet Temp, (°F)	Inlet air velocity (ft/sec)	Pressure drop (inches water)	Arrangement of multiclones	Diameter of each cyclone (ft.)	Body length (ft.)	Cone length (ft.)	Gas outlet diameter (ft.)
NATIONAL STEEL MULTICLONES DATA (GRATE-KILN)												
Phase II	030	2A	30	331,000	230	55	4	2 X 2	11	12	10	
Phase II	031	2B	31	331,000	230	55	4	2 X 2	11	12	10	
Phase II	035	n/a	30	343,000	613	71	5	2 X 3	8	16	8	
Phase II	036	n/a	31	315,000	662	65	5	2 X 3	8	16	8	
US STEEL MINNTAC MULTICLONES DATA (PRIMARY CONTROL FOR LINE 3, PRETREATMENT FOR LINES 4 - 7, GRATE KILNS)												
3	088		223 225 226	590,000	600	7.5	unknown		5.7	5.0	7.9	2.6
4	103		259 261 262	240,000 - 350,000	700	1.7 - 2.4	unknown		6.0	8.15	8.0	3.5
5	114		280 282 283	240,000 - 350,000	700	1.7 - 2.4	unknown		6.0	8.15	8.0	3.5
6	128		313 315 316	240,000 - 350,000	700	1.7 - 2.4	unknown		6.0	8.15	8.0	3.5
7	138		332 334 335	240,000 - 350,000	700	1.7 - 2.4	unknown		6.0	8.15	8.0	3.5

Appendix B, Table 1c: Operating and Design Parameters of Multiclones for Indurating Furnaces (Cont.)

HIBBING PRETREATMENT MULTICLONES DATA (WINDBOX EXHAUST GAS BEFORE VENTURI ROD SCRUBBERS)												
Line	CE#	Stack #	EU#	Flow (acfm)	Inlet Temp, (°F)	Inlet air velocity (ft/sec)	Pressure drop (inches water)	Arrangement of multiclones	Diameter of each tube (inches)	Tube length (inches)	Cone length (inches)	Gas outlet diameter (inches)
1	045	not applicable	018	350,000-400,000	300-350	34-39	3.4	72 across x 14 deep	11.5	32	1.25	7
2	046	not applicable	019	350,000-400,000	300-350	34-39	3.4	72 across x 14 deep	11.5	32	1.25	7
3	047	not applicable	020	350,000-400,000	300-350	34-39	3.4	72 across x 14 deep	11.5	32	1.25	7

* There are 11 other furnaces *(lines) which are identical to A1* in configuration (without heat exchanger). They are A3, B1, B3, C1, C3, D2, D4, E2., E4, F2, and F4.

** There are 11 other furnaces (lines) which are identical to A2 in configuration (with a heat exchanger). They are A4, B2, B4, C2, C4, D1, D3, E1., E3, F1, and F3.

*** G3 has the same configuration as G1.

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Appendix C

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Figure 1a - Primary and Secondary Crushing PM Emissions

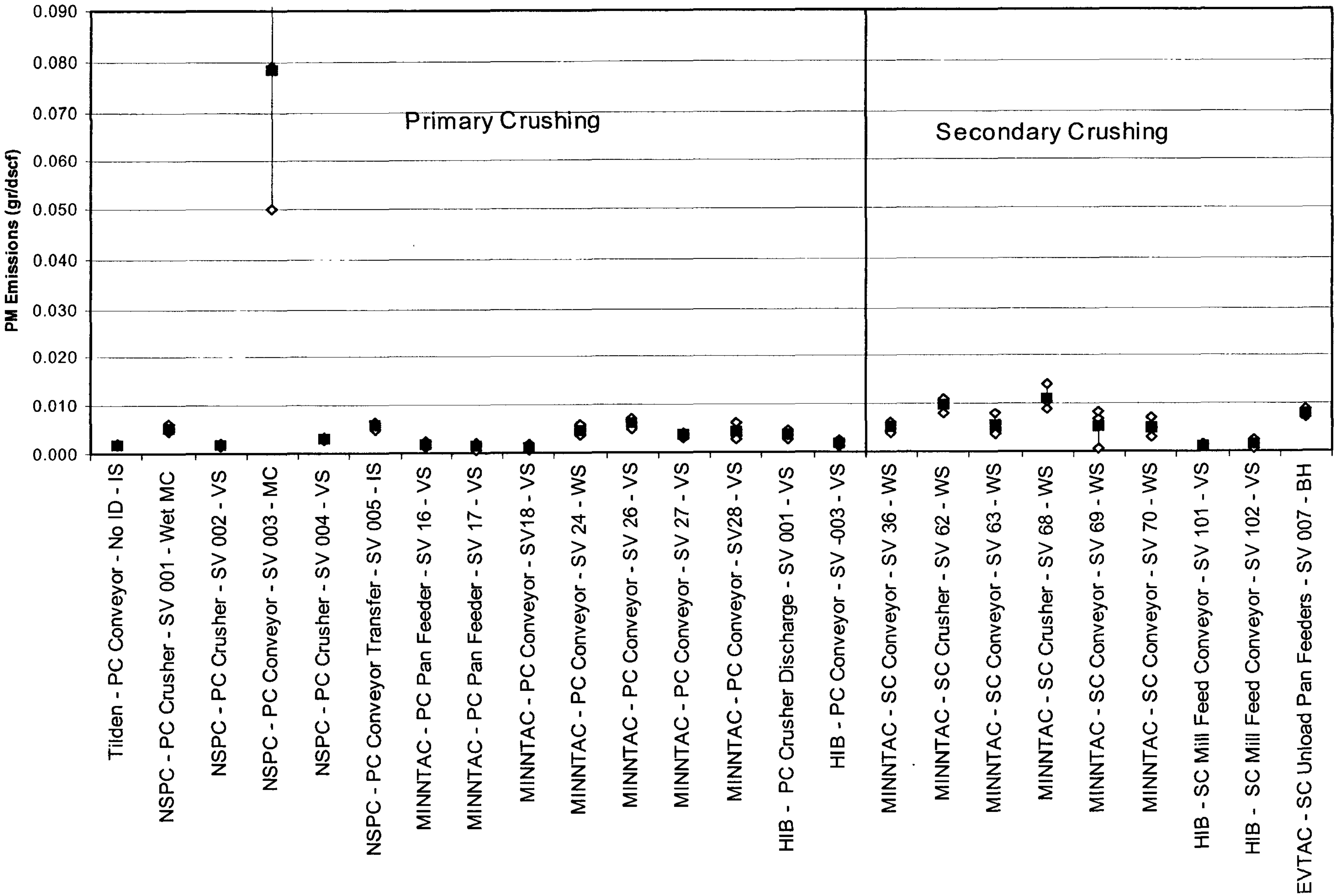


Figure 1b - Tertiary Crushing and Grate Feed PM Emissions

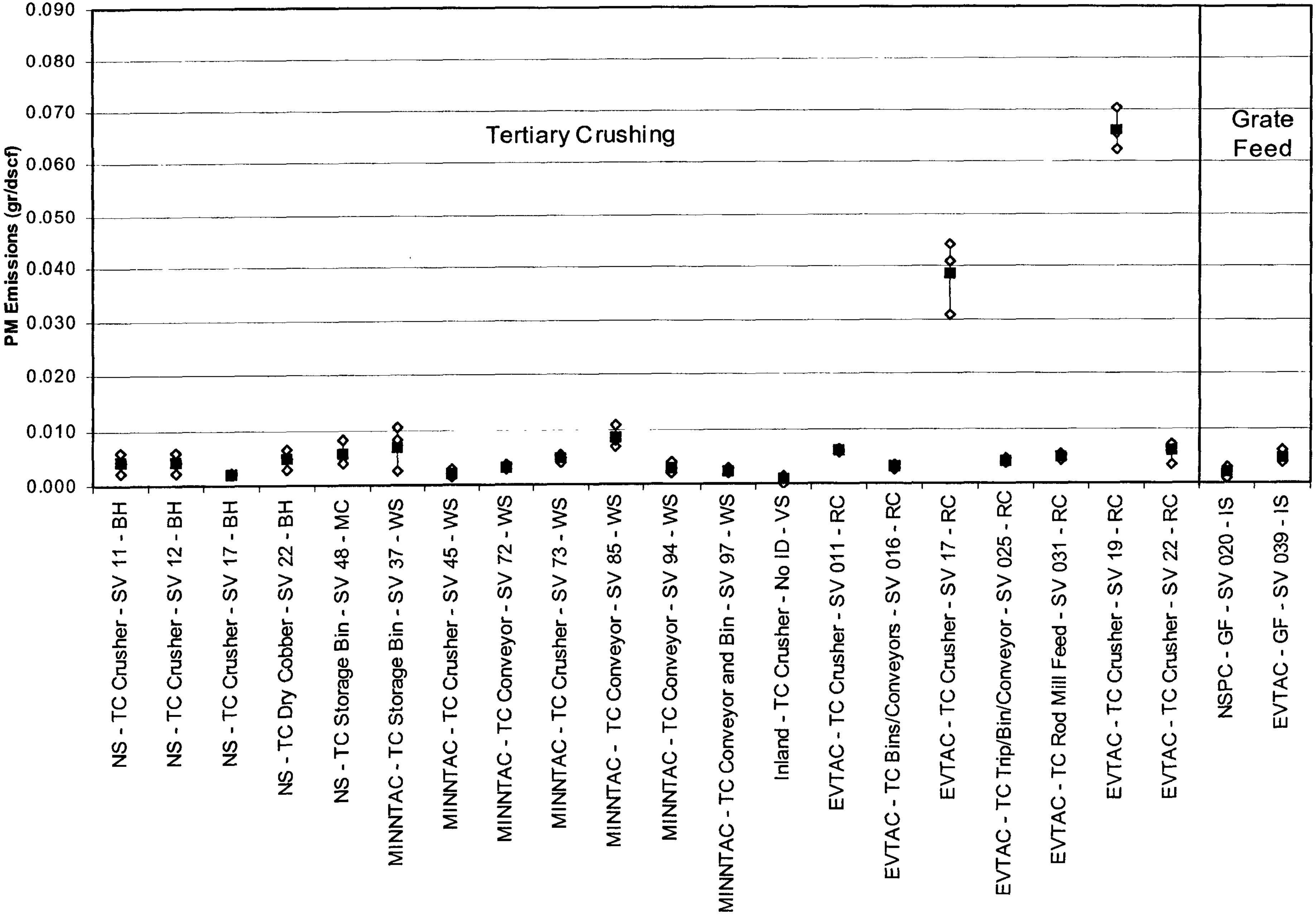
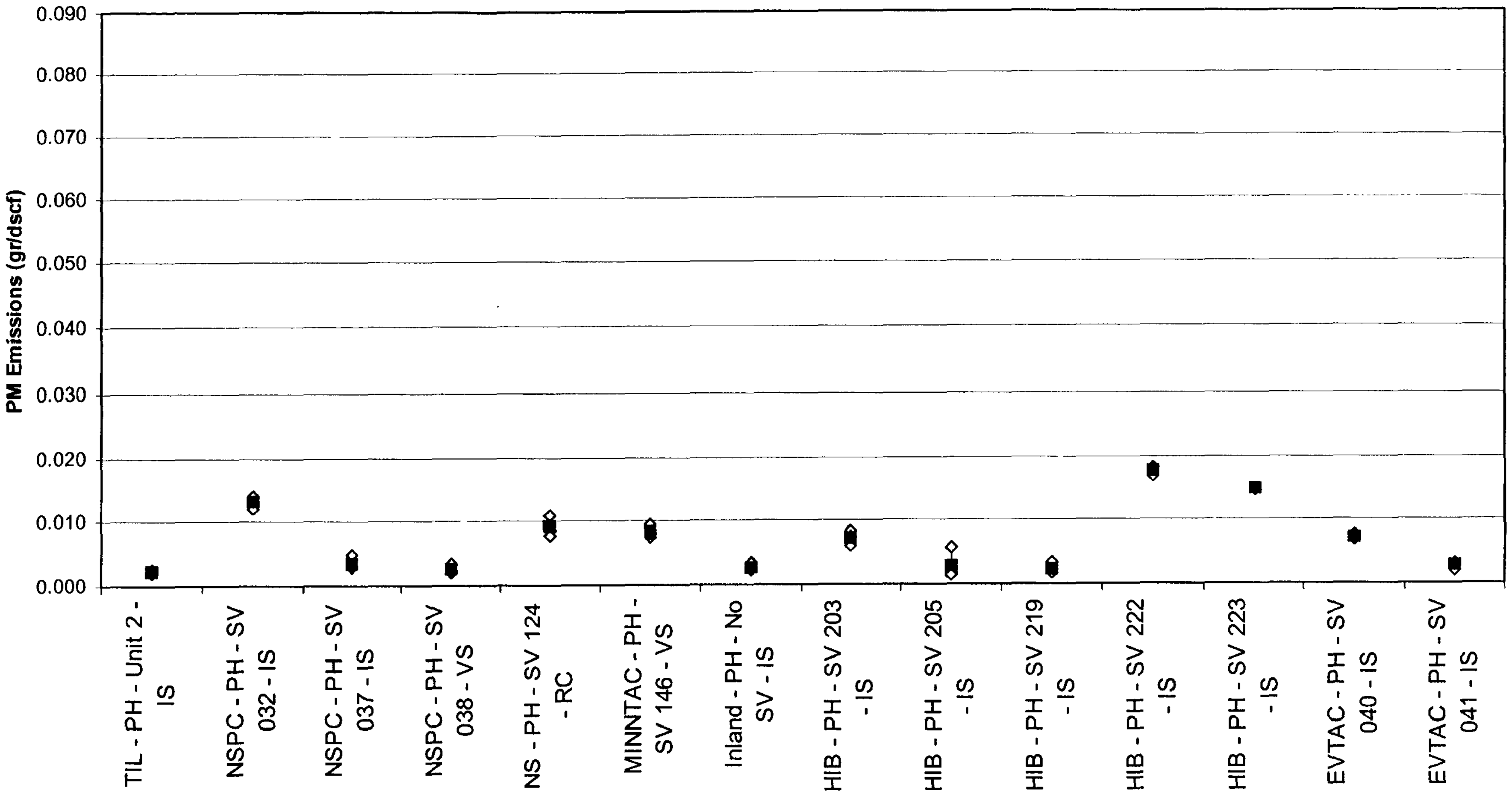


Figure 1c - Finished Pellet Handling PM Emissions



Appendix C, Table 1: Non-Valid PM Emissions Data for OCH and PH Emission Units

Unit Label	Plant's Unit name	Test Date	Run 1 Flow (dscf)	Run 1 Emis (gr/dscf)	Run 2 Flow (dscf)	Run 2 Emis. (gr/dscf)	Run 3 Flow (dscf)	Run 3 Emis. (gr/dscf)	Avg. Flow (dscf)	Avg Emis. (gr/dscf)
EVTAC - PC Crusher - SV 001 - BH	Primary Crusher (Thunderbird mine)	12/14/00	61,000	0.0022	60,000	0.0015	56,000	0.0013	59,000	0.0017
EVTAC - SC Crusher - SV 002 - BH	Secondary Crusher (Thunderbird mine)	12/14/00	28,000	0.003	26,000	0.001	26,000	0.0011	26,667	0.0017
EVTAC - SC Unloading - SV 008 - BH	Crude Ore Unloading	9/11/97	45,960	0.0096	42,166	0.0291	40,329	0.0306	42,818	0.0226
EVTAC - SC Ore Surge - SV 010 - BH	Crude Ore Surge	9/12/97	17,229	0.0266	17,288	0.0545	16,803	0.3063	17,107	0.1276
EVTAC - PH - SV 052 - VS	Pellet Loadout	10/97	12,000	0.0051	11,000	0.006			11,500	0.0055
EVTAC - PH - SV 063 - VS	Pellet Loadout Bin #3	10/97	1,600	0.035	1,600	0.064	1,600	0.045	1,600	0.0480
EVTAC - PH - SV 064 - VS	Pellet Loadout	10/97	19,000	0.059	19,000	0.034	19,000	0.101	19,000	0.0647
EVTAC - PH - SV 111 - VS	Pellet Loadout	7/12/01	39,000	0.0011	39,000	0.0007	38,000	0.0018	38,667	0.0012
HIB - PC Crusher Discharge - SV 001 - VS	Phase I Primary Crusher Dischage	7/16/99	14,021	0.0044	14,258	0.0021	13,991	0.0023	14,090	0.0029
HIB - PC Conveyor - SV -003 - VS	Phase I Ore Conveyor	6/23/94	31,000	0.0019	31,000	0.0011	31,700	0.0027	31,233	0.0019
MINNTAC - GD - SV 125 - IS	Line 6 Grate Discharge	1/30/80	8,390	0.008	8,330	0.011	8,340	0.0100	8,353	0.0097
MINNTAC - PH - SV 138 - IS	Step 3, 042 to 043 con. Trans.	1/10/80	14,900	0.0034	14,400	0.0032	14,500	0.0026	14,600	0.0031
MINNTAC - GF - SV 142 - IS	Line 3 Grate Feed	1/9/80	2,190	0.0021	2,210	0.0011	2,170	0.0016	2,190	0.0016
MINNTAC - PH - SV 146 - IS	Line 6, 041 Conveyors	1/10/80	8,960	0.0053	8,940	0.0053	8,860	0.0048	8,920	0.0051
MINNTAC - PC Crusher - SV 15 - BH	Primary Crusher	3/30/89	32,396	0.0174	31,116	0.012	30,313	0.0093	31,275	0.0130
MINNTAC - PC Crusher - SV 15 - BH	Primary Crusher	5/2/80	49,800	0.111	52,200	0.081	52,100	0.0950	51,367	0.0954
MINNTAC - PC Pan Feeder - SV 16 - ???	Coarse Crusher Pan Feeder to 001-01	7/21/80	15,550	0.006	15,500	0.007	15,600	0.0080	15,550	0.0070
MINNTAC - PC Conveyor - SV 16 - VS	Coarse Crusher Conveyor	4/01/93	30,059	0.0026	30,799	0.0018	30,879	0.0014	30,579	0.0019
MINNTAC - PC Conveyor - SV17 - VS	Coarse Crusher Conveyor	3/31/93	30,187	0.002	29,843	0.0006	30,036	0.0016	30,022	0.0014
MINNTAC - PC Pan Feeder - SV 18 - WS	Pan Feeder to 001-003	1/29/80	19,100	0.014	19,200	0.008	19,200	0.0100	19,167	0.0107
MINNTAC - PC Conveyor - SV 24 - WS	Conveyor Transfer 004 to 005	1/29/80	39,800	0.023	39,800	0.01	39,700	0.0150	39,767	0.0160
MINNTAC - SC Conveyor - SV 70 - WS	Conveyor Transfer 003 to 003	1/9/80	16,300	0.072	15,800	0.032	16,200	0.0040	16,100	0.0361
MINNTAC - TC Conveyor - SV 85 - WS	Conveyor Transfer 005 to 006	1/9/80	13,000	0.0027	13,000	0.0025	13,100	0.0122	13,033	0.0058
NS - TC Crusher - SV 12 - BH	Fine Crusher	5/24/94	15,695	0.0042	15,868	0.0013	15,896	0.0020	15,820	0.0025
NS - TC Cobbed Ore Transfer Bin - SV 30 - MC	Cobbed Ore Transfer Bin	11/23/99	14,700	0.041	14,900	0.049			14,800	0.0450
NS - PH - SV 124 - RC	Pellet Screen House	5/98	14,132	0.0097	14,700	0.0078	14,579	0.0077	14,470	0.0084
NS - TC Dry Cobber - SV 22 - BH	Dry Cobber	5/26/94	66,910	0.0034	66,670	0.0028	67,430	0.0023	67,003	0.0028
NS - TC Dry Cobber - SV 22 - BH	Dry Cobber	6/28/95	64,697	0.0026	64,475	0.0025	64,493	0.0014	64,555	0.0022
NS - TC Cobbed Ore Transfer Bin - SV 31 - BH	Cobbed Ore Transfer Bin	11/23/99	14,900	0.0003						0.0003
NS - TC Storage Bin - SV 48 - MC	Bin Storage (East)	5/24/94	29,637	0.0039	29,634	0.0023	29,925	0.0045	29,732	0.0036
NS - TC Storage Bin - SV 48 - MC	Bin Storage (East)	1/10/95	28,616	0.0048	29,522	0.0052	29,692	0.0058	29,277	0.0053
NS - GF Hearth Layer - SV 97 - BH	Hearth Layer	6/97	12,686	0.0247	12,551	0.0169	12,645	0.0205	12,627	0.0207
NSPC - PC Crusher - SV 001 - Wet MC	Primary Crusher #1	1/95	20,000	0.0274	18,000	0.0122	19,000	0.0200	19,000	0.0201
NSPC - PC Conveyor - SV 003 - MC	Drive House #1 Conveyor	8/01/97	11,370	0.033	11,407	0.039	11,384	0.0260	11,387	0.0327

Appendix C, Table 1: Non-Valid PM Emissions Data for OCH and PH Emission Units (Cont.)

Unit Label	Plant's Unit name	Test Date	Run 1 Flow (dscf)	Run 1 Emis. (gr/dscf)	Run 2 Flow (dscf)	Run 2 Emis. (gr/dscf)	Run 3 Flow (dscf)	Run 3 Emis. (gr/dscf)	Avg. Flow (dscf)	Avg Emis. (gr/dscf)
NSPC - PC Conveyor - SV 003 - MC	Drive House #1 Conveyor	7/31/01	10,400	0.079	10,300	0.053	10,300	0.0680	10,333	0.0667
NSPC - PH - SV 022 - IS	Grate Discharger	10/1/97	28,000	0.003	28,000	0.004			28,000	0.0035
NSPC - PH - SV 037 - IS	Pellet Screening Transfer #1	7/97	14,300	0.0007	12,000	0.0023	11,600	0.0058	12,633	0.0028
NSPC - PH - SV 038 - VS	Pellet Screening Transfer #3	7/97	3,100	0.001	3,100	0.0011	3,100	0.001	3,100	0.0010
Tilden - PC Crusher - No ID - VS	Primary Crusher	1/22/01	17,140	0.0061	20,274	0.0139	20,875	0.0161	19,430	0.0124

Appendix C, Table 2: Valid PM Emissions Data for OCH and PH Emission Units

Unit Label	Plant's Unit name	Test Date	Run 1 Flow (dscf)	Run 1 Emis. (gr/dscf)	Run 2 Flow (dscf)	Run 2 Emis. (gr/dscf)	Run 3 Flow (dscf)	Run 3 Emis. (gr/dscf)	Avg. Flow (dscf)	Avg Emis. (gr/dscf)
Tilden - PC Conveyor - No ID - IS	13 to 17 Conveyor	1/22/01	3,947	0.0018	3,948	0.002	3,945	0.0017	3,947	0.0018
TIL - PH - Unit 2 - IS	Cooler Vibrating Feeder	2001	14,390	0.0026	14,490	0.0024	14,526	0.002	14,469	0.0023
NSPC - PC Crusher - SV 001 - Wet MC	Primary Crusher #1	7/31/01	17,600	0.0046	17,600	0.0053	17,700	0.0060	17,633	0.0053
NSPC - PC Crusher - SV 002 - VS	Primary Crusher #2	5/6/99	22,419	0.0021	22,681	0.0019	22,529	0.0016	22,543	0.0019
NSPC - PC Conveyor - SV 003 - MC	Drive House #1 Conveyor	10/23/97	12,046	0.05	12,061	0.106	11,981	0.0790	12,029	0.0783
NSPC - PC Crusher - SV 004 - VS	Drive House #2 Conveyor	8/7/01	13,100	0.0035	13,100	0.0033	13,000	0.0028	13,067	0.0032
NSPC - PC Conveyor Transfer - SV 005 - IS	Crude Ore Feed	10/24/97	9,505	0.0057	9,794	0.005	9,643	0.0065	9,647	0.0057
NSPC - GF - SV 020 - IS	Phase II Grate Feed	8/6/97	24,900	0.002	25,200	0.001	25,600	0.0030	25,233	0.0020
NSPC - PH - SV 032 - IS	Pellet Cooler Product Belts	8/6/97	26,000	0.012	25,000	0.013	25,000	0.014	25,333	0.0130
NSPC - PH - SV 037 - IS	Pellet Screening Transfer #1	7/96	11,500	0.0047	11,800	0.0028	12,000	0.0031	11,767	0.0035
NSPC - PH - SV 038 - VS	Pellet Screening Transfer #3	10/96	3,100	0.0034	3,200	0.0019	3,100	0.0022	3,133	0.0025
NS - TC Crusher - SV 11 - BH	Fine Crusher	1/13/95	15,313	0.00608	15,354	0.00435	15,512	0.0023	15,393	0.0042
NS - TC Crusher - SV 12 - BH	Fine Crusher	1/13/95	15,313	0.0061	15,354	0.0044	15,512	0.0023	15,393	0.0043
NS - PH - SV 124 - RC	Pellet Screen House	5/98	14,565	0.0108	14,373	0.009	14,505	0.0077	14,481	0.0092
NS - TC Crusher - SV 17 - BH	Fine Crusher	6/27/95	15,759	0.0021	15,375	0.0019	15,650	0.0023	15,595	0.0021
NS - TC Dry Cobber - SV 22 - BH	Dry Cobber	1/13/95	64,878	0.0067	65,040	0.0049	65,558	0.0028	65,159	0.0048
NS - TC Storage Bin - SV 48 - MC	Bin Storage (East)	6/27/95	29,070	0.0082	28,903	0.0052	28,803	0.0039	28,925	0.0058
MINNTAC - PH - SV 146 - VS	Line 6, 041 Conveyors (298-06-06)	9/19/00	38,000	0.0093	39,000	0.0075	39,000	0.008	38,667	0.0083
MINNTAC - PC Pan Feeder - SV 16 - VS	Pan Feeder to 001-02	4/01/93	30,059	0.00259	30,799	0.00179	30,879	0.0014	30,579	0.0019
MINNTAC - PC Pan Feeder - SV 17 - VS	Pan Feeder to 001-02	3/31/93	30,187	0.00199	29,843	0.00062	30,036	0.0016	30,022	0.0014
MINNTAC - PC Conveyor - SV18 - VS	Coarse Crusher Conveyor	3/30/93	28,430	0.0019	27,410	0.0007	27,256	0.0011	27,699	0.0012
MINNTAC - PC Conveyor - SV 24 - WS	Conveyor Transfer 004 to 005	3/31/89	32,593	0.00572	32,869	0.00465	33,313	0.0037	32,925	0.0047
MINNTAC - PC Conveyor - SV 26 - VS	Reclaim Conveyor	5/1-2/80	6,420	0.007	6,460	0.005	6,400	0.0060	6,427	0.0060
MINNTAC - PC Conveyor - SV 27 - VS	05 Conveyor Feed	2/19/92	14,807	0.004	14,873	0.003	15,017	0.0036	14,899	0.0035
MINNTAC - PC Conveyor - SV28 - VS	05 Conveyor Discharge	2/18/92	15,699	0.0034	15,676	0.0028	15,646	0.0062	15,674	0.0041
MINNTAC - SC Conveyor - SV 36 - WS	Conveyor Transfer 003 to 004	7/21/80	14,600	0.004	14,600	0.006	14,600	0.0060	14,600	0.0053
MINNTAC - TC Storage Bin - SV 37 - WS	Tertiary Storage Bin	9/20/00	9,000	0.0084	9,000	0.0105	10,000	0.0025	9,333	0.0070
MINNTAC - TC Crusher - SV 45 - WS	Tertiary Crusher	9/20/00	13,000	0.0014	13,000	0.0029	13,000	0.0021	13,000	0.0021
MINNTAC - SC Crusher - SV 62 - WS	Secondary Crusher Line 5	7/21/80	20,400	0.01	20,500	0.011	20,000	0.0080	20,300	0.0097
MINNTAC - SC Conveyor - SV 63 - WS	Conveyor Transfer 008 to 009	1/8/80	14,000	0.0043	14,100	0.008	14,000	0.0037	14,033	0.0053
MINNTAC - SC Crusher - SV 68 - WS	Secondary Crusher Line 15	1/8/80	24,700	0.009	24,900	0.0103	25,000	0.0140	24,867	0.0111
MINNTAC - SC Conveyor - SV 69 - WS	Conveyor Transfer 001 to 070 bin	1/8/80	12,100	0.0082	12,200	0.0066	12,300	0.0006	12,200	0.0051
MINNTAC - SC Conveyor - SV 70 - WS	Conveyor Transfer 003 to 004	1/31/80	16,800	0.007	16,700	0.005	16,700	0.0030	16,733	0.0050
MINNTAC - TC Conveyor - SV 72 - WS	Conveyor Transfer 006 to 080 bins	1/9/80	38,000	0.0038	37,900	0.0029	37,800	0.0028	37,900	0.0032

Appendix C, Table 2: Valid PM Emissions Data for OCH and PH Emission Units (Cont.)

Unit Label	Plant's Unit name	Test Date	Run 1 Flow (dscf)	Run 1 Emis. (gr/dscf)	Run 2 Flow (dscf)	Run 2 Emis. (gr/dscf)	Run 3 Flow (dscf)	Run 3 Emis. (gr/dscf)	Avg. Flow (dscf)	Avg Emis. (gr/dscf)
MINNTAC - TC Crusher - SV 73 - WS	Tertiary Crusher Line 18)	1/8/80	23,500	0.0055	23,800	0.0049	23,900	0.0040	23,733	0.0048
MINNTAC - TC Conveyor - SV 85 - WS	Turn Bin Conveyors 005 & 006	7/25/80	13,300	0.007	13,400	0.011	13,500	0.0080	13,400	0.0087
MINNTAC - TC Conveyor - SV 94 - WS	Conveyor Transfer, Step 3	1/31/80	18,500	0.004	18,600	0.003	18,600	0.0020	18,567	0.0030
MINNTAC - TC Conveyor and Bin - SV 97 - WS	Section 17 Bins and 021 Conveyors	2/01/80	31,700	0.003	32,600	0.002	32,000	0.0020	32,100	0.0023
Inland - PH - No SV - IS	Machine Discharge	6/19/97	42,380	0.003285	43,027	0 002138	42,436	0.002176	42,614	0.0025
Inland - TC Crusher - No ID - VS	Tertiary Crusher	6/19/97	30,048	0.0014	30,461	0	30,031	0.0009	30,180	0.0008
HIB - PC Crusher Discharge - SV 001 - VS	Phase I Primary Crusher Discharge	6/23/94	12,900	0.0026	12,500	0.0036	12,700	0.0046	12,700	0.0036
HIB - PC Conveyor - SV -003 - VS	Phase I Ore Conveyor	7/15/99	14,080	0.0021	14,115	0.0011	13,987	0.0024	14,061	0.0019
HIB - SC Mill Feed Conveyor - SV 101 - VS	Mill Feed Conveyor	7/15/97	12,161	0.0014	12,280	0.0012	12,219	0.0013	12,220	0.0013
HIB - SC Mill Feed Conveyor - SV 102 - VS	Mill Feed Conveyor	6/23/94	10,900	0.0006	10,800	0.0025	10,700	0.0016	10,800	0.0016
HIB - PH - SV 203 - IS	Phase I Hearth Layer Bin	7/99	34,100	0.0083	34,600	0.0061	34,500	0.0073	34,400	0.0072
HIB - PH - SV 205 - IS	Phase I Hearth Layer Feed	7/99	29,500	0.0057	29,600	0.0016	29,500	0.0013	29,533	0 0029
HIB - PH - SV 219 - IS	Machine Discharge	7/99	93,300	0.0023	95,700	0.0016	93,100	0.0033	94,033	0.0024
HIB - PH - SV 222 - IS	Phase I Hearth Layer Screen	7/99	31,000	0.0181	30,400	0.0167	30,800	0.0181	30,733	0.0176
HIB - PH - SV 223 - IS	Transfer House	7/99	21,300	0.0149	21,500	0.0146	21,700	0 0148	21,500	0 0148
EVTAC - SC Unload Pan Feeders - SV 007 - BH	Crude Ore Unload Pan Feeders	9/11/97	23,075	0.009	22,721	0.0071	22,405	0.0077	22,734	0.0079
EVTAC - TC Crusher - SV 011 - RC	Tertiary Crusher	7/10/01	33,000	0.0063	33,000	0.0056	33,000	0.0060	33,000	0.0060
EVTAC - TC Bins/Conveyors - SV 016 - RC	3rd Stage Crushing Bins/Conveyors	4/19/01	28,000	0.0035	27,000	0.0027	27,000	0.0029	27,333	0.0030
EVTAC - TC Crusher - SV 17 - RC	4th Stage Crusher	9/9/97	22,206	0.044	22,314	0.031	22,321	0.0410	22,280	0.0387
EVTAC - TC Trip/Bin/Conveyor - SV 025 - RC	4th Stage Crushing Trip/Bin/Conveyor	4/20/01	22,000	0.0036	22,000	0.0046	22,000	0.0037	22,000	0.0040
EVTAC - TC Rod Mill Feed - SV 031 - RC	Rod Mill Feed	7/9-12/01	24,000	0.0052	23,000	0.0054	24,000	0.0044	23,667	0.0050
EVTAC - GF - SV 039 - IS	Line 2 Grate Feed	10/14/97	27,000	0.0061	27,000	0.0039	28,000	0.0038	27,333	0.0046
EVTAC - PH - SV 040 - IS	Grate Discharge	10/24/97	26,000	0.0078	27,000	0.0069	26,000	0.007	26,333	0.0072
EVTAC - PH - SV 041 - IS	Peller Cooler Discharge	10/97	41,000	0.0021	44,000	0.0032	39,000	0.0029	41,333	0.0027
EVTAC - TC Crusher - SV 19 - RC	4th Stage Crusher	9/9/97	19,000	0.0621	19,000	0.0654	19,000	0.0702	19,000	0.0659
EVTAC - TC Crusher - SV 22 - RC	4th Stage Crusher	9/9/97	20,502	0.0035	21,338	0.0073	23,079	0.0071	21,640	0.0060

Appendix C, Table 3: Above-the-Floor Costs for OCH and PH

PARAMETER	VALUE	FLOW RANGE	BASIS
Scrubber capital cost ($ per acfm)	$3.54 $2.84 $2.31	0 to 22,500 22,501 to 50,000 50,001 or greater	15,000 cfm UW-4 from Ducon, 10/12/01 30,000 cfm Impinjet from Sly, 10/12/01 70,000 cfm Impinjet from Sly, 10/12/01
Interest Rate (percent)	0.07		OMB
Equipment Lifetime (years)	25		Estimated equipment life.
Capital Recovery Factor (CRF)	0.086		Calculated

Total Annual O&M Costs ($/cfm)	Model 1	0.29
	Model 2	0.22
	Model 3	0.28

Plant	Process	Emission Unit	Control Description	SV ID	Flow rate (acfm)	Flow rate (dcfm) [a]	Test data or Assigned Test data (gr/dscf)[b]	Adjusted Flow rate (acfm) [c]	Total Capital Costs Costs ($)	Annualized Capital Costs ($/yr)	O&M Costs ($/yr)	PM Emissions at 0.008 gr/dscf (Tons/Year)	PM Emissions at 0.005 gr/dscf (Tons/Year)	PM Reduction Tons/Year
MINTAC	OCH	Surge pile/reclaim	MBS	26	6,319	6,427	0.0060	7,583	$26,844	$2,304	$2,199	1.93	1.21	
	OCH	Conveyor	MBS	35	22,500	22,884	0.0053	27,001	$76,682	$6,580	$6,021	6.87	4.30	
	OCH	Conveyor	MBS	36	14,355	14,600	0.0053	17,226	$60,981	$5,233	$4,996	4.39	2.74	
	OCH	Conveyor	MBS	60	20,000	20,341	0.0051	24,000	$68,160	$5,849	$5,352	6.11	3.82	
	OCH	Conveyor	MBS	63	13,798	14,033	0.0053	16,557	$58,613	$5,030	$4,802	4.21	2.63	
	OCH	Conveyor transfer bin	MBS	69	11,996	12,200	0.0051	14,395	$50,957	$4,373	$4,174	3.66	2.29	
	OCH	Conveyor transfer	MBS	71	16,250	16,527	0.0051	19,500	$69,030	$5,924	$5,655	4.96	3.10	
	OCH	Tertiary storage bin	MBS	37	9,177	9,333	0.0070	11,012	$38,982	$3,345	$3,193	2.80	1.75	
							MINNTAC - OCH		$450,250	$38,636	$36,392	34.94	21.84	13.10
EVTAC (Fairlane Plant)	OCH	North loadout tunnel	Baghouse	3	38,533	39,190	0.0065	46,240	$131,321	$11,269	$10,311	11.77	7.36	
	OCH	Unloading pan feeders	Baghouse	7	22,353	22,734	0.0079	26,824	$76,179	$6,537	$5,982	6.83	4.27	
	OCH	3rd stage	Rotoclone WS	11	32,447	33,000	0.0060	38,936	$110,579	$9,489	$8,683	9.91	6.19	
	OCH	3rd stage	Rotoclone WS	12	40,306	40,993	0.0060	48,367	$137,363	$11,787	$10,786	12.31	7.69	
	OCH	3rd stage	Rotoclone WS	13	40,306	40,993	0.0060	48,367	$137,363	$11,787	$10,786	12.31	7.69	
	OCH	3rd stage	Rotoclone WS	14	40,306	40,993	0.0060	48,367	$137,363	$11,787	$10,786	12.31	7.69	
	OCH	3rd stage	Rotoclone WS	15	40,306	40,993	0.0060	48,367	$137,363	$11,787	$10,786	12.31	7.69	

Appendix C, Table 3: Above-the-Floor Costs for OCH and PH (Cont.)

Plant	Process	Emission Unit	Control Description	SV ID	Flow rate (acfm)	Flow rate (dcfm) [a]	Test data or Assigned Test data (gr/dscf)[b]	Adjusted Flow rate (acfm) [c]	Total Capital Costs Costs ($)	Annualized Capital Costs ($/yr)	O&M Costs ($/yr)	PM Emissions at 0.008 gr/dscf (Tons/Year)	PM Emissions at 0.005 gr/dscf (Tons/Year)	PM Reduction Tons/Year
	OCH	4th stage	Rotoclone WS	22	21,277	21,640	0.0060	25,533	$72,513	$6,222	$5,694	6.50	4.06	
	OCH	Grate Discharge	Ducon IS	40	25,859	26,300	0.0072	31,031	$88,128	$7,562	$6,920	7.90	4.94	
	OCH	Grate Discharge	Ducon IS	44	14,612	14,861	0.0072	17,534	$62,071	$5,326	$5,085	4.46	2.79	
								EVTAC - OCH	$1,090,243	$93,554	$85,818	96.62	60.39	36.23
Northshore	OCH	Secondary Crushing	Baghouse		29,497	30,000	0.0065	35,397	$100,526	$8,626	$7,893	9.01	5.63	
	OCH	West Car Dump	Baghouse	7	62,500	63,565	0.0065	75,000	$173,249	$14,867	$21,000	19.09	11.93	
	OCH	*Coarse Tails Conveyor*	Baghouse	26	9,000	9,153	0.0065	10,800	$38,230	$3,281	$3,132	2.75	1.72	
	OCH	Storage bins (east)	multiclone	48	29,234	29,732	0.0058	35,080	$99,628	$8,549	$7,823	8.93	5.58	
								Northshore - OCH	$411,634	$35,323	$39,848	39.78	24.86	14.92
NSPC	OCH	Primary Crushing	Wet MC	1	17,337	17,633	0.0053	20,805	$73,650	$6,320	$6,033	5.30	3.31	
	OCH	Conveyor	UW-4 S	5	9,485	9,647	0.0057	11,382	$40,294	$3,458	$3,301	2.90	1.81	
	OCH	Conveyor	UW-4 S	6	11,307	11,500	0.0057	13,569	$48,033	$4,122	$3,935	3.45	2.16	
	OCH	Conveyor	UW-4 S	7	11,307	11,500	0.0057	13,569	$48,033	$4,122	$3,935	3.45	2.16	
	OCH	Conveyor	UW-4 S	8	11,307	11,500	0.0057	13,569	$48,033	$4,122	$3,935	3.45	2.16	
	OCH	Conveyor	UW-4 S	9	11,307	11,500	0.0057	13,569	$48,033	$4,122	$3,935	3.45	2.16	
	OCH	Conveyor	UW-4 S	10	11,307	11,500	0.0057	13,569	$48,033	$4,122	$3,935	3.45	2.16	
								NSPC - OCH	$354,109	$30,386	$29,009	25.46	15.91	9.55
Hibbing	OCH	Hearth layer bin	Ducon IS	203	33,823	34,400	0.0072	40,588	$115,270	$9,891	$9,051	10.33	6.46	
	OCH	Hearth layer bin	Ducon IS	204	19,000	19,324	0.0072	22,800	$64,752	$5,556	$5,084	5.80	3.63	
								Hibbing - OCH	$180,023	$15,448	$14,136	16.14	10.08	6.05
Inland	OCH	Fine ore underfeeds	Baghouse	9,10	32,000	32,545	0.0065	38,399	$109,054	$9,358	$8,563	9.77	6.11	
	OCH	Hearth layer conveyor	Ducon IS	19	9,500	9,662	0.0065	11,400	$40,356	$3,463	$3,306	2.90	1.81	
								Inland - OCH	$149,411	$12,821	$11,869	12.68	7.92	4.75

Appendix C, Table 3: Above-the-Floor Costs for OCH and PH (Cont.)

Plant	Process	Emission Unit	Control Description	SV ID	Flow rate (acfm)	Flow rate (dcfm) [a]	Test data or Assigned Test data (gr/dscf)[b]	Adjusted Flow rate (acfm) [c]	Total Capital Costs Costs ($)	Annualized Capital Costs ($/yr)	O&M Costs ($/yr)	PM Emissions at 0.008 gr/dscf (Tons/Year)	PM Emissions at 0.005 gr/dscf (Tons/Year)	PM Reduction Tons/Year
Empire	OCH	Primary crusher	IS		28,000	28,477	0.0065	33,600	$95,423	$8,188	$7,493	8.55	5.35	
	OCH	Ore feed conveyor	IS		15,000	15,256	0.0065	18,000	$63,721	$5,468	$5,220	4.58	2.86	
								Empire - OCH	$159,144	$13,656	$12,713	13.13	8.21	4.93
Tilden	OCH	Conveyor	Scrubber		29,497	30,000	0.0065	35,397	$100,526	$8,626	$7,893	9.01	5.63	
	OCH	Conveyor	Scrubber		29,497	30,000	0.0065	35,397	$100,526	$8,626	$7,893	9.01	5.63	
	OCH	Conveyor	Scrubber		29,497	30,000	0.0065	35,397	$100,526	$8,626	$7,893	9.01	5.63	
								Tilden - OCH	$301,579	$25,879	$23,680	27.03	16.89	10.14
			TOTAL OCH ABOVE THE FLOOR COSTS & EMISSIONS						$3,096,394	$265,703	$253,466	265.78	166.12	99.67
Minntac	PH	Grate feed	Ducon IS		15,000	15,256	0.0065	18,000	$63,721	$5,468	$5,220	4.58	2.86	
	PH	Pellet conveyor transfer	Ducon IS	122	8,000	8,136	0.0065	9,600	$33,982	$2,916	$2,784	2.44	1.53	
								MINNTAC - PH	$97,704	$8,384	$8,004	7.03	4.39	2.63
NSPC	PH	Cooler dump zone	Ducon IS	23	19,861	20,200	0.0065	23,834	$67,688	$5,808	$5,315	6.07	3.79	
								National - PH	$67,688	$5,808	$5,315	6.07	3.79	2.28
Inland	PH	Drop into hearth layer screen	Ducon IS	20	22,400	22,782	0.0065	26,880	$76,340	$6,551	$5,994	6.84	4.28	
								Inland - PH	$76,340	$6,551	$5,994	6.84	4.28	2.57
Tilden	PH	Cooler discharge	Sly IS		30,000	30,511	0.0065	36,000	$102,239	$8,773	$8,028	9.16	5.73	
	PH	Pel. Loadout trans. Con.	Sly IS		12,000	12,205	0.0065	14,401	$50,978	$4,374	$4,176	3.67	2.29	
								MINNTAC - PH	$153,217	$13,148	$12,204	12.83	8.02	4.81
			TOTAL PH ABOVE THE FLOOR COSTS & EMISSIONS						$394,948	$33,891	$31,517	32.76	20.48	12.29
			TOTAL ABOVE THE FLOOR COSTS & EMISSIONS						$3,491,342	$299,594	$284,983	298.55	186.59	111.96

Appendix C, Table 3: Above-the-Floor Costs for OCH and PH (Cont.)

a - Actual flow rates were used where available. If not, the flow rate of a similar unit was used. If no similar units, used approx Avg of 30,000 dcfm.
b - Actual emissions data was used where available. If not, data for similar units were used. If no similar units, the number of non-compliant units was based on the percetage of non-compliant units for that control from the available data.
c - Flow rates for the calculation of the capital and O & M costs were calculated by multiplying the acfm by a 20% over-sizing factor. This adjusted flow rate was then multiplied by the $/cfm for the model that is closest to the adjusted flow rate.

MBS = Marble Bed Scrubber
WS = Wet Scrubber
MC= Multiclone
S = Scrubber
IS = Impingement Scrubber

Appendix C, Table 4: Non-Valid PM Emissions Data for Indurating Furnaces

Unit Label	Unit Type	Test Date	Run 1 Avg. Flow per Stack (dscf)	Run 1 Avg Emis. per Stack (gr/dscf)	Run 2 Avg. Flow per Stack (dscf)	Run 2 Avg Emis. per Stack (gr/dscf)	Run 3 Avg Flow per Stack (dscf)	Run 3 Avg Emis per Stack (gr/dscf)	Test Avg. Flow (dscf)	Unadjusted Flow Wtd. Avg. Emis. (gr/dscf)	Notes
Empire - Dry ESP - L2 (coal)	GK	08/13/95	281,779	0.009	235,618	0.008			258,699	0.0085	Only two runs.
Empire - Dry ESP - L2 (coal)	GK	08/17/95	264,381	0.005	271,144	0.007			267,763	0.0060	Only two runs.
Empire - Dry ESP - L3 (coal)	GK	08/11/95	277,110	0.014	267,393	0.010			272,252	0.0120	Only 2 runs. ESP malfunc. Control mod.
Empire - Dry ESP - L3 (coal)	GK	08/17/95	267,994	0.017	268,183	0.018			268,089	0.0175	Only 2 runs. ESP malfunc. Control mod.
Empire - Dry ESP - L4 (coal)	GK	08/14/95	460,701	0.008	458,805	0.003			459,753	0.0055	Only two runs. Control mod.
Empire - Dry ESP - L4 (gas)	GK	08/28/96	534,065	0.007	514,891	0.003	535,484	0.003	528,147	0.0043	Control mod.
EVTAC - VS - L1 (NG)	GK	11/21/97	284,000	0.005	282,000	0.004	283,000	0.004	283,000	0.0043	Line 1 was shut down June 1999.
MINNTAC - VS - L3	GK	07/24/80	277,000	0.368	227,000	0.202	227,000	0.370	243,667	0.3133	Not clear if catch is dry
MINNTAC - VS - L3	GK	02/01/80	277,000	0.019	249,000	0.017	260,000	0.020	262,000	0.0187	No dry catch data!!!
MINNTAC - VS - L4	GK	03/31/92	465,585	0.012	443,513	0.012	455,749	0.012	454,949	0.0118	No dry catch data!!!
MINNTAC - VS - L5	GK	03/31/92	453,898	0.008	463,325	0.008	464,730	0.085	460,651	0.0335	No dry catch data!!!
MINNTAC - VS - L5	GK	07/21/80	414,000	0.492	411,000	0.492	425,000	0.407	416,667	0.4637	Not clear if catch is dry
MINNTAC - VS - L6	GK	03/28/89	83,513	0.116	86,217	0.105	87,924	0.127	85,885	0.1160	No dry catch data!!!
MINNTAC - VS - L7	GK	11/28/01	342,000	0.012	339,000	0.018	336,000	0.018	339,000	0.0160	Atypical process conditions.
MINNTAC - VS - L7	GK	03/28/89	310,878	0.015	302,871	0.017	278,589	0.027	297,446	0.0196	No dry catch data!!!
NS - Wet ESP - L6	TG	10/10-12/95	52,507	0.009	52,961	0.005	52,937	0.009	52,802	0.0077	Only tested 1 of 3 stacks.
Tilden - Dry ESP - L2 (coal/gas) - HEM	GK	05/16/00	293,814	0.069	271,378	0.055	298,342	0.039	287,845	0.0542	Unrepresentative of typical performance
Tilden-Dry ESP - L2 (coal) - HEM	GK	07/13/00	500,726	0.017	493,457	0.021	484,201	0.022	492,795	0.0200	Did not test each stack individually.

TG = Travel Grate
GK = Grate Kiln
L = Line

Appendix C, Table 5: Valid PM Emissions Data for Indurating Furnaces

Unit Label	Unit Type	Test Date	Run 1 Avg. Flow per Stack (dscf)	Run 1 Avg Emis. per Stack (gr/dscf)	Run 2 Avg. Flow per Stack (dscf)	Run 2 Avg Emis. per Stack (gr/dscf)	Run 3 Avg Flow per Stack (dscf)	Run 3 Avg Emis per Stack (gr/dscf)	Test Avg. Flow (dscf)	Unadjusted Flow Wtd. Avg. Emis. (gr/dscf)	Adjusted Flow Wtd. Avg. Emis. (gr/dscf) 1.37	Highest Adjusted Test Per Furnace
Empire - DESP - L1 (coal/gas)	GK	05/20/00	267,407	0.005	276,387	0.008	269,268	0.011	271,021	0.0082	0.0113	
Empire - DESP - L1 (gas)	GK	05/21/00	272,105	0.006	272,786	0.005	274,174	0.003	273,022	0.0045	0.0062	
Empire - DESP - L1 (Coal)	GK	08/28/00	254,294	0.010	255,369	0.011	248,416	0.008	252,693	0.0097	0.0133	0.0133
Empire - DESP - L2 (gas)	GK	05/20/00	327,700	0.012	323,946	0.005	331,318	0.008	327,655	0.0081	0.0112	
Empire - DESP - L2 (Gas)	GK	08/29/00	330,256	0.001	318,569	0.001	321,935	0.001	323,587	0.0010	0.0013	0.0112
Empire - DESP - L3 (gas)	GK	05/21/00	249,403	0.008	241,649	0.006	262,197	0.006	251,083	0.0066	0.0090	
Empire - DESP - L3 (Coal)	GK	08/28/00	307,502	0.002	287,201	0.002	294,649	0.002	296,451	0.0021	0.0029	0.0090
Empire - DESP - L4 (coal/gas)	GK	05/23/00	448,150	0.002	447,264	0.005	436,113	0.005	443,842	0.0037	0.0051	
Empire - DESP - L4 (gas)	GK	05/22/00	446,981	0.005	447,932	0.007	456,044	0.007	450,319	0.0062	0.0085	
Empire - DESP - L4 (Coal)	GK	08/29/00	582,259	0.000	583,960	0.001	579,074	0.001	581,764	0.0005	0.0006	0.0085
EVTAC - VS - L2 (coal/coke)	GK	12/3-4/96	287,720	0.013	290,236	0.011	288,656	0.013	288,870	0.0120	0.0164	
EVTAC - VS - L2	GK	4/17-20/01	308,500	0.010	310,500	0.011	309,000	0.011	309,333	0.0105	0.0144	
EVTAC - VS - L2	GK	6/26-27/01	298,500	0.013	300,500	0.013	295,500	0.012	298,167	0.0125	0.0171	0.0171
Hibbing - VS - L1 (NG)	TG	05/9-13/94	129,525	0.005	121,600	0.007	131,575	0.006	127,567	0.0060	0.0082	0.0082
Hibbing - VS - L2 (NG)	TG	05/9-13/94	143,150	0.005	142,500	0.005	142,475	0.006	142,708	0.0053	0.0072	
Hibbing - VS - L2 (Fuel Oil)	TG	6/29-30/94	153,550	0.007	157,200	0.008	157,225	0.005	155,992	0.0066	0.0090	
Hibbing - VS - L2 (NG)	TG	07/99	161,000	0.005	161,750	0.004	160,750	0.004	161,167	0.0043	0.0058	0.0090
Hibbing - VS - L3 (NG)	TG	09/29/94	162,525	0.012	162,675	0.012	159,200	0.010	161,467	0.0113	0.0155	0.0155
Inland - VS - L1 (NG)	TG	6/17-20/97	145,557	0.008	145,075	0.007	144,267	0.006	144,966	0.0068	0.0094	0.0094
MINNTAC - Multi/Grav - L3	GK	03/25/94	295,837	0.617	315,600	0.498	302,731	0.475	304,723	0.5300	0.7261	
MINNTAC - Multi/Grav - L3	GK	6/16-18/98	241,603	0.747	241,861	0.746	240,775	0.779	241,413	0.7573	1.0375	1.0375
MINNTAC - VS - L4	GK	04/28/93	433,690	0.008	486,968	0.012	471,755	0.007	464,138	0.0090	0.0123	
MINNTAC - VS - L4	GK	6/20-23/00	401,000	0.006	401,000	0.006	406,000	0.007	402,667	0.0062	0.0085	0.0123
MINNTAC - VS - L5	GK	10/25/01	412,000	0.007	437,000	0.007	404,000	0.011	417,667	0.0081	0.0111	
MINNTAC - VS - L5	GK	4/27-28/93	452,410	0.009	463,696	0.008	456,712	0.010	457,606	0.0090	0.0123	
MINNTAC - VS - L5	GK	09/3-4/97	452,858	0.009	469,552	0.007	464,145	0.007	462,185	0.0077	0.0105	
MINNTAC - VS - L5	GK	6/20-23/00	432,000	0.008	423,000	0.005	415,000	0.006	423,333	0.0061	0.0084	0.0123
MINNTAC - VS - L6	GK	6/20-23/00	355,000	0.018	351,000	0.015	347,000	0.017	351,000	0.0167	0.0228	
MINNTAC - VS - L6	GK	03/28/89	315,683	0.022	326,539	0.019	326,539	0.025	322,920	0.0220	0.0301	0.0301
MINNTAC - VS - L7	GK	09/3-4/97	298,179	0.014	323,559	0.013	348,649	0.009	323,462	0.0120	0.0164	

Appendix C, Table 5: Valid PM Emissions Data for Indurating Furnaces (Cont.)

Unit Label	Unit Type	Test Date	Run 1 Avg. Flow per Stack (dscf)	Run 1 Avg Emis. per Stack (gr/dscf)	Run 2 Avg. Flow per Stack (dscf)	Run 2 Avg Emis. per Stack (gr/dscf)	Run 3 Avg Flow per Stack (dscf)	Run 3 Avg Emis per Stack (gr/dscf)	Test Avg. Flow (dscf)	Unadjusted Flow Wtd. Avg. Emis. (gr/dscf)	Adjusted Flow Wtd. Avg. Emis. (gr/dscf) 1.37	Highest Adjusted Test Per Furnace
MINNTAC - VS - L7	GK	6/20-23/00	342,000	0.010	349,000	0.009	338,000	0.009	343,000	0.0093	0.0128	
MINNTAC - VS - L7	GK	09/05/00	363,000	0.008	358,000	0.010	354,600	0.010	358,533	0.0093	0.0128	
MINNTAC - VS - L7	GK	08/02/01	362,000	0.011	362,000	0.014	364,000	0.014	362,667	0.0130	0.0178	
MINNTAC - VS - L7	GK	08/30/01	370,000	0.013	367,000	0.008	368,000	0.011	368,333	0.0107	0.0146	
MINNTAC - VS - L7	GK	02/20/01	359,004	0.009	363,977	0.008	357,544	0.007	360,175	0.0080	0.0110	
MINNTAC - VS - L7	GK	03/29/89	310,879	0.015	302,871	0.017	278,589	0.027	297,446	0.0196	0.0269	0.0269
NS - Wet ESP - L11	TG	1/10-13/95	69,830	0.010	70,927	0.010	69,786	0.008	70,181	0.0092	0.0126	
NS - Wet ESP - L11	TG	7/30-31/96	62,375	0.009	60,830	0.006	61,538	0.006	61,581	0.0067	0.0091	0.0126
NS - Wet ESP - L12	TG	1/10-13/95	64,840	0.009	63,115	0.007	62,817	0.008	63,590	0.0077	0.0105	
NS - Wet ESP - L12	TG	7/30-31/96	57,615	0.007	58,127	0.007	58,437	0.007	58,060	0.0067	0.0091	0.0105
NSPC - Multi/Grav - L2	TG	07/31/97	233,875	0.136	233,054	0.138	229,739	0.127	232,222	0.1332	0.1824	
NSPC - Multi/Grav - L2	TG	7/25-26/00	257,712	0.057	253,930	0.066	252,623	0.062	254,755	0.0612	0.0838	0.1824
Tilden - W&D ESP - L1 (gas) - HEMATITE	GK	05/15/00	292,283	0.028	285,697	0.009	287,814	0.013	288,598	0.0167	0.023	0.023
Tilden - Dry ESP - L2 (gas) - HEMATITE	GK	05/24/00	286,456	0.019	285,872	0.017	284,999	0.019	285,776	0.0182	0.0250	0.0250
Tilden - Dry ESP - L2 (coal/gas) - MAGNETITE	GK	02/01	254,801	0.014	255,459	0.011	257,835	0.011	256,032	0.0121	0.0166	
Tilden - Dry ESP - L2 (gas) - MAGNETITE	GK	05/04/94	265,762	0.004	262,470	0.004	260,945	0.004	263,059	0.0040	0.0055	
Tilden - Dry ESP - L2 (gas) - MAGNETITE	GK	03/13/95	261,251	0.006	260,385	0.008	258,155	0.010	259,930	0.0080	0.0110	0.0166

Appendix C, Table 6: Indurating Furnace Relative Standard Deviation Analysis

Unit Label	Unit Type	Test Date	Run 1 Avg Emis. per Stack (gr/dscf)	Run 2 Avg Emis. per Stack (gr/dscf)	Run 3 Avg Emis per Stack (gr/dscf)	Test Avg. Flow (dscf)	Flow Wtd. Avg. Emis. (gr/dscf)	Std Dev By Furnace Between All Tests	Relative Std Dev
Empire - Dry ESP - Line 1 (coal/gas)	Grate Kiln	05/20/00	0.005	0.008	0.011	271,021	0.0082		
Empire - Dry ESP - Line 1 (gas)	Grate Kiln	05/21/00	0.006	0.005	0.003	273,022	0.0045		
Empire - Dry ESP - Line 1 (Coal)	Grate Kiln	08/28/00	0.010	0.011	0.008	252,693	0.0097	0.0027	35.5%
Empire - Dry ESP - Line 2 (gas)	Grate Kiln	05/20/00	0.012	0.005	0.008	327,655	0.0081		
Empire - Dry ESP - Line 2 (Gas)	Grate Kiln	08/29/00	0.001	0.001	0.001	323,587	0.0010	0.0051	111.4%
Empire - Dry ESP - Line 3 (gas)	Grate Kiln	05/21/00	0.008	0.006	0.006	251,083	0.0066		
Empire - Dry ESP - Line 3 (Coal)	Grate Kiln	08/28/00	0.002	0.002	0.002	296,451	0.0021	0.0032	73.2%
Empire - Dry ESP - Line 4 (coal/gas)	Grate Kiln	05/23/00	0.002	0.005	0.005	443,842	0.0037		
Empire - Dry ESP - Line 4 (gas)	Grate Kiln	08/27-28/96	0.007	0.003	0.003	528,147	0.0043		
Empire - Dry ESP - Line 4 (gas)	Grate Kiln	05/22/00	0.005	0.007	0.007	450,319	0.0062		
Empire - Dry ESP - Line 4 (Coal)	Grate Kiln	08/29/00	0.000	0.001	0.001	581,764	0.0005	0.0024	64.7%
EVTAC - VS - Line 2 (coal/coke)	Grate Kiln	12/3-4/96	0.013	0.011	0.013	288,870	0.0120		
EVTAC - VS - Line 2	Grate Kiln	04/17-20/01	0.010	0.011	0.011	309,333	0.0105		
EVTAC - VS - Line 2	Grate Kiln	06/26-27/01	0.013	0.013	0.012	298,167	0.0125	0.0010	8.9%
Hibbing - VS - Line 1 (NG)	Travel Grate	03/9-13/94	0.005	0.007	0.006	127,567	0.0060		
Hibbing - VS - Line 2 (NG)	Travel Grate	03/9-13/94	0.005	0.005	0.006	142,708	0.0053		
Hibbing - VS - Line 2 (Fuel Oil)	Travel Grate	06/29-30/94	0.007	0.008	0.005	155,992	0.0066		
Hibbing - VS - Line 2 (NG)	Travel Grate	07/7/99	0.005	0.004	0.004	161,167	0.0043	0.0012	21.8%
Hibbing - VS - Line 3 (NG)	Travel Grate	09/29/94	0.012	0.012	0.010	161,467	0.0113		
Inland - VS - Line 1 (NG)	Travel Grate	06/17-20/97	0.008	0.007	0.006	144,966	0.0068		
MINNTAC - Multi/Grav - Line 3	Grate Kiln	03/25/94	0.617	0.498	0.475	304,723	0.5300		
MINNTAC - Multi/Grav - Line 3	Grate Kiln	07/16-18/98	0.747	0.746	0.779	241,413	0.7573	0.1607	25.0%
MINNTAC - VS - Line 4	Grate Kiln	04/28/93	0.008	0.012	0.007	464,138	0.0090		
MINNTAC - VS - Line 4	Grate Kiln	07/20-23/00	0.006	0.006	0.007	402,667	0.0062	0.0020	26.1%
MINNTAC - VS - Line 5	Grate Kiln	04/28/93	0.009	0.008	0.010	457,606	0.0090		
MINNTAC - VS - Line 5	Grate Kiln	09/3-4/97	0.009	0.007	0.007	462,185	0.0077		
MINNTAC - VS - Line 5	Grate Kiln	10/25/01	0.007	0.007	0.011	417,667	0.0081		
MINNTAC - VS - Line 5	Grate Kiln	07/20-23/00	0.008	0.005	0.006	423,333	0.0061	0.0012	15.7%
MINNTAC - VS - Line 6	Grate Kiln	07/20-23/00	0.018	0.015	0.017	351,000	0.0167		
MINNTAC - VS - Line 6	Grate Kiln	03/28/89	0.022	0.019	0.025	322,920	0.0220	0.0037	19.4%

Appendix C, Table 6: Indurating Furnace Relative Standard Deviation Analysis (Cont.)

Unit Label	Unit Type	Test Date	Run 1 Avg Emis. per Stack (gr/dscf)	Run 2 Avg Emis. per Stack (gr/dscf)	Run 3 Avg Emis per Stack (gr/dscf)	Test Avg. Flow (dscf)	Flow Wtd. Avg. Emis. (gr/dscf)	Std Dev By Furnace Between All Tests	Relative Std Dev
MINNTAC - VS - Line 7	Grate Kiln	09/3-4/97	0.014	0.013	0.009	323,462	0.0120		
MINNTAC - VS - Line 7	Grate Kiln	07/20-23/00	0.010	0.009	0.009	343,000	0.0093		
MINNTAC - VS - Line 7	Grate Kiln	09/05/00	0.008	0.010	0.010	358,533	0.0093		
MINNTAC - VS - Line 7	Grate Kiln	08/02/01	0.011	0.014	0.014	362,667	0.0130		
MINNTAC - VS - Line 7	Grate Kiln	08/30/01	0.013	0.008	0.011	368,333	0.0107		
MINNTAC - VS - Line 7	Grate Kiln	02/20/01	0.009	0.008	0.007	360,175	0.0080	0.0019	18.0%
NS - Wet ESP - Line 11	Travel Grate	01/10-13/95	0.010	0.010	0.008	70,181	0.0092		
NS - Wet ESP - Line 11	Travel Grate	07/30-31/96	0.009	0.006	0.006	61,581	0.0067	0.0018	22.3%
NS - Wet ESP - Line 12	Travel Grate	01/10-13/95	0.009	0.007	0.008	63,590	0.0077		
NS - Wet ESP - Line 12	Travel Grate	07/30-31/96	0.007	0.007	0.007	58,060	0.0067	0.0007	9.9%
NSPC - Multi/Grav - Line 2	Grate Kiln	07/31/97	0.136	0.138	0.127	232,222	0.1332		
NSPC - Multi/Grav - Line 2	Grate Kiln	07/25-26/00	0.057	0.066	0.062	254,755	0.0612	0.0509	52.4%
Tilden - Dry ESP - Line 2 (coal/gas)	Grate Kiln	Feb-01	0.014	0.011	0.011	256,032	0.0121		
Tilden - Dry ESP - Line 2 (gas)	Grate Kiln	05/2-4/94	0.004	0.004	0.004	263,059	0.0040		
Tilden - Dry ESP - Line 2 (gas)	Grate Kiln	03/13-16/95	0.006	0.008	0.010	259,930	0.0080	0.0041	50.5%
							Average	0.0162	37.0%
							Median	0.0024	25.0%
							High	0.1607	111.4%
							Low	0.0007	8.9%

Appendix C, Table 7: Indurating Furnace Above-the-Floor Capital Costs

PARAMETER	VALUE	BASIS
Interest Rate (percent)	0.07	OMB
Equipment Lifetime (years)	25	Estimated equipment life.
Capital Recovery Factor (CRF)	0.086	Calculated

Capital Costs	**1997** BASE ESP COSTS FROM NATIONAL STEEL [b]	**1999** BASE ESP COSTS FROM NATIONAL STEEL [b, d]	**1991** BASE VS COSTS FROM MINNTAC [a]	**1999** BASE VS COSTS FROM MINNTAC [a, d]
Equipment Cost	$11,732,900	$10,844,141	$1,100,400	$1,267,509
Direct Installation Costs	$8,679,500	$8,022,034	$3,972,250	$4,575,485
Total Direct Costs	$20,412,400	$18,866,176	$5,072,650	$5,842,995
Indirect Installation Costs	$5,326,000	$4,922,559	$756,500	$871,384
Total Capital Investment	$25,738,400	$23,788,735	$5,829,150	$6,714,378
Annualized Capital Costs	$2,208,625	$2,041,324	$500,202	$576,164

[a] MINNTAC capital costs are based on costs provided by MINNTAC for "agglomerator line 4 & 5 waste gas scrubber order of magnitude estimate." (Letter from Larry Salmela of MINNTAC, 11/23/99)

[b] National capital costs are based on costs provided by National on 11/23/99.

[c] Used a power of six scaling assumption. ESP costs were scaled from the National costs based on flow rate. VS costs were scaled from the MINNTAC costs based on flow rate.

[d] Costs scaled to first quar. 1999 using the Vatavuk cost indexes (VAPPCCI) for large wet scrubbers and large ESPs.

[e] For VS this represents a new VS. For ESPs cost represents retrofit cost of 0.35 of full cost.

[f] Assumed that they would bear the full installation costs for new VS and for ESP retrofit.

Appendix C, Table 7: Indurating Furnace Above-the-Floor Capital Costs (Cont.)

Affected Source	Grate Kiln Furn. Proc. Hem.			Grate Kiln Furnaces Processing Magnetite						Straight Grate Furnaces Processing Magnetite				
Facility/Line Stack Current Control New Control	Tilden/1 Stack A Dry ESP ESP retro	Tilden/2 Stack B Dry ESP ESP retro	Tilden/2 Stack C Dry ESP ESP retro	Empire/1 Dry ESP ESP retro	Empire/2 Dry ESP ESP retro	MINNTAC/4 VS new VS	MINNTAC/5 VS new VS	Hibbing/1 Stack A VS new VS	Hibbing/1 Stack B VS new VS	Hibbing/3 All 4 Stacks VS new VS	Inland/1 Stacks A&B VS new VS	NS/11 All 5 Stacks WESP ESP retro	NS/12 All 5 Stacks WESP ESP retro	NS/6 All 3 Stacks WESP ESP retro
Scaling Factor [c]	0.57	0.47	0.51	0.48	0.54	0.75	0.95	0.45	0 47	0.53	0.50	0.21	0.20	0.18
Equipment Cost [e]	$2,163,847	$1,775,316	$1,939,497	$1,835,080	$2,047,323	$947,040	$1,205,885	$567,492	$590,901	$2,705,246	$1,267,903	$4,054,760	$3,878,416	$2,054,224
Direct Installation Costs [f]	$4,573,492	$3,752,294	$4,099,307	$3,878,611	$4,327,208	$3,418,647	$4,353,031	$2,048,547	$2,133,049	$9,765,460	$4,576,908	$8,570,112	$8,197,391	$4,341,793
Total Direct Costs	$6,737,340	$5,527,609	$6,038,804	$5,713,691	$6,374,531	$4,365,687	$5,558,915	$2,616,040	$2,723,951	$12,470,706	$5,844,811	$12,624,872	$12,075,807	$6,396,017
Indirect Installation Costs [f]	$2,806,431	$2,302,519	$2,515,457	$2,380,031	$2,655,304	$651,068	$829,018	$390,138	$406,231	$1,859,795	$871,655	$5,258,876	$5,030,164	$2,664,254
Total Capital Investment	$9,543,771	$7,830,129	$8,554,262	$8,093,722	$9,029,834	$5,016,756	$6,387,934	$3,006,178	$3,130,182	$14,330,501	$6,716,466	$17,883,748	$17,105,971	$9,060,271
Annualized Capital Costs	$818,956	$671,907	$734,046	$694,526	$774,855	$430,490	$548,152	$257,962	$268,603	$1,229,708	$576,343	$1,534,614	$1,467,872	$777,467

[a] MINNTAC capital costs are based on costs provided by MINNTAC for "agglomerator line 4 & 5 waste gas scrubber order of magnitude estimate." (Letter from Larry Salmela of MINNTAC, 11/23/99)

[b] National capital costs are based on costs provided by National on 11/23/99.

[c] Used a power of six scaling assumption. ESP costs were scaled from the National costs based on flow rate. VS costs were scaled from the MINNTAC costs based on flow rate.

[d] Costs scaled to first quar. 1999 using the Vatavuk cost indexes (VAPPCCI) for large wet scrubbers and large ESPs.

[e] For VS this represents a new VS. For ESPs cost represents retrofit cost of 35% of new ESP.

[f] Assumed that they would bear the full installation costs for new VS and for ESP retrofit.

Appendix C, Table 8: Indurating Furnace Venturi Scrubber Annual Costs for the Above-the-Floor Analysis

Unit Parameters	MINNTAC		Hibbing			Inland	NOTES:
	Line 4	Line 5	Line 1A	Line 1B	Line 3 (all 4)	Line 1 (2 stacks)	
Emission Stream Flow Rate (acfm)	339,600	508,000	144,640	154,720	193,760	173,959	Values are from the test results conducted on the furnaces. The flow rates were multiplied by a 20% over-sizing factor.
System Pressure Drop, inches H20	20	20	20	20	20	20	Assumed Value
System Operating Hours per year	8,760	8,760	8,760	8,760	8,760	8,760	24 hours of operation per day for whole year is assumed.
I. DIRECT ANNUAL COSTS							
A. UTILITIES							
1. Increase in Elec. Cons. over Baseline Control (equation 4.11-2 of controls handbook)							
Fan Power Requirement (kWh/yr)	5,384,562	8,054,638	2,293,348	2,453,172	3,072,187	2,758,227	Assumes fan-motor efficiency of 65% and fluid specific gravity of 1.0. Assumed that old wet scrubbers have 10 p.d. of pressure drop in baseline (Section 114 response for National multiclone).
Electricity Unit Cost ($/kWh)	0.046	0.046	0.046	0.046	0.046	0.046	1999 industrial energy cost for MN from U.S. Dept. of Energy.
Electricity Cost ($/yr)	$247,690	$370,513	$105,494	$112,846	$565,282	$253,757	
2. Water							
Water Consumption (gallons/year)	0	0	0	0	0	0	Assume no net increase in water consumption
Water Cost ($/yr)	$0	$0	$0	$0	$0	$0	There is no utility cost for the water, since they draw water from tailings basin.
TOTAL UTILITIES COST ($/YR)	**$247,690**	**$370,513**	**$105,494**	**$112,846**	**$565,282**	**$253,757**	
B. OPERATING LABOR							
1. Operator Labor							
Operator Labor Hours (hours/year)	0	0	0	0	0	0	Assumed no net increase in operating labor.
Operator Labor Rate ($/hour)	$14.66	$14.66	$14.66	$14.66	$14.66	$14.66	"Machine operators, assemblers, and inspectors", MN, BLS, 1999.
Operator Labor Cost ($/year)	$0	$0	$0	$0	$0	$0	
2. Supervisory Labor							
Supervisory Costs ($/year)	$0	$0	$0	$0	$0	$0	Assumed no net increase in supervisory labor.

Appendix C, Table 8: Indurating Furnace Venturi Scrubber Annual Costs for the Above-the-Floor Analysis (Cont.)

Unit Parameters	MINNTAC		Hibbing			Inland	NOTES:
	Line 4	Line 5	Line 1A	Line 1B	Line 3 (all 4)	Line 1 (2 stacks)	
C. MAINTENANCE							
1. Labor							
Maintenance Labor Hours (hours/year)	0	0	0	0	0	0	Assumed no net increase in maintenance labor.
Maintenance Labor Rate ($/hour)	$19.25	$19.25	$19.25	$19.25	$19.25	$19.25	"Industrial Machinery Repairers", MN, BLS, 1999.
Maintenance Labor Cost ($/year)	$0	$0	$0	$0	$0	$0	
2. Materials	$0	$0	$0	$0	$0	$0	Assumes 100% of Maintenance Labor Cost
CALCULATED TOTAL OPERATING LABOR AND MAINTENANCE COST ($/YR)	$0	$0	$0	$0	$0	$0	Calculated Total Maintenance and Labor for comparison.
TOTAL OPERATING LABOR AND MAINTENANCE COST	$0	$0	$0	$0	$0	$0	
D. WASTEWATER TREATMENT							
WASTEWATER TREATMENT	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	Do not treat the wastewater, it is sent to the tailings basin.
TOTAL DIRECT ANNUAL COSTS ($/YR)	$247,690	$370,513	$105,494	$112,846	$565,282	$253,757	
II. INDIRECT ANNUAL COSTS							
A. OVERHEAD COSTS	$0	$0	$0	$0	$0	$0	60% of the operating labor and maintenance.
B. ADMINISTRATIVE COSTS	$100,335	$127,759	$60,124	$62,604	$286,610	$134,329	2% of total capital costs.
C. INSURANCE COSTS	$50,168	$63,879	$30,062	$31,302	$143,305	$67,165	1% of total capital costs.
D. PROPERTY TAXES	$50,168	$63,879	$30,062	$31,302	$143,305	$67,165	1% of total capital costs.
TOTAL INDIRECT ANNUAL COSTS ($/YR)	$200,670	$255,517	$120,247	$125,207	$573,220	$268,659	
TOTAL ANNUAL COSTS ($/YR)	$448,360	$626,031	$225,741	$238,053	$1,138,503	$522,416	

Appendix C, Table 9: Indurating Furnace ESP Annual Costs for the Above-the-Floor Analysis

FACILITY LINE/STACK	TILDEN Line 1A	TILDEN Line 2B	TILDEN Line 2C	EMPIRE Line 1	EMPIRE Line 2	NS Line 11 (all)	NS Line 12 (all)	NS Line 6 (all)	NOTES:
Emission Stream Flow Rate (acfm)	431,186	310,037	359,282	327,626	393,186	73,897	69,672	63,362	From Test Data. Added a 20% over sizing factor.
New System Pressure Drop, inches H20	20	20	20	20	20	20	20	20	Actual for Empire. Applied Empire value to rest.
System Operating Hours per year	8,760	8,760	8,760	8,760	8,760	8,760	8,760	8,760	Assumed full operation.
ESP DESIGN PARAMETERS									
Current Collection Plate Area (ft2)	71800	51600	59800	46,792	57,029	12200	11600	10560	Uses average from Empire actuals = approx 200 ft2/1000 acfm.
New Collection Plate Area (ft2	107700	77400	89700	70188.3	85543.2	18300	17400	15840	Increased size by 50%
Increase in Collection Plate Area (ft2)	35,900	25,800	29,900	23,396	28,514	6,100	5,800	5,280	
A. UTILITIES									
1. Electricity									(equation 4.10-2 of controls handbook)
Fan Power Requirement (kWh/yr)	13,673,438	9,831,639	11,393,276	10,389,426	12,468,400	2,343,369	2,209,383	2,009,298	Assumes fan-motor efficiency of 65% and fluid specific gravity of 1.0
Electricity Unit Cost ($/kWh)	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	1999 industrial energy cost for MN from U.S. Dept of Energy
Fan Electricity Cost ($/yr)	$628,978	$452,255	$524,091	$477,914	$573,546	$538,975	$508,158	$277,283	
Power Requirement for TR sets and motor-driven or electromagnetic rapper systems (kWh/yr)	610,099	438,456	508,133	397,603	484,585	103,666	98,568	89,730	(equation 4 10-4 of controls handbook) Includes compressed air costs.
Electricity Unit Cost ($/kWh)	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	1999 industrial energy cost for MN from U.S. Dept of Energy
TR Set and Rapper System Electricity Cost ($/yr)	$28,065	$20,169	$23,374	$18,290	$22,291	$23,843	$22,671	$12,383	
2. Water									
Water Consumption (gallons/year)	NA	NA	NA	NA	NA	NA	NA	NA	Assumed no increase
3. Dust Disposal	NA	NA	NA	NA	NA	NA	NA	NA	Assumed to be zero since captured material is recycled back into process.
TOTAL UTILITIES COST ($/YR)	**$657,043**	**$472,424**	**$547,465**	**$496,203**	**$595,837**	**$562,818**	**$530,829**	**$289,666**	
B. OPERATING LABOR									
1. Operator Labor									
Operator Labor Hours (hours/year)	0	0	0	0	0	0	0	0	Assumed no increase.
Operator Labor Rate ($/hour)	14.66	14.66	14.66	14.66	14.66	14.66	14.66	14.66	Machine Operators, assemblers, and inspectors", MN, BLS, 1999.
Operator Labor Cost ($/year)	$0	$0	$0	$0	$0	$0	$0	$0	

Appendix C, Table 9: Indurating Furnace ESP Annual Costs for the Above-the-Floor Analysis (Cont.)

FACILITY LINE/STACK	TILDEN Line 1A	TILDEN Line 2B	TILDEN Line 2C	EMPIRE Line 1	EMPIRE Line 2	NS Line 11 (all)	NS Line 12 (all)	NS Line 6 (all)	NOTES:
2. Supervisory Labor									
Supervisory Costs ($/year)	$0	$0	$0	$0	$0	$0	$0	$0	Assumed no increase.
3. ESP Coordinator Labor									
ESP Coordinator Costs ($/year)	$0	$0	$0	$0	$0	$0	$0	$0	Assumed no increase.
TOTAL OPERATING LABOR COST ($/YR)	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	
C. MAINTENANCE									
1. Labor									
Labor Cost ($)	$0	$0	$0	$0	$0	$0	$0	$0	Assumed no increase.
Maintenance Labor Cost ($/year)	$0	$0	$0	$0	$0	$0	$0	$0	
2. Materials	$0	$0	$0	$0	$0	$0	$0	$0	Assumed no increase.
TOTAL MAINTENANCE COST ($/YR)	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	
D. WASTEWATER TREAT.									
WASTEWATER TREATMENT	NA	NA	NA	NA	NA	NA	NA	NA	Assumed no increase.
TOTAL DIRECT ANNUAL COSTS ($/YR)	**$657,043**	**$472,424**	**$547,465**	**$496,203**	**$595,837**	**$562,818**	**$530,829**	**$289,666**	
II. INDIRECT ANN. COSTS									
A. OVERHEAD COSTS	$0	$0	$0	$0	$0	$0	$0	$0	60% of the operating labor and maintenance.
B. ADMIN. COSTS	$190,875	$156,603	$171,085	$161,874	$180,597	$357,675	$342,119	$181,205	2% of total capital costs.
C. INSURANCE COSTS	$95,438	$78,301	$85,543	$80,937	$90,298	$178,837	$171,060	$90,603	1% of total capital costs.
D. PROPERTY TAXES	$95,438	$78,301	$85,543	$80,937	$90,298	$178,837	$171,060	$90,603	1% of total capital costs.
TOTAL INDIRECT ANNUAL COSTS ($/YR)	**$381,751**	**$313,205**	**$342,170**	**$323,749**	**$361,193**	**$715,350**	**$684,239**	**$362,411**	
TOTAL ANNUAL COSTS	**$1,038,794**	**$785,630**	**$889,635**	**$819,952**	**$957,031**	**$1,278,168**	**$1,215,067**	**$652,077**	

Appendix C, Table 10: Ore Dryer Above-the-Floor Costs

PARAMETER	VALUE	Flow Range	BASIS
Scrubber capital cost ($ per acfm)	$1.09	22,501 to 50,000	30,000 cfm VVO from Ducon, 10/12/01
Interest Rate (percent)	0.07		OMB
Equipment Lifetime (years)	25		Estimated equipment life
Capital Recovery Factor (CRF)	0.086		Calculated

Plant	Process	Emission Unit	Control Description	Flow rate (acfm)	Flow rate (dcfm)	Test data or Assigned Test data (gr/dscf)	Adjusted Flow rate (acfm) [a]	Total Capital Costs ($)	Annualized Capital Costs ($/yr)	O&M Costs ($/yr)	Total Annual Control Costs ($/yr)	PM MACT Base. Emiss. Tons/Year	PM Above the Floor Emissions Tons/Year	PM Reduction Tons/Year[a]
Tilden	Ore Dryer	Dryer # 2 North Stack	IS	39,138	39,805	0.0280	46,966	$51,161	$4,390	$128,789	$133,179	77.71	37.36	40.35
	Ore Dryer	Dryer # 2 South Stack	IS	36,069	36,684	0.0520	43,283	$47,150	$4,046	$118,690	$122,736	71.62	34.43	37.18
	Ore Dryer	Dryer # 1	IS	55,251	56,193	0.0170	66,301	$0	$0	$0	$0	109.70	109.70	0.00
							TOTAL	$98,311	$8,436	$247,479	$255,915	259.03	181.49	77.53

a - Above-the-Floor Reduction as a percent of total PM emissions at MACT for ore dryers = 30 percent.

IS = Impingement Scrubber

Appendix C, Table 11: Above-the-Floor Emission Reductions for Ore Dryers

Element	Composition of Elements, ppm by weight (a)	MACT Baseline Emis. of Elements Tons/Year	Above the Floor Emis. Red. of Elements, Tons/Year
Antimony, Sb	7.43	0.00	0.00
Arsenic, As	14.22	0.00	0.00
Beryllium, Be	2.24	0.00	0.00
Cadmium, Cd	0.58	0.00	0.00
Chromium, Cr	28.12	0.01	0.00
Cobalt, Co	14.95	0.00	0.00
Lead, Pb	9.00	0.00	0.00
Manganese, Mn	4085.17	1.06	0.32
Mercury, Hg	3.41	0.00	0.00
Nickel, Ni	6.06	0.00	0.00
Selenium, Se	6.20	0.00	0.00
	TOTAL	1.08	0.32

a Element compositions for Tilden were not available.
Values obtained by averaging the other facility compostion values for OCH.

Appendix C, Table 12: Ore Dryers: Venturi Scrubber Capital Costs for the Above-the-Floor Analysis

PARAMETER	VALUE	BASIS
Interest Rate (percent)	0.07	OMB
Equipment Lifetime (years)	25	Estimated equipment life.
Capital Recovery Factor (CRF)	0.086	Calculated

Capital Cost[1]	Model 2
Flow Rate, cfm	30,000
Equipment Cost (EC)	$16,000
Purchased Equipment Cost (PEC)[2]	$17,280
Total Direct Cost (TDC)[2,3]	$28,685
Indirect Installation Cost (IC)[2]	$6,048
Total Capital Investment (TCI) in Y2001 dollars	$34,733
Total Capital Investment (TCI)[4] in Y1999 dollars	$32,680
Annualized Capital Cost (ACC)	$2,804
Dollar per cfm	$1.089

[1] Model unit 2 provided by Ducon. Represents their VVO model, which is a venturi throat wet scrubber.

[2] PEC, DC and IC based on Table 4.11-5 of Control Technologies for Hazardous Air Pollutants Handbook, June 1991. EPA/625/6-91/014.

[3] Direct Installation cost includes a 10% PEC cost for site preparation.

[4] The costs provided were for 2001. In order to make all costs consistent, the costs were scaled from 2001 to 1999 assuming 3% interest.

Appendix C, Table 13: Ore Dryer Venturi Scrubber Annual Costs for the Above-the-Floor Analysis

Model Parameters	Model 2	Notes
Capital Cost	$32,680	
Emission Stream Flow Rate (acfm)	30,000	Model 1 provided by Ducon. Models 2 and 3 provided by Sly, Inc.
System Pressure Drop, inches H20	37.0	The diff. in p.d. between new and existing. P.D. provided by Ducon = 8 to 60. Used cons. est. of 20. Exist. controls at 3.
System Operating Hours per year	8,760	
I. DIRECT ANNUAL COSTS		
A. Utilities		
1. Increase in Electricity Consumption over Base Line Control (equation 4.11-2 of controls handbook)		
Fan Power Requirement (kWh/yr)	1,759,972	Assumes fan-motor efficiency of 65% and fluid specific gravity of 1.0
Electricity Unit Cost ($/kWh)	0.046	1999 industrial energy cost for MN from U.S. Department of Energy.
Electricity Cost ($/yr)	$80,959	
2. Water		
Water Consumption (gallons/year)	78,840,000	Provided by Ducon
Water Cost ($/yr)	$0	There is no utility cost for the water, since they draw water from tailings basin.
TOTAL UTILITIES COST ($/YR)	**$80,959**	
B. OPERATING LABOR		
1. Operator Labor		
Operator Labor Hours (hours/year)	0	Assumed that operating labor for new controls will be same as existing.
Operator Labor Rate ($/hour)	$14.66	"Machine operators, assemblers, and inspectors", MN, BLS,1999.
Operator Labor Cost ($/year)	$0	
2. Supervisory Labor		
Supervisory Costs ($/year)	$0	Assumed that supervisory labor for new controls will be same as existing controls.

Appendix C, Table 13: Ore Dryer Venturi Scrubber Annual Costs for the Above-the-Floor Analysis (Cont.)

Model Parameters	Model 2	Notes
C. MAINTENANCE		
1. Labor		
Maintenance Labor Hours (hours/year)	0	Assumed that maintenance labor for new controls will be same as existing controls.
Maintenance Labor Rate ($/hour)	$19.25	"Industrial Machinery Repairers", MN, Bureau of Labor Statistics, 1999.
Maintenance Labor Cost ($/year)	$0	
2. Materials	$0	Assumes 100% of Maintenance Labor Cost
TOTAL OPERATING LABOR AND MAINTENANCE COST ($/YR)	**$0**	Calculated Total Maintenance and Labor for comparison.
D. WASTEWATER TREATMENT	**$0.00**	Do not treat the wastewater, it is sent to the tailings basin.
TOTAL DIRECT ANNUAL COSTS ($/YR)	**$80,959**	
II. INDIRECT ANNUAL COSTS		
A. OVERHEAD COSTS	$0	60% of the operating labor and maintenance.
B. ADMINISTRATIVE COSTS	$654	2% of total capital costs.
C. INSURANCE COSTS	$327	1% of total capital costs.
D. PROPERTY TAXES	$327	1% of total capital costs.
TOTAL INDIRECT ANNUAL COSTS ($/YR)	**$1,307**	
TOTAL ANNUAL COSTS ($/YR)	**$82,266**	
TOTAL ANNUAL COSTS ($/CFM)	**$2.74**	

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Appendix D

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Appendix D, Table 1: Non Indurating Costs

Parameter	Value	Flow Range	Basis
Scrubber capital cost ($ per acfm)	$3.54	0 to 22,500	15,000 cfm UW-4 from Ducon, 10/12/01
	$2.84	22,501 to 50,000	30,000 cfm Impinjet from Sly, 10/12/01
	$2.31	50,001 or greater	70,000 cfm Impinjet from Sly, 10/12/01
Interest Rate (percent)	0.07		OMB
Equipment Lifetime (years)	25		Estimated equipment life.
Capital Recovery Factor (CRF)	0.086		Calculated

Plant	Process	Emission Unit	Control	SV ID	Fow Rate (acfm)	Flow Rate (dcfm)	Data (gr/dscf)	Adjusted Flow Rate (acfm) [a]	Total Capital Costs ($)	Annualized Capital Costs ($/yr)	O&M Costs ($/yr)	NOTES
EVTAC	OCH	4th stage	RC	17	23,244	22,280	0.0390	27,893	$79,190	$6,795	$6,219	(g)
(Fairlane Plant)	OCH	4th stage	RC	18	23,295	22,314	0.0369 (b)	27,954	$79,364	$6,810	$6,233	
	OCH	4th stage	RC	19	19,154	19,000	0.0660	22,985	$65,256	$5,600	$5,125	(g)
	OCH	4th stage	RC	20	19,222	19,550	0.0369 (b)	23,066	$65,487	$5,620	$5,143	(h)
	OCH	4th stage	RC	21	20,000	20,341	0.0369 (b)	24,000	$68,138	$5,847	$5,351	(h)
	OCH	4th stage	RC	23	30,402	30,920	0.0369 (b)	36,482	$103,577	$8,888	$8,134	(h)
	OCH	4th stage	RC	24	30,402	30,920	0.0369 (b)	36,482	$103,577	$8,888	$8,134	(h)
	OCH	Transfer house (north)	RC	26	25,619	26,056	0.018 (d)	30,743	$87,281	$7,490	$6,855	(h)
	OCH	Transfer house (south)	RC	28	15,000	15,256	0.0173 (c)	18,000	$63,726	$5,468	$5,175	(h)
							EVTAC - OCH		$715,596	$61,406	$56,369	
							EVTAC - PH		$0	$0	$0	
							EVTAC Total		$715,596	$61,406	$56,369	
Northshore (Sil. Bay)	PH	Furnace discharge	RC	120	32,000	28,925	0.0173 (c)	38,400	$109,021	$9,355	$8,562	(g)
	PH	Furnace discharge	RC	121	32,000	28,925	0.0173 (c)	38,400	$109,021	$9,355	$8,562	(g)
	PH	East furnaces discharge	RC	122	32,000	28,925	0.0173 (c)	38,400	$109,021	$9,355	$8,562	(g)
	PH	East furnaces screening	RC	123	32,000	28,925	0.0173 (c)	38,400	$109,021	$9,355	$8,562	(g)
	PH	Pellet conveying	RC	124	32,000	14,500	0.0090	38,400	$109,021	$9,355	$8,562	
	PH	Pellet Screen House	RC	125	32,000	28,925	0.0173 (c)	38,400	$109,021	$9,355	$8,562	(i)

Appendix D, Table 1: Non Indurating Costs (Cont.)

Plant	Process	Emission Unit	Control	SV ID	Fow Rate (acfm)	Flow Rate (dcfm)	Data (gr/dscf)	Adjusted Flow Rate (acfm) [a]	Total Capital Costs ($)	Annualized Capital Costs ($/yr)	O&M Costs ($/yr)	NOTES
Northshore (Babbitt)	PH	Furnace discharge	RC	255	25,000	28,925	0.0173 (c)	30,000	$85,172	$7,309	$6,689	(g)
	PH	Furnace discharge end	RC	265	32,000	28,925	0.0173 (c)	38,400	$109,021	$9,355	$8,562	(i)
	OCH	Primary Crusher (Line 2)	MC		60,000	61,023		72,000	$166,598	$14,296	$16,054	(l)
	OCH	Secondary Crusher	MC		15,000	15,256		18,000	$63,726	$5,468	$4,013	(l)
	OCH	Secondary Crusher	MC		15,000	15,256		18,000	$63,726	$5,468	$4,013	(l)
	OCH	Secondary Crusher	MC		15,000	15,256		18,000	$63,726	$5,468	$4,013	(l)
	OCH	Secondary Crusher	MC		15,000	15,256		18,000	$63,726	$5,468	$4,013	(l)
	OCH	Storage Bins (West)	MC	32	29,400	29,901		35,280	$100,163	$8,595	$7,866	
	OCH	Storage Bins (West)	MC	33	29,400	29,901		35,280	$100,163	$8,595	$7,866	
	OCH	Storage Bins (West)	MC	34	29,400	29,901		35,280	$100,163	$8,595	$7,866	
	OCH	Storage Bins (West)	MC	35	29,400	29,901		35,280	$100,163	$8,595	$7,866	
	OCH	Storage Bins (West)	MC	36	29,400	29,901		35,280	$100,163	$8,595	$7,866	
	OCH	Storage Bins (West)	MC	37	29,400	29,901		35,280	$100,163	$8,595	$7,866	
	OCH	Storage Bins (West)	MC	38	29,400	29,901		35,280	$100,163	$8,595	$7,866	
	OCH	Storage Bins (West)	MC	39	29,400	29,901		35,280	$100,163	$8,595	$7,866	
	OCH	Storage Bins (West)	MC	40	29,400	29,901		35,280	$100,163	$8,595	$7,866	
	OCH	Storage Bins (West)	MC	41	29,400	29,901		35,280	$100,163	$8,595	$7,866	
	OCH	Storage Bins (West)	MC	42	29,400	29,901		35,280	$100,163	$8,595	$7,866	
	OCH	Storage Bins (West)	MC	43	29,400	29,901		35,280	$100,163	$8,595	$7,866	
	OCH	Storage Bins (East)	MC	44	30,769	28,925		36,923	$104,827	$8,995	$8,233	
	OCH	Storage Bins (East)	MC	45	30,769	28,925		36,923	$104,827	$8,995	$8,233	
	OCH	Storage Bins (East)	MC	46	30,769	28,925		36,923	$104,827	$8,995	$8,233	
	OCH	Storage Bins (East)	MC	47	30,769	28,925		36,923	$104,827	$8,995	$8,233	
	OCH	Storage Bins (East)	MC	49	30,769	28,925		36,923	$104,827	$8,995	$8,233	
	OCH	Storage Bins (East)	MC	50	30,769	28,925		36,923	$104,827	$8,995	$8,233	
	OCH	Storage Bins (East)	MC	51	30,769	28,925		36,923	$104,827	$8,995	$8,233	
	OCH	Storage Bins (East)	MC	52	30,769	28,925		36,923	$104,827	$8,995	$8,233	
	OCH	Storage Bins (East)	MC	53	30,769	28,925		36,923	$104,827	$8,995	$8,233	

Appendix D, Table 1: Non Indurating Costs (Cont.)

Plant	Process	Emission Unit	Control	SV ID	Fow Rate (acfm)	Flow Rate (dcfm)	Data (gr/dscf)	Adjusted Flow Rate (acfm) [a]	Total Capital Costs ($)	Annualized Capital Costs ($/yr)	O&M Costs ($/yr)	NOTES
	OCH	Furnace feed (west)	RC	260	32,800	28,925	0.0173 (c)	39,360	$111,746	$9,589	$8,776	(g)
							Northshore - OCH		$2,678,646	$229,856	$209,372	
							Northshore - PH		$848,318	$72,795	$66,623	
							Northshore Total		$3,526,964	$302,651	$275,994	
NSPC	PH	Cooler vibrating feeder	RC	27	15,732	16,000		18,878	$119,241	$10,232	$0	(k)
	PH	Pellet product conveyor	RC	28	9,144	9,300		10,973	$85,172	$7,309	$0	(l)
	PH	Pellet cooler product belts	IS	32	24,908	25,333	0.0130	29,890	$0	$0	$8,593	
	OCH	Drive House No. 1Prim. Con.	MC	3	12,292	12,029	0.0783	14,750	$204,414	$17,541	$4,241	
							NSPC - OCH		$204,414	$17,541	$4,241	
							NSPC - PH		$84,861	$7,282	$8,593	
							NSPC Total		$126,738	$10,875	$12,833	
Hibbing	PH	Hearth layer screening	IS	222	35,000	30,733	0.0176	42,000	$119,241	$10,232	$9,365	
	PH	Pellet transfer house	IS	223	25,000	21,500	0.0148	30,000	$85,172	$7,309	$6,689	
							Hibbing - OCH		$0	$0	$0	
							Hibbing - PH		$204,414	$17,541	$16,054	
							Hibbing Total		$204,414	$17,541	$16,054	
Minntac	OCH	Secondary crushing(fine)	MB	31	22,500	22,884	0.0104 (e)	27,001	$76,657	$6,578	$6,020	
	OCH	Secondary crushing(fine)	MB	32	22,500	22,884	0.0104 (e)	27,000	$76,655	$6,578	$6,020	
	OCH	Secondary crushing(fine)	MB	33	22,500	22,884	0.0104 (e)	27,000	$76,655	$6,578	$6,020	
	OCH	Secondary crushing(fine)	MB	34	22,500	22,884	0.0104 (e)	27,000	$76,655	$6,578	$6,020	
	OCH	Secondary crushing(fine)	MB	62	19,960	20,300	0.0097	23,952	$68,002	$5,835	$5,341	
	OCH	Secondary crushing(fine)	MB	55	21,400	21,765	0.0104 (e)	25,680	$72,908	$6,256	$5,726	
	OCH	Secondary crushing(fine)	MB	56	20,900	21,256	0.0104 (e)	25,080	$71,204	$6,110	$5,592	
	OCH	Secondary crushing(fine)	MB	57	20,900	21,256	0.0104 (e)	25,080	$71,204	$6,110	$5,592	
	OCH	Secondary crushing(fine)	MB	58	21,300	21,663	0.0104 (e)	25,560	$72,567	$6,227	$5,699	
	OCH	Secondary crushing(fine)	MB	59	20,900	21,256	0.0104 (e)	25,080	$71,204	$6,110	$5,592	
	OCH	Secondary crushing(fine)	MB	64	26,250	26,697	0.0104 (e)	31,500	$89,431	$7,674	$7,023	
	OCH	Secondary crushing(fine)	MB	65	26,250	26,697	0.0104 (e)	31,500	$89,431	$7,674	$7,023	

Appendix D, Table 1: Non Indurating Costs (Cont.)

Plant	Process	Emission Unit	Control	SV ID	Fow Rate (acfm)	Flow Rate (dcfm)	Data (gr/dscf)	Adjusted Flow Rate (acfm) [a]	Total Capital Costs ($)	Annualized Capital Costs ($/yr)	O&M Costs ($/yr)	NOTES
	OCH	Secondary crushing(fine)	MB	66	26,250	26,697	0.0104 (e)	31,500	$89,431	$7,674	$7,023	
	OCH	Secondary crushing(fine)	MB	67	26,250	26,697	0.0104 (e)	31,500	$89,431	$7,674	$7,023	
	OCH	Secondary crushing(fine)	MB	68	24,450	24,867	0.0111	29,340	$83,299	$7,148	$6,542	
	OCH	Conveyor transfer	MB	85	16,000	16,273	0.0087 (f)	19,200	$67,975	$5,833	$5,520	
	OCH	Conveyor transfer	MB	85	13,175	13,400	0.0087 (f)	15,810	$55,973	$4,803	$4,545	
								Minntac - OCH	$1,298,682	$111,441	$102,322	
								Minntac - PH	0	0	0	
								Minntac Total	$1,298,682	$111,441	$102,322	
								OCH	$4,734,801	$406,296	$372,304	
								PH	$1,137,592	$97,617	$91,269	
								Non-Indurating Total	$5,872,393	$503,913	$463,573	

a - Flow rates for the calculation of the capital and O & M costs were calculated by multiplying the acfm by a 20% over-sizing factor. This adjusted flow rate was then multiplied by the $/cfm for the model that is closest to the adjusted flow rate.
b - Emission value calculated by averaging test results of EVTAC SV17, SV19 and SV22
c - Emission value calculated by averaging the test results of EVTAC SV11, SV16, SV17, SV19, SV22, SV25, SV31 and National Steel SV124
d - Emission value calculated by averaging the test results of EVTAC SV11, SV16, SV17, SV19, SV22, SV25 and SV31
e - Emission value calculated by averaging the test reulsts of Minntac SV62 and SV 68
f - Emission value calculated by averaging the test reulsts of Minntac SV85
g - acfm and dcfm from values recorded during emission tests
h - dcfm calculated from acfm using ideal gas law equation
i - Estimated acfm from other units
j - Currently not in operation; flow rate based on other crushers
k - Shut down
l - Unit was removed

Appendix D, Table 2: Total Number of Monitoring Devices on Controls [a]

Facility	Ore Crushing and Handling			Indurating Furnace			Pellet Handling		Total # of Controls
	# of Scrubbers	# of Baghouses	# of ESPs	# of Scrubbers	# of Baghouses	# of ESPs	# of Scrubbers	# of Baghouses	
MINNTAC[b]	0	3		0			0		3
National[a,c]	16			0			9		25
EVTAC[d]	24	10		1			6		41
Northshore[e]	28	30				13	8	1	80
Inland	10	6		4			8	1	29
Tilden	15	2	2			5	7		31
Hibbing	15			12			9		36
Empire[f]	19					4	16		39
TOTAL	127	51	2	17	0	22	63	2	284

a - Assumed that new indurating furnaces include monitoring equipment. Assumed monitoring equipment for OCH and PH would be extra.

b - MINNTAC's scrubbers already have monitoring equipment installed. Therefore, none of their scrubbers will incur MRR capital costs as a result of the rule. MINNTAC has 84 scrubbers in ore crushing and handling, 5 scrubbers in indurating, and 17 scrubbers in pellet handling.

c - Assumed that National will install wet scrubbers on its one indurating furnace. The capital costs for the wet scrubbers include the monitoring device.

d - For the purpose of monitoring, all Rotoclones and multiclones are considered the same as scrubbers.

e - Northshore currently has 2 multiclones and 1 rotoclone WS but will replace the 2 Multiclones with scrubbers prior to compliance.

f - Empire also has 2 HDCC for ore crushing and handling that were not considered in monitoring costs.

Appendix D, Table 3: Non-Indurating Scrubber Annual Cost

Model Parameters	Model 1	Model 2	Model 3	Notes
Emission Stream Flow Rate (acfm)	15,000	30,000	70,000	Model 1 provided by Ducon. Models 2 and 3 provided by Sly, Inc.
System Pressure Drop, inches H20	2.0	1.5	2.5	Rates provided by sly were 5, 4.5 and 5.5, respectively. Assume that 3 inches in the baseline, therefore used diference.
System Operating Hours per year	8,760	8,760	8,760	Assumed operate 24 hrs a day 365 days a year.
Capital Cost	$53,105	$85,172	$161,971	
I. DIRECT ANNUAL COSTS				
A. UTILITIES				
1. Increase in Electricity Consumption over Base Line Control (equation 4.11-2 of controls handbook)				
Fan Power Requirement (kWh/yr)	47,567	71,350	277,473	Assumes fan-motor efficiency of 65% and fluid specific gravity of 1.0
Electricity Unit Cost ($/kWh)	0.046	0.046	0.046	1999 industrial energy cost for MN from U.S. Department of Energy.
Electricity Cost ($/yr)	$2,188	$3,282	$12,764	
2. Water				
Water Consumption (gallons/year)	23,652,000	47,304,000	110,376,000	Provided by Sly
Water Cost ($/yr)	$0	$0	$0	There is no utility cost for the water, since they draw water from tailings basin.
TOTAL UTILITIES COST ($/YR)	**$2,188**	**$3,282**	**$12,764**	
B. OPERATING LABOR				
1. Operator Labor				
Operator Labor Hours (hours/year)	0	0	0	Assumed that operating labor for new controls will be same as existing.
Operator Labor Rate ($/hour)	$14.66	$14.66	$14.66	"Machine operators, assemblers, and inspectors", MN, BLS,1999.
Operator Labor Cost ($/year)	$0	$0	$0	
2. Supervisory Labor				
Supervisory Costs ($/year)	$0	$0	$0	Assumed that supervisory labor for new controls will be same as existing controls.

Appendix D, Table 3: Non-Indurating Scrubber Annual Cost (Cont.)

Model Parameters	Model 1	Model 2	Model 3	Notes
C. MAINTENANCE				
1. Labor				
Maintenance Labor Hours (hours/year)	0	0	0	Assumed that maintenance labor for new controls will be same as existing controls.
Maintenance Labor Rate ($/hour)	$19.25	$19.25	$19.25	"Industrial Machinery Repairers", MN, Bureau of Labor *Statistics*, 1999.
Maintenance Labor Cost ($/year)	$0	$0	$0	
2. Materials	$0	$0	$0	Assumes 100% of Maintenance Labor Cost
TOTAL OPERATING LABOR AND MAINTENANCE COST ($/YR)	**$0**	**$0**	**$0**	**Calculated Total Maintenance and Labor for comparison.**
D. WASTEWATER TREATMENT				
WASTEWATER TREATMENT	**$0.00**	**$0.00**	**$0.00**	Do not treat the wastewater, it is sent to the tailings basin.
TOTAL DIRECT ANNUAL COSTS ($/YR)	**$2,188**	**$3,282**	**$12,764**	
II. INDIRECT ANNUAL COSTS				
A. OVERHEAD COSTS				
OVERHEAD COSTS	$0	$0	$0	60% of the operating labor and maintenance.
B. ADMINISTRATIVE COSTS				
ADMINISTRATIVE COSTS	$1,062	$1,703	$3,239	2% of total capital costs.
C. INSURANCE COSTS				
INSURANCE COSTS	$531	$852	$1,620	1% of total capital costs.
D. PROPERTY TAXES				
PROPERTY TAXES	$531	$852	$1,620	1% of total capital costs.
TOTAL INDIRECT ANNUAL COSTS ($/YR)	**$2,124**	**$3,407**	**$6,479**	
TOTAL ANNUAL COSTS ($/YR)	**$4,312**	**$6,689**	**$19,243**	
TOTAL ANNUAL COSTS ($/CFM)	**$0.29**	**$0.22**	**$0.27**	

Appendix D, Table 4: Furnace Capital Costs

Parameter	Value	Basis
Interest Rate (percent)	0.07	OMB
Equipment Lifetime (years)	25	Estimated equipment life
Capital Recovery Factor (CRF)	0.086	Calculated

	MINNTAC			EVTAC		Hibbing [e]				National		
	SCRUBBER [a]			SCRUBBER (Line 2)		SCRUBBER (Line 3)				SCRUBBER (Line 2)		TOTAL
Cost Parameter	**Line 3**	**Line 6**	**Line 7**	**Stack A**	**Stack B**	**Stack A**	**Stack B**	**Stack C**	**Stack D**	**Stack A**	**Stack B**	
Scaling Factor [b]	1.00	0.85	0.84	0.79	0.75	0.51	0.56	0.50	0.56	0.70	0.70	
Capital Costs												
Equipment Cost (1991 dollars) [c]	$1,100,400	$935,578	$928,029	$871,653	$826,765	$43,579	$43,579	$43,579	$43,579	$771,914	$771,914	$6,380,570
Direct Installation Costs (1991 dollars) [c]	$3,972,250	$3,377,273	$3,350,023	$3,146,512	$2,984,476	$43,579	$43,579	$43,579	$43,579	$2,786,474	$2,786,474	$22,577,798
Total Direct Costs (1991 dollars) [c]	$5,072,650	$4,312,851	$4,278,052	$4,018,165	$3,811,241	$87,158	$87,158	$87,158	$87,158	$3,558,388	$3,558,388	$28,958,368
Indirect Installation Costs (1991 dollars) [c]	$756,500	$643,189	$637,999	$599,241	$568,382	$0	$0	$0	$0	$530,673	$530,673	$4,266,658
Total Capital Investment (1991 dollars) [c]	$5,829,150	$4,956,040	$4,916,051	$4,617,406	$4,379,623	$87,158	$87,158	$87,158	$87,158	$4,089,062	$4,089,062	$33,225,026
Total Capital Investment (TCI) [d] Adjusted to Y1999 (VAPCCI)	$6,714,378	$5,708,676	$5,662,614	$5,318,616	$5,044,723	$100,394	$100,394	$100,394	$100,394	$4,710,036	$4,710,036	$38,270,656
Annualized Capital Costs	$576,164	$489,864	$485,912	$456,393	$432,890	$8,615	$8,615	$8,615	$8,615	$404,171	$404,171	$3,284,025

Appendix D, Table 4: Furnace Capital Costs (Cont.)

Notes:

[a] MINNTAC line 3 capital cost is based on costs provided by MINNTAC for "agglomerator line 4 & 5 waste gas scrubber order of magnitude estimate." (Letter from Larry Salmela of MINNTAC, 11/23/99). It was assumed that this estimate included the CPMS.

[b] The capital scrubber costs for Minntac line 6, 7, EVTAC, Hibbing and National were scaled from the MINNTAC line 3 scrubber capital costs based on the acfm using a power of six scaling assumption. As an example: (509,509 acfm at National/460,000 acfm at MINNTAC)^0.6 = 1.06.

[c] Original costs for MINNTAC were for two scrubbers. These costs were divided by 2.

[d] The TCI was scaled from the first quarter 1991 to the first quarter 1994 using the average annual percent increase from 1994 to 1999, as determined using the Vatavuk index for large wet scrubbers. The TCI was scaled from first quarter of 1994 to the first quarter of 1999 using the Vatavuk air pollution control cost indexes (VAPPCCI) for large wet scrubbers.

[e] Cost for Hibbing are the costs for rebuilding the scrubbers, not replacement. These costs were provided by Hibbing in 2002 dollars (3/26/02 fax from Andrea Hayden of Hibbing, to Conrad Chin of U.S. EPA). The costs were scaled back from 2002 to 1999 using 3% annual interest. The costs were further scaled back from 1999 to 1991 using the VAPPCCI.

Appendix D, Table 5: Furnace Annual Costs

Unit Parameters	MINNTAC			EVTAC Line 2		Hibbing Line 3				NATIONAL Line 2		NOTES
	LINE 3	Line 6	Line 7	Stack A	Stack B	Stack A	Stack B	Stack C	Stack D	Stack A	Stack B	
Emission Stream Flow Rate (acfm)	552,000	421,200	415,551	374,335	342,761	181,880	207,840	176,400	208,920	305,705	305,705	(a)
System Pressure Drop, inches H20	10	10	10	10	10	10	10	10	10	10	10	Assumed Value
System Operating Hours per year	8,410	8,760	8,760	8,760	8,760	8,760	8,760	8,760	8,760	8,243	8,243	(b)
I. DIRECT ANNUAL COSTS												
A. UTILITIES												
1. Increase in Electricity Consumption over Baseline Control (equation 4.11-2 of controls handbook)												
Fan Power Requirement (kWh/yr)	5,041,560	0	0	0	0	0	0	0	0	2,736,644	2,736,644	(c)
Electricity Unit Cost ($/kWh)	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	(d)
Electricity Cost ($/yr)	$231,912	$0	$0	$0	$0	$0	$0	$0	$0	$125,886	$125,886	
2. Water												
Water Consumption (gallons/year)	2,785,392,000	0	0	0	0	0	0	0	0	1,511,957,767	1,511,957,767	(e)
Water Cost ($/yr)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	(f)
TOTAL UTILITIES COST ($/YR)	**$231,912**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$125,886**	**$125,886**	
B. OPERATING LABOR												
1. Operator Labor												
Operator Labor Hours (hours/year)	2,103	0	0	0	0	0	0	0	0	2,061	2,061	(g)
Operator Labor Rate ($/hour)	$14.66	$14.66	$14.66	$14.66	$14.66	$14.66	$14.66	$14.66	$14.66	$14.66	$14.66	(h)
Operator Labor Cost ($/year)	$30,823	$0	$0	$0	$0	$0	$0	$0	$0	$30,211	$30,211	
2. Supervisory Labor												
Supervisory Costs ($/year)	$4,623	$0	$0	$0	$0	$0	$0	$0	$0	$4,532	$4,532	(i)
C. MAINTENANCE												
1. Labor												
Maintenance Labor Hours (hours/year)	1,051	0	0	0	0	0	0	0	0	1,030	1,030	(j)
Maintenance Labor Rate ($/hour)	$19.25	$19.25	$19.25	$19.25	$19.25	$19.25	$19.25	$19.25	$19.25	$19.25	$19.25	(k)
Maintenance Labor Cost ($/year)	$20,237	$0	$0	$0	$0	$0	$0	$0	$0	$19,835	$19,835	
2. Materials	$20,237	$0	$0	$0	$0	$0	$0	$0	$0	$19,835	$19,835	(l)

Appendix D, Table 5: Furnace Annual Costs (Cont.)

Unit Parameters	MINNTAC			EVTAC Line 2		Hibbing Line 3				NATIONAL Line 2		NOTES
	LINE 3	Line 6	Line 7	Stack A	Stack B	Stack A	Stack B	Stack C	Stack D	Stack A	Stack B	
CALCULATED TOTAL OPERATING LABOR AND MAINTENANCE COST ($/YR)	**$75,919**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$74,412**	**$74,412**	(m)
FACILITY PROVIDED OPERATING LABOR AND MAINTENANCE COST ($/YR)	**$75,000**											(n)
TOTAL OPERATING LABOR AND MAINTENANCE COST	**$75,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$74,412**	**$74,412**	
D. WASTEWATER TREATMENT												
WASTEWATER TREATMENT	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	(o)
TOTAL DIRECT ANNUAL COSTS ($/YR)	**$306,912**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$200,297**	**$200,297**	
II. INDIRECT ANNUAL COSTS												
A. OVERHEAD COSTS	$45,000	$0	$0	$0	$0	$0	$0	$0	$0	$44,647	$44,647	(p)
B. ADMINISTRATIVE COSTS	$134,288	$114,174	$113,252	$106,372	$100,894	$2,008	$2,008	$2,008	$2,008	$94,201	$94,201	(q)
C. INSURANCE COSTS	$67,144	$57,087	$56,626	$53,186	$50,447	$1,004	$1,004	$1,004	$1,004	$47,100	$47,100	(r)
D. PROPERTY TAXES	$67,144	$57,087	$56,626	$53,186	$50,447	$1,004	$1,004	$1,004	$1,004	$47,100	$47,100	(s)
TOTAL INDIRECT ANNUAL COSTS ($/YR)	**$313,575**	**$228,347**	**$226,505**	**$212,745**	**$201,789**	**$4,016**	**$4,016**	**$4,016**	**$4,016**	**$233,048**	**$233,048**	
TOTAL ANNUAL COSTS ($/YR)	**$620,487**	**$228,347**	**$226,505**	**$212,745**	**$201,789**	**$4,016**	**$4,016**	**$4,016**	**$4,016**	**$433,346**	**$433,346**	

Appendix D, Table 5: Furnace Annual Costs (Cont.)

a - Minntac line 3 value provided by MINNTAC, 7/18/01. Other values are from the test results conducted on the furnaces. Average value used for the furnaces that have more than one valid test. The flow rates were multiplied by a 20% over-sizing factor.

b - Minntac value provided by MINNTAC, 7/18/01. National value provided by Sarrah Mattila, 08/20/01. For the remaining furnaces 24 hours of operation per day for whole year is assumed.

c - Assumes fan-motor efficiency of 65% and fluid specific gravity of 1.0. Assumed that multiclone has 4 inches p.d. and old wet scrubbers have 10 p.d.of pressure drop in baseline (Section 114 response for National multiclone).

d - 1999 industrial energy cost for MN from U.S. Dept. of Energy.

e - Assume no net increase in water consumption for units currently using wet scrubbers or wet ESPs

f - There is no utility cost for the water, since they draw water from tailings basin

g - For Multiclones assumed 2 hrs per 8 hour shift. For units currently controlled by wet scrubbers or ESPs assumed no net increase in operating labor

h - "Machine operators, assemblers, and inspectors", MN, BLS, 1999

i - For multiclones assumed 15% of Operating Labor. For units currently controlled by wet scrubbers or ESPs assumed no net increase in supervisory labor.

j - For units currently controlled by multiclones assumed 1 hr per 8 hour shift. For units currently controlled by wet scrubbers or ESPs assumed no net increase in maintenance labor

k - "Industrial Machinery Repairers", MN, BLS, 1999

l - Assumes 100% of Maintenance Labor Cost

m - Calculated Total Maintenance and Labor for comparison

n - This is the value used in the analysis

o - Do not treat the wastewater, it is sent to the tailings basin.

p - 60% of the operating labor and maintenance.

q - 2% of total capital costs.

r - 1% of total capital costs.

s - 1% of total capital costs.

Appendix E

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Appendix E, Table 1: Increased Electricity and Waste Water Usage

Plant	SV ID	Size of Rotoclone	Increased Electricity Usage (Kwhr/yr)	Increased Electricity Cost ($/yr)	Increased Waste Water Usage (gal/yr)
EVTAC	17	33	66,339	$3,052	43,847,779
(Fairlane Plant)	18	33	66,484	$3,058	43,944,279
	19	30	54,666	$2,515	36,119,713
	20	30	54,860	$2,524	36,248,380
	21	30	57,080	$2,626	37,720,480
	23	28	86,768	$3,991	57,410,008
	24	28	86,768	$3,991	57,410,008
	26	24	73,117	$3,363	48,373,847
	28	30	57,080	$2,626	28,259,680
	EVTAC Total		603,160	$27,745	389,334,174
Northshore (Sil. Bay)	120	48	91,328	$4,201	60,361,400
	121	48	91,328	$4,201	60,361,400
	122	48	91,328	$4,201	60,361,400
	123	48	91,328	$4,201	60,361,400
	124	48	91,328	$4,201	60,361,400
	125	48	91,328	$4,201	60,361,400
	255	48	71,350	$3,282	47,116,280
	265	48	91,328	$4,201	60,361,400
Northshore (Babbitt)	None		171,240	$7,877	113,529,600
	None		42,810	$1,969	28,382,400
	None		42,810	$1,969	28,382,400
	None		42,810	$1,969	28,382,400
	None		42,810	$1,969	28,382,400
	32		83,908	$3,860	55,629,504
	33		83,908	$3,860	55,629,504
	34		83,908	$3,860	55,629,504
	35		83,908	$3,860	55,629,504
	36		83,908	$3,860	55,629,504
	37		83,908	$3,860	55,629,504
	38		83,908	$3,860	55,629,504
	39		83,908	$3,860	55,629,504
	40		83,908	$3,860	55,629,504
	41		83,908	$3,860	55,629,504
	42		83,908	$3,860	55,629,504
	43		83,908	$3,860	55,629,504
	44		87,815	$4,039	58,219,871
	45		87,815	$4,039	58,219,871

Appendix E, Table 1: Increased Electricity and Waste Water Usage (Cont.)

Plant	SV ID	Size of Rotoclone	Increased Electricity Usage (Kwhr/yr)	Increased Electricity Cost ($/yr)	Increased Waste Water Usage (gal/yr)
	46		87,815	$4,039	58,219,871
	47		87,815	$4,039	58,219,871
	49		87,815	$4,039	58,219,871
	50		87,815	$4,039	58,219,871
	51		87,815	$4,039	58,219,871
	52		87,815	$4,039	58,219,871
	53		87,815	$4,039	58,219,871
	260	48	93,611	$4,306	61,875,128
	Northshore Total		2,943,969	$135,423	1,950,113,295
National	27		0	0	0
	28		0	0	0
	32		94,785	$4,360	47,130,725
	3		46,775	$2,152	23,258,431
	National Total		141,560	$6,512	70,389,155
Hibbing	222		0	0	0
	223		0	0	0
	Hibbing Total		0	0	0
Minntac	31		64,217	$2,954	12,615,288
	32		64,215	$2,954	12,614,400
	33		64,215	$2,954	12,614,400
	34		64,215	$2,954	12,614,400
	62		56,966	$2,620	7,808,314
	55		61,076	$2,809	15,789,024
	56		59,649	$2,744	14,842,944
	57		59,649	$2,744	14,842,944
	58		60,790	$2,796	15,599,808
	59		59,649	$2,744	14,842,944
	64		74,918	$3,446	15,505,200
	65		74,918	$3,446	14,979,600
	66		74,918	$3,446	14,979,600
	67		74,918	$3,446	14,979,600
	68		69,780	$3,210	12,099,312
	85		60,886	$2,801	315,360
	85		50,135	$2,306	0
	Minntac Total		1,095,113	50,375	207,043,138
NonIndurating Total			4,783,803	$220,055	2,616,879,762
Indurating Total (from Appendix D Table 5)			10,514,847	$483,683	5,809,307,535
Grand Total			15,298,649	$703,738	8,426,187,297

Appendix E, Table 2: Approximate Baseline Water Usage for Wet Scrubbers

Affected Source	(A) Number of Wet Scrubbers	(B) Approximate Wet Scrubber Water Usage (gpm)	(C) Minutes Per Hour	(D) Assumed Operation Hours Per Year	(E) Approximate Total Water Usage (Billion Gallons) (AxBxCxD=E)
OCH	160	45	60	8760	3.8
Indurating Furnaces	23	3,000	60	8760	362.7
PH	71	45	60	8760	1.7
Ore Dryers	3	1,000	60	8760	1.6
				Total	369.8

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TECHNICAL REPORT DATA

(Please read Instructions on reverse before completing)

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16. ABSTRACT

This background information document (BID) provides information relevant to the proposal of national emission standards for hazardous air pollutants (NESHAP) for limiting hazardous air pollutants (HAP) emissions from taconite iron ore processing plants. The standards are being developed according to section 112(d) of Title III of the Clean Air Act (CAA) as amended in 1990.

17. KEY WORDS AND DOCUMENT ANALYSIS

a DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Taconite Iron Ore Production Ore Crushing and Handling Pellet Handling Indurating Furnaces Metallic HAP Emissions	Air Pollution control	

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