Emission Factor Documentation for AP-42
Section 11.23

Taconite Ore Processing

Final Report

For U. S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Emission Factor and Inventory Group

EPA Contract 68-D2-0159
Work Assignment No. 4-02

MRI Project No. 4604-02

February 1997

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Emission Factor and Inventory Group
Research Triangle Park, NC 27711

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NOTICE

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PREFACE

This report was prepared by Midwest Research Institute (MRI) for the Office of Air Quality Planning and Standards (OAQPS), U. S. Environmental Protection Agency (EPA), under Contract No. 68-D2-0159, Work Assignment No. 4-02. Mr. Ron Myers was the requester of the work.

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF TABLES

EMISSION FACTOR DOCUMENTATION FOR AP-42 SECTION 11.23
TACONITE ORE PROCESSING

1. INTRODUCTION

The document *Compilation of Air Pollutant Emission Factors* (AP-42) has been published by the U. S. Environmental Protection Agency (EPA) since 1972. Supplements to AP-42 have been routinely published to add new emission source categories and to update existing emission factors. AP-42 is routinely updated by EPA to respond to new emission factor needs of EPA, State and local air pollution control programs, and industry.

An emission factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. Emission factors usually are expressed as the weight of pollutant divided by the unit weight, volume, distance, or duration of the activity that emits the pollutant. The emission factors presented in AP-42 may be appropriate to use in a number of situations, such as making source-specific emission estimates for areawide inventories for dispersion modeling, developing control strategies, screening sources for compliance purposes, establishing operating permit fees, and making permit applicability determinations. The purpose of this report is to provide background information from test reports and other information to support revisions to AP-42 Section 11.23, Taconite Ore Processing.

This background report consists of five sections. Section 1 includes the introduction to the report. Section 2 gives a description of the taconite ore processing industry. It includes a characterization of the industry, an overview of the different process types, a description of emissions, and a description of the technology used to control emissions resulting from taconite ore processing. Section 3 is a review of emission data collection and laboratory analysis procedures. It describes the literature search, the screening of emission data reports, and the quality rating system for both emission data and emission factors. Section 4 details revisions to the existing AP-42 section narrative and pollutant emission factor development. It includes the review of specific data sets, a description of how candidate emission factors were developed, and a summary of changes to the AP-42 section. Section 5 presents the revised AP-42 Section 11.23, Taconite Ore Processing.

2. INDUSTRY DESCRIPTION[1]

The taconite ore processing industry (Standard Industrial Classification [SIC] Code 1011) produces usable concentrations of iron-bearing material by removing nonferrous rock (gangue) from low-grade ore. The six-digit source classification code (SCC) for taconite ore processing is 3-03-023.

Taconite, a hard, banded, low-grade ore, is the predominant iron ore remaining in the United States. Ninety-nine percent of the crude iron ore produced in the United States is taconite. If magnetite is the principal iron mineral, the rock is called magnetic taconite; if hematite is the principal iron mineral, the rock is called hematic taconite.

About 98 percent of the demand for taconite comes from the iron and steel industry. The remaining two percent 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 ore shipped to the iron and steel industry is in the form of pellets. Other forms of processed ore include sinter and briquettes. The average iron content of pellets is 63 percent.

2.1 CHARACTERIZATION OF THE INDUSTRY[1]

Combined U.S. and Canadian production represents only 12 percent of the world output of usable ore. About 45 other countries mine crude ore, most of which is a higher grade than taconite. The leading producer is the former U.S.S.R., which accounts for about 24 percent of world output in terms of metal content. Other large producers include Brazil, Australia, France, Mexico, and South Africa.

Domestic steel companies control about 76 percent of usable ore production in the United States. Canadian companies control about 11 percent. Due in large part to the location of taconite mines, close ownership ties exist between U.S. and Canadian steel companies.

There are 21 companies operating 21 taconite mines nationwide. However, 99 percent of the output is accounted for by only 10 mines. Table 2-1 shows the geographic spread and production rate of taconite mines in the United States. The Missouri mine is the only underground mine; all other mines are open pit.

TABLE 2-1. NUMBER AND PRODUCTION RATE OF TACONITE MINES BY STATE[a]

State	No. of mines	No. of pellet plants	Crude ore produced[b]	Usable ore produced[b]
Minnesota	7	7	140,000	41,000
Michigan	2	3	45,000	16,000
Missouri	1	0	1,600	1,000
Other	11	0	1,100	1,000
Total	21	10	187,700	59,000

[a]Reference 1.
[b]Thousand metric tons per year in 1989.

Because 98 percent of its sales are to the iron and steel industry, the prosperity of the taconite ore processing industry is highly dependent upon the well-being of iron and steel industry.

2.2 PROCESS DESCRIPTION[2-6]

Processing of taconite consists of crushing and grinding the ore to liberate iron-bearing particles, concentrating the ore by separating the particles from the waste material (gangue), and pelletizing the iron ore concentrate. A simplified flow diagram of these processing steps is shown in Figure 2-1. Table 2-2 provides a key to the SCCs for taconite ore processing, as indicated in Figure 2-1.

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 six stages, depending on the hardness of the ore. One or two stages of crushing may be performed at the mine prior to transport to the processing facility. Gyratory crushers are generally used for primary crushing, and cone crushers are used for secondary and tertiary fine crushing. Intermediate vibrating screens remove undersize material from the feed to the next crusher and allow for closed-circuit operation of the fine crushers. After crushing, the size of the materials is further reduced by wet grinding in rod mills or ball mills. The rod and ball mills are also in closed circuit with classification systems such as cyclones. An alternative to crushing is to feed some coarse ores directly to wet or dry semiautogenous or autogenous grinding mills (using larger pieces of the ore to grind/mill the smaller pieces), then to pebble or ball mills. Ideally, the liberated particles of iron minerals and barren gangue should be removed from the grinding circuits as soon as they are formed, with larger particles returned for further grinding.

Concentration is the second step in taconite ore processing. As the iron ore minerals are liberated by the crushing steps, the iron-bearing particles must be concentrated. Because only about 33 percent of the crude taconite becomes a shippable product for iron making, a large amount of gangue is generated. Magnetic separation and flotation are the most commonly used methods for concentrating the taconite ore.

Crude ores in which most of the recoverable iron is magnetite (or, in rare cases, maghemite) are normally concentrated by magnetic separation. The crude ore may contain 30 to 35 percent total iron by assay, but theoretically only about 75 percent of the iron is recoverable magnetite. The remaining iron is discarded with the gangue.

Nonmagnetic taconite ores are concentrated by froth flotation or by a combination of selective flocculation and flotation. The method is determined by the differences in surface activity between the iron and gangue particles. Sharp separation is often difficult.

Various combinations of magnetic separation and flotation may be used to concentrate ores containing various iron minerals (magnetite and hematite, or maghemite) and wide ranges of mineral grain sizes. Flotation is also often used as a final polishing operation on magnetic concentrates.

Pelletization is the third major step in taconite ore processing. Iron ore concentrates must be coarser than about No. 10 mesh to be acceptable as blast furnace feed without further treatment. The finer concentrates are agglomerated into small "green" pellets, which are classified as either acid or flux pellets. Acid pellets are produced from iron ore and a binder, and flux pellets are produced by adding

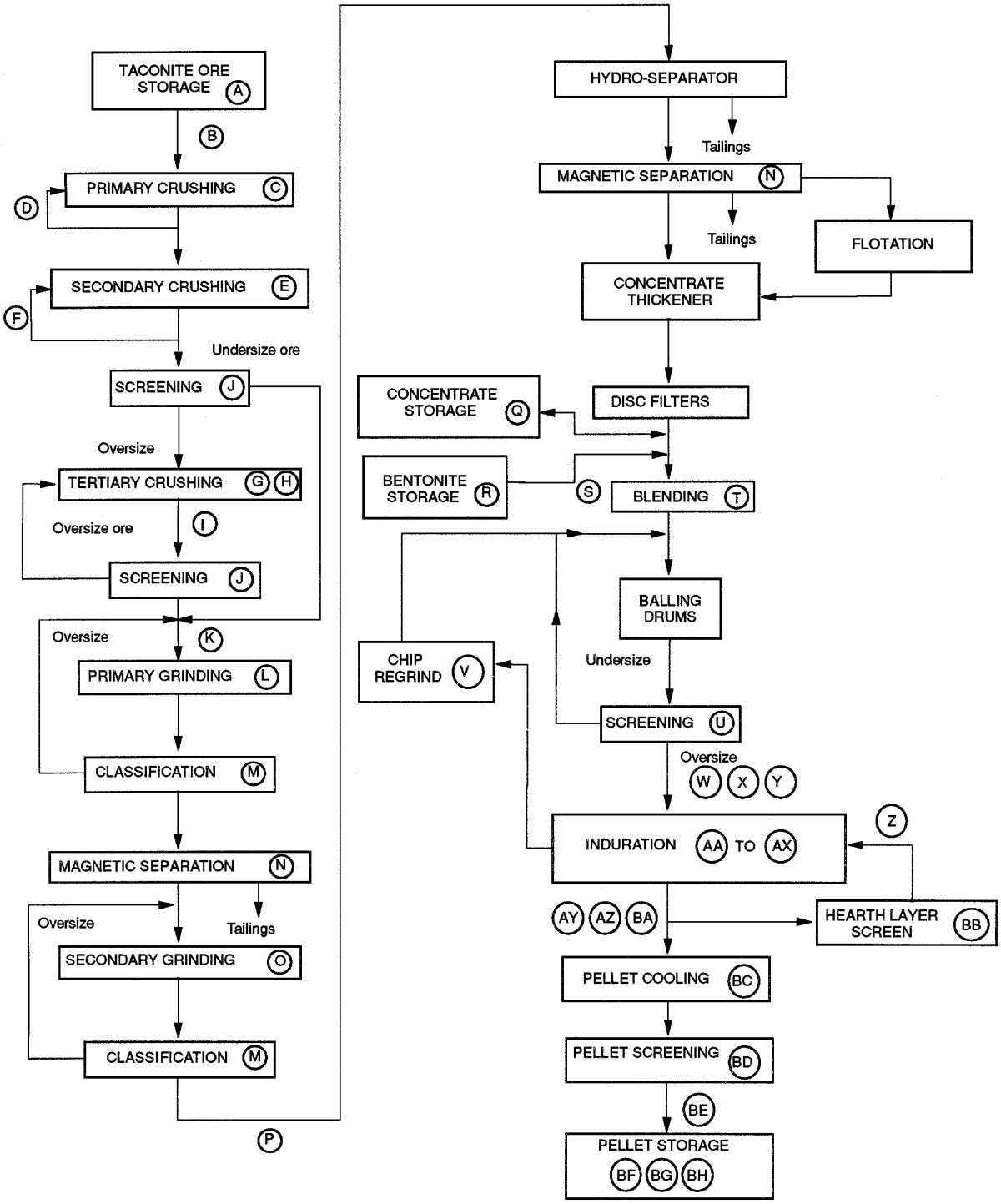

Figure 2-1. Process flow diagram for taconite ore processing.
(Refer to Table 2-2 for Source Classification Codes)

TABLE 2-2. KEY FOR SOURCE CLASSIFICATION CODES FOR TACONITE ORE PROCESSING

Key	Source	SCC
A	Ore storage	3-03-023-05
B	Ore transfer	3-03-023-04
C	Primary crusher	3-03-023-01
D	Primary crusher return conveyor transfer	3-03-023-25
E	Secondary crushing line	3-03-023-27
F	Secondary crusher return conveyor transfer	3-03-023-28
G	Tertiary crushing	3-03-023-02
H	Tertiary crushing line	3-03-023-30
I	Tertiary crushing line discharge conveyor	3-03-023-31
J	Screening	3-03-023-03
K	Grinder feed	3-03-023-34
L	Primary grinding	3-03-023-06
M	Classification	3-03-023-36
N	Magnetic separation	3-03-023-17
O	Secondary grinding	3-03-023-38
P	Conveyor transfer to concentrator	3-03-023-41
Q	Concentrate storage	3-03-023-44
R	Bentonite storage	3-03-023-07
S	Bentonite transfer to blending	3-03-023-45
T	Bentonite blending	3-03-023-08
U	Green pellet screening	3-03-023-47
V	Chip regrinding	3-03-023-11
W	Grate/kiln furnace feed	3-03-023-49
X	Straight grate furnace feed	3-03-023-79
Y	Vertical shaft furnace feed	3-03-023-69
Z	Hearth layer feed to furnace	3-03-023-48
AA	Grate/kiln, gas-fired, acid pellets	3-03-023-51
AB	Grate/kiln, gas-fired, flux pellets	3-03-023-52
AC	Grate/kiln, gas- and oil-fired, acid pellets	3-03-023-53
AD	Grate/kiln, gas- and oil-fired, flux pellets	3-03-023-54

TABLE 2-2 (continued)

Key	Source	SCC
AE	Grate/kiln, coke-fired, acid pellets	3-03-023-55
AF	Grate/kiln, coke-fired, flux pellets	3-03-023-56
AG	Grate/kiln, coke- and coal-fired, acid pellets	3-03-023-57
AH	Grate/kiln, coke- and coal-fired, flux pellets	3-03-023-58
AI	Grate/kiln, coal-fired, acid pellets	3-03-023-59
AJ	Grate/kiln, coal-fired, flux pellets	3-03-023-60
AK	Grate/kiln, coal- and oil-fired, acid pellets	3-03-023-61
AL	Grate/kiln, coal- and oil-fired, flux pellets	3-03-023-62
AM	Vertical shaft, gas-fired, top gas stack, acid pellets	3-03-023-71
AN	Vertical shaft, gas-fired, top gas stack, flux pellets	3-03-023-72
AO	Vertical shaft, gas-fired, bottom gas stack, acid pellets	3-03-023-73
AP	Vertical shaft, gas-fired, bottom gas stack, flux pellets	3-03-023-74
AQ	Straight grate, gas-fired, acid pellets	3-03-023-81
AR	Straight grate, gas-fired, flux pellets	3-03-023-82
AS	Straight grate, oil-fired, acid pellets	3-03-023-83
AT	Straight grate, oil-fired, flux pellets	3-03-023-84
AU	Straight grate, coke-fired, acid pellets	3-03-023-85
AV	Straight grate, coke-fired, flux pellets	3-03-023-86
AW	Straight grate, coke- and gas-fired, acid pellets	3-03-023-87
AX	Straight grate, coke- and gas-fired, flux pellets	3-03-023-88
AY	Grate/kiln furnace discharge	3-03-023-50
AZ	Vertical shaft furnace discharge	3-03-023-70
BA	Straight grate furnace discharge	3-03-023-80
BB	Hearth layer screen	3-03-023-93
BC	Pellet cooler	3-03-023-15
BD	Pellet screen	3-03-023-95
BE	Pellet transfer to storage	3-03-023-16
BF	Pellet storage bin loading	3-03-023-96
BG	Secondary storage bin loading	3-03-023-97
BH	Tertiary storage bin loading	3-03-023-98

TABLE 2-2 (continued)

Key	Source	SCC
b	Haul road, rock	3-03-023-21
b	Haul road, taconite	3-03-023-22
b	Nonmagnetic separation	3-03-023-18
b	Tailings basin	3-03-023-40
b	Other, not classified	3-03-023-99
c	Traveling grate feed	3-03-023-09
c	Traveling grate discharge	3-03-023-10
c	Indurating furnace: gas-fired	3-03-023-12
c	Indurating furnace: oil-fired	3-03-023-13
c	Indurating furnace: coal-fired	3-03-023-14
c	Kiln	3-03-023-19
c	Conveyors, transfer, and loading	3-03-023-20

[a]Refers to labels in Figure 2-1.
[b]Not shown in Figure 2-1.
[c]Inactive code.

between 1 and 10 percent limestone to the ore and binder before pelletization. Agglomeration is normally accomplished by tumbling moistened concentrate with a balling drum or balling disc. A binder, usually powdered bentonite, may be added to the concentrate to improve ball formation and the physical qualities of the "green" balls. The bentonite is lightly mixed with the carefully moistened feed at 5 to 10 kilograms per megagram (kg/Mg) (10 to 20 pounds per ton [lb/ton]).

The pellets are hardened by a procedure called induration. The green balls are dried and heated in an oxidizing atmosphere at incipient fusion temperature of 1290° to 1400°C (2350° to 2550°F), depending on the composition of the balls, for several minutes and then cooled. The incipient fusion temperature for acid pellets falls in the lower region of this temperature range, and the fusion temperature for flux pellets falls in the higher region of this temperature range. The three general types of indurating apparatus currently used are the vertical shaft furnace, the straight grate, and the grate/kiln. Most large plants and new plants use the grate/kiln. Currently, natural gas is the most common fuel used for pellet induration, but heavy oil is used at a few plants; coal and coke may also be used.

In the vertical shaft furnace, the wet green balls are distributed evenly over the top of the slowly descending bed of pellets. A stream of hot gas of controlled temperature and composition rises counter to the descending bed of pellets. Auxiliary fuel combustion chambers supply hot gases midway between the top and bottom of the furnace.

The straight grate furnace consists of a continuously moving grate, onto which a bed of green pellets is deposited. The grate passes through a firing zone of alternating up and down currents of heated gas. The fired pellets are cooled either on an extension of the grate or in a separate cooler. An important feature of the straight grate is the "hearth layer," which consists of a 10- to 15-centimeter (4- to 6-inch) thick layer of fired pellets that protects the grate. The hearth layer is formed by diverting a portion of the fired pellets exiting the firing zone of the furnace to a hearth layer screen, which removes the fines. These pellets then are conveyed back to the feed end of the straight grate and deposited on to the bare

grate. The green pellets being fed to the furnace are deposited on the hearth layer prior to the burning zone of the furnace.

The grate/kiln apparatus consists of a continuous traveling grate followed by a rotary kiln. The grate/kiln product must be cooled in a separate cooler, usually an annular cooler with counter-current airflow.

2.3 EMISSIONS[2-5]

Particulate matter (PM) sources in taconite ore processing plants are indicated in Figure 2-1. Particulate matter emissions also arise from ore mining operations.

The taconite ore is handled dry through the crushing stages. All crushers, size classification screens, and conveyor transfer points are major points of particulate emissions. Crushed ore is normally wet ground in rod and ball mills. A few plants, however, use dry autogenous or semi-autogenous grinding and have higher emissions than do conventional plants. The ore remains wet through the rest of the beneficiation process (through concentrate storage, Figure 2-1) so PM emissions after crushing are generally insignificant.

The first source of emissions in the pelletizing process is the transfer and blending of bentonite. There are no other significant emissions in the balling section, since the iron ore concentrate is normally too wet to cause appreciable dusting. Additional emission points in the pelletizing process include the main waste gas stream from the indurating furnace, pellet handling, furnace transfer points (grate feed and discharge), and annular coolers for plants using the grate/kiln furnace. Induration furnaces generate sulfur dioxide (SO_2). The SO_2 originates both from the fuel and the raw material (concentrate, binder, and limestone). Induration furnaces also emit combustion products such as nitrogen oxides (NO_x), carbon monoxide (CO), and carbon dioxide (CO_2). Because of the additional heating requirements, emissions of NO_x and SO_2 generally are higher when flux pellets are produced than when acid pellets are produced.

The largest source of PM emissions in taconite ore mines is traffic on unpaved haul roads. Wind erosion is also a significant PM emission source at taconite mines. Although blasting is a notable source of the various size fractions of PM, it is a short-term event and most materials settle quickly.

2.4 CONTROL TECHNOLOGY[2-6]

Particulate matter emissions from taconite ore processing plants are controlled by a variety of devices, including cyclones, multiclones, rotoclones, scrubbers, baghouses, and electrostatic precipitators. Water sprays are also used to suppress dusting.

Emissions from crushing and conveying operations are generally controlled by a hood-and-duct system that leads to a cyclone, rotoclone, multicyclones, wet scrubber, or fabric filter. The inlet of the control device is often fed by more than one duct.

The combination of multicyclones and wet scrubbers is a common control configuration for furnace waste gas. The purpose of the multicyclones is to recover material from preheat gases after they pass through the bed of green pellets. The wet scrubber reduces SO_2 concentrations in the furnace waste gas in addition to PM that may be entrained by the waste gas stream as it leaves the preheat stage and passes through the bed of pellets in the drying stage.

Annular coolers normally operate in stages. The exhaust of the first-stage cooler is usually vented to the indurating furnace as preheated combustion gas. The second and third stages generally are left uncontrolled.

REFERENCES FOR SECTION 2

1. C.M. Cvetic and P.H. Kuck, "Iron Ore," in: *Minerals Yearbook, Vol. I*, U.S. Government Printing Office, 1991, pp. 521-547.

2. J. P. Pilney and G. V. Jorgensen, *Emissions from Iron Ore Mining, Beneficiation and Pelletization, Volume 1*, EPA Contract No. 68-02-2113, Midwest Research Institute, Minnetonka, MN, June 1983.

3. A. K. Reed, *Standard Support and Environmental Impact Statement for the Iron Ore Beneficiation Industry (Draft)*, EPA Contract No. 68-02- 1323, Battelle Columbus Laboratories, Columbus, OH, December 1976.

4. *Air Pollution Emission Test, Empire Mining Company, Palmer, MI*, EMB 76-IOB-2, U. S. Environmental Protection Agency, Research Triangle Park, NC, November 1975.

5. T. A. Cuscino *et al., Taconite Mining Fugitive Emissions Study*, Minnesota Pollution Control Agency, Roseville, MN, June 1979.

6. Written communication from P. O'Neill, Minnesota Pollution Control Association, Minneapolis, MN, to R. E. Myers, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 20, 1996.

3. GENERAL DATA REVIEW AND ANALYSIS

3.1 LITERATURE SEARCH AND SCREENING

Data for this investigation were obtained from a number of sources within the Office of Air Quality Planning and Standards (OAQPS) and from outside organizations. The AP-42 Background Files located in the Emission Factor and Inventory Group (EFIG) were reviewed for information on the industry, processes, and emissions. The Factor Information and Retrieval (FIRE), Crosswalk/Air Toxic Emission Factor Data Base Management System (XATEF), and VOC/PM Speciation Data Base Management System (SPECIATE) data bases were searched by SCC code for identification of the potential pollutants emitted and emission factors for those pollutants. A general search of the Air CHIEF CD-ROM also was conducted to supplement the information from these data bases.

Information on the industry, including number of plants, plant location, and annual production capacities, was obtained from the *Minerals Yearbook*, *Census of Minerals*, *Census of Manufactures*, and other sources. The Aerometric Information Retrieval System (AIRS) data base also was searched for data on the number of plants, plant location, and estimated annual emissions of criteria pollutants. A number of sources of information were investigated specifically for emission test reports and data. A search of the Test Method Storage and Retrieval (TSAR) data base was conducted to identify test reports for sources within the taconite ore industry. Copies of these test reports were obtained from the files of the Emissions, Monitoring, and Analysis Division (EMAD). The EPA library was searched for additional test reports. A list of plants that have been tested within the past 5 years was compiled from the AIRS data base. Using this information and information obtained on plant location from the *Minerals Yearbook*, *Census of Manufactures*, and *Census of Minerals*, State and Regional offices were contacted about the availability of test reports. However, the information obtained from these offices was limited. Publications lists from the Office of Research and Development (ORD) and Control Technology Center (CTC) were also searched for reports on emissions from the taconite ore industry. In addition, representative trade associations, including the American Iron Ore Association, the American Mining Congress, the American Iron and Steel Institute, and The Iron Mining Association of Minnesota, were contacted for assistance in obtaining information about the industry and emissions.

To screen out unusable test reports, documents, and information from which emission factors could not be developed, the following general criteria were used:

1. Emission data must be from a primary reference:

a. Source testing must be from a referenced study that does not reiterate information from previous studies.

b. The document must constitute the original source of test data. For example, a technical paper was not included if the original study was contained in the previous document. If the exact source of the data could not be determined, the document was eliminated.

2. The referenced study should contain test results based on more than one test run. If results from only one run are presented, the emission factors must be down rated.

3. The report must contain sufficient data to evaluate the testing procedures and source operating conditions (e.g., one-page reports were generally rejected).

A final set of reference materials was compiled after a thorough review of the pertinent reports, documents, and information according to these criteria.

3.2 DATA QUALITY RATING SYSTEM[1]

As part of the analysis of the emission data, the quantity and quality of the information contained in the final set of reference documents were evaluated. The following data were excluded from consideration:

1. Test series averages reported in units that cannot be converted to the selected reporting units;

2. Test series representing incompatible test methods (i.e., comparison of EPA Method 5 front half with EPA Method 5 front and back half);

3. Test series of controlled emissions for which the control device is not specified;

4. Test series in which the source process is not clearly identified and described; and

5. Test series in which it is not clear whether the emissions were measured before or after the control device.

Test data sets that were not excluded were assigned a quality rating. The rating system used was that specified by EFIG for preparing AP-42 sections. The data were rated as follows:

A—Multiple test runs that were performed using sound methodology and reported in enough detail for adequate validation. These tests do not necessarily conform to the methodology specified in EPA reference test methods, although these methods were used as a guide for the methodology actually used.

B—Tests that were performed by a generally sound methodology but lack enough detail for adequate validation.

C—Tests that were based on an unproven or new methodology or that lacked a significant amount of background information.

D—Tests that were based on a generally unacceptable method but may provide an order-of-magnitude value for the source.

The following criteria were used to evaluate source test reports for sound methodology and adequate detail:

1. Source operation. The manner in which the source was operated is well documented in the report. The source was operating within typical parameters during the test.

2. Sampling procedures. The sampling procedures conformed to a generally acceptable methodology. If actual procedures deviated from accepted methods, the deviations are well documented. When this occurred, an evaluation was made of the extent to which such alternative procedures could influence the test results.

3. Sampling and process data. Adequate sampling and process data are documented in the report, and any variations in the sampling and process operation are noted. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and are given a lower rating.

4. Analysis and calculations. The test reports contain original raw data sheets. The nomenclature and equations used were compared to those (if any) specified by EPA to establish equivalency. The depth of review of the calculations was dictated by the reviewer's confidence in the ability and conscientiousness of the tester, which in turn was based on factors such as consistency of results and completeness of other areas of the test report.

3.3 EMISSION FACTOR QUALITY RATING SYSTEM[1]

The quality of the emission factors developed from analysis of the test data was rated using the following general criteria:

A—Excellent: Developed from A- and B-rated source test data taken from many randomly chosen facilities in the industry population. The source category is specific enough so that variability within the source category population may be minimized.

B—Above average: Developed only from A- or B-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industries. The source category is specific enough so that variability within the source category population may be minimized.

C—Average: Developed only from A-, B- and/or C-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. In addition, the source category is specific enough so that variability within the source category population may be minimized.

D—Below average: The emission factor was developed only from A-, B-, and/or C-rated test data from a small number of facilities, and there is reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of the emission factor are noted in the emission factor table.

E—Poor: The emission factor was developed from C- and D-rated test data, and there is reason to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of these factors are footnoted.

The use of these criteria is somewhat subjective and depends to an extent upon the individual reviewer. Details of the rating of each candidate emission factor are provided in Section 4.

REFERENCE FOR SECTION 3

1. *Procedures for Preparing Emission Factor Documents, Third Revised Draft Version*, Office of Air Quality Planning and Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, November 1996.

4. AP-42 SECTION DEVELOPMENT

4.1 INTRODUCTION

This section describes how the revised AP-42 section on taconite ore processing was developed. First, descriptions of data sets reviewed for this revision are presented, followed by a discussion of how candidate emission factors were developed from the data. Finally, the proposed changes to the existing AP-42 section on taconite ore processing are summarized.

4.2 REVIEW OF SPECIFIC DATA SETS

Forty-seven new emission test reports and test summaries were documented and reviewed in the process of developing the section on taconite ore processing. The three test reports (References 1, 2, and 3) and two other reports (References 4 and 45) in the current background files for Section 11.23 also were reviewed. Two of these original five reports (References 1 and 3) had not been used previously to develop emission factors, and one report used previously to develop emission factors was missing from the background file. Four of the five original references contained some data that were not used before. The results from a trace metal analysis on fine crushing emissions were also found and are presented in this document. Reference 45 included data on emissions from vehicle traffic at taconite ore mines. These data were presented in the previous version of AP-42. However, because the predictive emission factor equations presented in Chapter 13 of AP-42 provide more accurate estimates of emission from traffic, the data from Reference 45 were deleted from the revised AP-42 section. In addition, summaries of emission tests and an accompanying letter (Reference 53) submitted by a State air pollution control agency were reviewed. Five of the summaries were taken from references already included in the files for the study; the other four summaries are included as References 54 to 57.

Emission factors could not be developed from 11 of the test reports and summaries (References 36 to 44, 50, and 51) due to a lack of process data. The following paragraphs describe the references that included sufficient data to develop emission factors for taconite ore processing sources.

4.2.1 Reference 1

This emission test (Report No. 76-IOB-3) was sponsored by the Emissions Measurements Branch of EPA and was conducted from November 17 to 20, 1975. The emissions measured included filterable and condensible inorganic PM and SO_2 from a gas-fired grate/kiln processing acid pellets. The samples were also analyzed for asbestos, but none was detected.

Sulfur dioxide emissions were measured in accordance with Method 6. Particulate matter and asbestos sampling procedures were in accordance with Method 5, with two noted exceptions. A millipore filter was used in place of the usual glass fiber filter in order to conduct subsequent asbestos analysis, and the filter temperature had to be maintained below 93°C (200°F) to prevent degradation. No information is provided on the analytical procedures used to quantify the condensible inorganic PM (back half of the sampling train) emissions.

Four sites were sampled--the inlet and outlet of the venturi scrubber on the main grate/kiln stack and the inlet and outlet of a small Ducon scrubber controlling emissions from the discharge end of the grate/kiln traveling grate. Three samples were collected at each site. The sample taken during the first run on the venturi scrubber inlet was discarded because a problem developed in the support mechanism

for the inlet sample train, and the glass filter disk was broken. Samples were taken from the inlet and outlet of both controls simultaneously to estimate the efficiency of the control systems.

A rating of B was assigned to the filterable PM and SO_2 emission data in this report. Multiple runs were performed, sufficient process descriptions were provided, and the data were presented in adequate detail. However, because of temperature irregularities, the data was down-rated from A to B. Due to the lack of documentation, the condensible inorganic PM data is rated C.

4.2.2 Reference 2

This emissions test (Project No. 76-IOB-2) was sponsored by EPA in an effort to collect data for the establishment of emission standards for iron ore beneficiation facilities. The test was conducted from November 18 to 21, 1975. Samples were collected for measurement of PM and asbestos emissions from a natural gas- and No. 2 oil-fired grate kiln processing acid pellets. However, no data pertaining to asbestos emissions were reported. Carbon dioxide emissions were also quantified.

The four sampling locations and the number of samples collected were as follows: (1) nine samples of uncontrolled emissions from the grate/kiln--four for PM and five for particle size distribution, (2) five samples of ESP-controlled emissions from the grate/kiln--three for PM and two for particle size distribution, (3) three samples of uncontrolled pellet discharge emissions, and (4) three samples of pellet discharge emissions after control by a rotoclone. Because the rotoclone malfunctioned during the test, the results for controlled emissions from the pellet discharge were discarded. All particle size distribution tests were conducted using cascade impactors with a cyclone preseparator. The particle size data are summarized in Table 4-1.

TABLE 4-1. SUMMARY OF PARTICLE SIZE DATA FOR TACONITE ORE GRATE/KILN INDURATING FURNACES[a]

Aerodynamic diameter, μm	Cumulative percent less than diameter	
	Uncontrolled	ESP-controlled
2.5	17.4	48.0
6.0	25.6	71.0
10.0	35.2	81.5

[a]Reference 2. Data rated A.

Sampling procedures followed those outlined in Methods 1 through 5. The Method 5 impinger catch was extracted with chloroform-ether in order to quantify the condensible organic particulate emissions. The residue was combined with the residue from the liquid portion to give total condensible PM. Several deviations were noted, all of which pertained to the collection and rinsing of asbestos fibers.

A rating of A was assigned to the filterable PM and particle size data in this report. Multiple runs based on predescribed methodologies were performed, sufficient process descriptions were provided, and the data were presented in adequate detail. The condensible PM data are rated B. The method used (extraction with chloroform-ether) was sound, but data were lacking in detail.

4.2.3 Reference 3

This emission test was sponsored by EPA, and its primary purpose was to identify and quantify possible asbestos emissions. The test was conducted from September 11 to 13, 1973. Four emission points were sampled for PM: fine crusher exhaust stack, straight grate waste gas stack, pellet drying hood vent stack, and a concentrator stack. Three samples were taken at each location. The report contains the analytical results of only one run on each source except the concentrator stack for which no results are reported. Data on filterable PM and asbestos emissions are reported.

This facility operated eight furnaces (processing acid pellets). In an effort to reduce emissions, three were recently modified by the addition of a roll screen to reduce fines from the green pellet feed. Because the only furnace tested was modified, the straight grate and drying hood vent stack test results may not be representative of uncontrolled emissions from typical sources.

Sampling procedures followed those predescribed in Method 5. Three deviations from the method were necessary for collection of asbestos-containing PM. The deviations were (1) the use of a Millipore type AA membrane filter in place of a glass fiber filter, (2) maintenance of probe temperature at 62° to 82°C (150° to 180°F) rather than 93°C (225°F) to prevent decomposition of the membrane filter, and (3) the probe was washed with water rather than acetone and kept separate from the impinger contents and wash.

With the exception of the asbestos samples, a rating of D was assigned to the test data presented in this reference. The test followed established procedures and provided adequate detail about the process. However, only one test run was performed. The asbestos emission data are unrated because there is some question as to whether or not the material was correctly identified as asbestos.

4.2.4 Reference 4

This reference was prepared for EPA in June of 1978. Its purpose was to identify emission sources in the iron ore mining, beneficiation, and pelletizing industry; to quantify those emissions; to rank the emissions based on their environmental impact; and to recommend future research, development, and/or demonstration projects to reduce emissions from the most critical sources. To complete these objectives the investigators conducted emission tests at a crushing operation controlled by a baghouse, a vertical shaft furnace (processing acid pellets) fired with fuel oil, a shovel loading site at a taconite mine, and an uncontrolled annular cooler. The first two emission sources were located at one plant and the next two at another plant.

Volume 1 contains summaries of the test results, and Volume 2 of this report contains most of the detailed information from the emission tests, including production rates at the sites sampled. However, a copy of Volume 2 could not be obtained. Three sites were sampled for asbestos emissions and none of them were determined to emit asbestiform material. Also, a trace metal analysis was performed on the emissions from three emission points associated with the fine crusher. The ore feeding this crusher was unusually soft for taconite ore, resulting in emissions that were approximately one percent of normal crushing operations. Thus, it is reasonable to suspect that the composition of the this ore may have been significantly different from most other taconite ores. In addition, the report presents only concentrations, and no data is provided on volumetric flow rates or process operating rates. Therefore, the data were of limited value and could not be used for AP-42.

Reference 4 also includes summaries of emission data for several controlled and uncontrolled taconite ore processing sources. The bases of the emission data in Reference 4 include "field testing," "field sampling," emission estimates, tests sponsored by control device manufacturers and manufacturers' ratings of control equipment. These data form the basis of the uncontrolled PM emission factors in the taconite ore processing section of the current version of AP-42; the controlled data presented in Reference 4 are not included in the current version of AP-42. In addition, these uncontrolled and controlled emission data form the basis for the table of control efficiencies (Table 11.23-2) in the current version of Section 11.23.

The emission data in Reference 4 are presented in tables, and the primary sources of the data are not identified. However, because most of the data summarizes the results of tests on sources for which (other than fine crushing) no other emission test data are available, the results are presented here. Table 4-2 summarizes the data from field testing, field sampling, and manufacturer-sponsored testing taken from this reference; data based on emission estimates and manufacturers' ratings are not presented in Table 4-2. The emission factors presented in Table 4-2 for uncontrolled emissions differ significantly from those uncontrolled emission factors included in the current version of AP-42. There are two reasons for these differences. First, as mentioned above, data for emission estimates and manufacturers' ratings were not considered for emission factor development in Table 4-2, but were incorporated into the emission factors in the current version of the section. Second, the emission factors presented in Table 4-2 take into account the number of tests conducted on each configuration of source and control device (i.e., each test for each configuration is counted as a single data point in the average), whereas the emission factors in the current version of the section are based on each configuration as a single point.

The data presented in Table 4-2 are given a rating of C because they are based on a secondary reference; no descriptions of the tests are provided and only average emission rates for each test are presented.

4.2.5 Reference 5

This report documents measurements of filterable PM, SO_2, and CO_2 from a petroleum coke- and natural gas-fired straight grate pelletizing machine. The purpose of the emission test was to demonstrate compliance with State regulations. The test was conducted in August 1985. Another test on this furnace also was documented in Reference 8.

The pelletizing machine has two exhausts: the windbox and hood exhausts. The windbox exhaust is precleaned by a multitube mechanical collector, and then joins the hood exhaust in a common header. This combined exhaust is then routed to four venturi rod wet scrubbers, each of which has an exhaust stack. Only one of the scrubber exhaust stacks was tested.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Sulfur dioxide determinations were performed in accordance with the large impinger version of EPA Method 6 using the back half of the Method 5 sampling train, and three test runs were conducted. The CO_2 concentrations were determined by Orsat analysis, and three runs were conducted. Emission factors were developed for filterable PM, SO_2, and CO_2.

The emission data for filterable PM, SO_2, and CO_2 are rated D. The test methodologies appear to be sound, and no problems were reported, but the report lacked adequate documentation for a higher

TABLE 4-2. SUMMARY OF PM EMISSION TEST DATA PRESENTED IN REFERENCE 4[a]

Process	Control	No. of tests	Average emission factor	
			kg/Mg	lb/ton
Crude ore dump pockets	None	2	0.022	0.044
	Cyclone	2	0.0033	0.0066
Coarse crushing	None	16	0.029	0.058
	Dry mechanized	1	0.013	0.026
	Multiclone	4	0.0028	0.0057
	Rotoclone	4	0.0018	0.0036
	Scrubber	6	0.0010	0.0020
	Cyclone	1	0.011	0.022
Ore transfer	None	32	0.43	0.86
	Scrubber	25	0.0029	0.0057
	Multiclone	5	0.0015	0.0029
	Rotoclone	1	0.0038	0.0076
	Dry mechanized	1	0.0010	0.0019
Fine crushing	None	22	6.6	13
	Rotoclone	11	0.0061	0.012
	Scrubber	11	0.055	0.11
Bentonite transfer	None	2	1.6	3.2
	Scrubber	1	0.053	0.11
Bentonite blending	None	4	9.6	19
	Scrubber	2	0.13	0.25
	baghouse	2	0.053	0.11
Grate feed	None	2	0.32	0.63
	Scrubber	2	0.0041	0.0082
Grate discharge	None	2	0.69	1.4
	Scrubber	2	0.0048	0.0096
Kiln	None	61	18	36
	Cyclone	58	3.4	6.7
	ESP	3	0.20	0.41
Pellet handling	None	7	0.52	1.0
	Rotoclone	1	0.00018	0.00036
	Scrubber	6	0.0049	0.0099

[a]All data rated C.

rating. In addition, because only one of the four stacks was tested and volumetric flowrates for the other three stacks were not reported, emission rates from the untested stacks were assumed to be equal to those from the stack tested, thus introducing a significant potential for error.

4.2.6 Reference 6

This report documents measurements of filterable PM, SO_2, and CO_2 emissions from the same sources addressed in Reference 5: a petroleum coke- and coal-fired straight grate pelletizing machine. The purpose of the emission test was to demonstrate compliance with State regulations. The test was conducted in April 1985. Another test on this same furnace is documented in Reference 9.

The pelletizing machine has two exhausts: the windbox and hood exhausts. It appears that these exhausts are combined before passing through a scrubber system consisting of four wet scrubbers, each with an individual stack. Only one of the four scrubber exhaust stacks were tested.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Sulfur dioxide determinations were performed in accordance with the large impinger version of EPA Method 6 using the back half of the Method 5 sampling train, and three test runs were conducted. The CO_2 concentrations were determined by Orsat analysis, and three runs were conducted. Emission factors were developed for filterable PM, SO_2, and CO_2.

The emission data for filterable PM, SO_2, and CO_2 are rated D. The test methodologies appear to be sound, and no problems were reported, but the report lacked adequate documentation for a higher rating. In addition, because only one of the four stacks was tested and volumetric flowrates for the other three stacks were not reported, emission rates from the untested stacks were assumed to be equal to those from the stack tested, thus introducing a significant potential for error.

4.2.7 Reference 7

This report documents measurements of filterable PM emissions from four conveyors that feed taconite from the primary crusher to four different rotary grinding mills. The purpose of the emission tests was to demonstrate compliance with State regulations. The tests were conducted in January 1977. The PM emissions from each conveyor are controlled with a wet scrubber.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted on each conveyor. Emission factors were developed for filterable PM for each conveyor. The emission data for filterable PM are rated B. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation for a higher rating.

4.2.8 Reference 8

This report documents measurements of filterable PM emissions from a hearth layer feeder, two straight grate induration furnaces fired with No. 6 fuel oil (Bunker C), one induration machine discharge, a hearth layer screen, a fired pellet transfer point, and a bentonite storage bin. The purpose of the tests was to demonstrate compliance with State regulations. The tests were conducted in June and July 1977. Other tests on these furnaces are documented in References 5 and 31. Particulate matter emissions from the bentonite storage bin are controlled by a fabric filter. Particulate matter emissions from the two induration furnaces are each controlled by a multiclone dust collector followed by four venturi wet

scrubbers, each with its own stack. Particulate matter emissions from all of the other sources tested are each controlled by an individual wet scrubber.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted on each source. However, the PM sample for test run No. 1 conducted on indurating machine No. 1 was destroyed in a laboratory accident, and only two runs of data are available for this source. Emission factors were developed for filterable PM for each source tested.

The emission data for filterable PM are rated B, with the exception of the two induration furnaces. The test methodology appears to be sound, but the report lacked adequate documentation to warrant a higher rating. The emission data for filterable PM from the straight grate furnaces are rated D. Because only one of the four stacks on each furnace was tested and volumetric flowrates for the other three stacks were not reported, emission rates from the untested stacks were assumed to be equal to those from the stack tested, thus introducing a significant potential for error. In addition, only two runs of PM data are available for furnace No. 2.

4.2.9 Reference 9

This report documents measurements of filterable PM emissions from a hearth layer feeder, a straight grate induration furnace fired with No. 6 fuel oil (Bunker C), an induration machine discharge, and a grinder feed line. Carbon dioxide emission data are also presented for the induration furnace. The purpose of the tests was to demonstrate compliance with State regulations. The tests were conducted in September 1979. Another test on this same furnace is documented in Reference 6. Particulate matter emissions from the induration furnace are controlled by a scrubber system consisting of four wet scrubbers, each with an individual stack. Particulate matter emissions from each of the other sources tested are controlled by an individual wet scrubber.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted on each source. Carbon dioxide concentrations in the indurating furnace exhaust were determined by Orsat analysis, and data for three test runs are reported. Emission factors were developed for filterable PM for each source, and CO_2 emission factors were developed for the indurating furnace.

With the exception of the data for the indurating furnace, the emission data for filterable PM are rated B. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation to warrant a higher rating. The filterable PM and CO_2 data for the indurating furnace are rated D. Because only one of the four stacks on the furnace was tested and volumetric flowrates for the other three stacks were not reported, emission rates from the untested stacks were assumed to be equal to those from the stack tested, thus introducing a significant potential for error.

4.2.10 Reference 10

This report documents measurements of filterable PM emissions from the first stage of a 2-stage taconite ore primary crusher. The purpose of the emission test was to assess control device performance. The test was conducted in March 1990. The PM emissions from the crusher are controlled with a cyclone precleaner and multiclone in series.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Emission factors were developed for filterable PM. The emission data for filterable PM are

rated B. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation for a higher rating.

4.2.11 Reference 11

This report documents measurements of filterable PM emissions from the second stage of 2-stage primary crusher. The crusher tested was the same crusher as for Reference 10. The purpose of the emission test was to assess control device performance. The test was conducted in March 1990. The PM emissions from the crusher are controlled with a cyclone precleaner and multiclone in series.

Particulate matter emissions were measured at the inlet and outlet of the multiclone using EPA Method 5, and three test runs were conducted. Emission factors were developed for filterable PM. The emission data for filterable PM are rated B. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation for a higher rating.

4.2.12 Reference 12

This report documents measurements of filterable PM and CO_2 emissions from the top gas stacks of two natural gas-fired vertical shaft induration furnaces processing acid pellets. The purpose of the emission tests was to assess control device performance. The tests were conducted in May 1984. Other tests conducted at this facility are documented in References 13, 14, 24, 56, and 57. The report specifies only feed rates; production rates were estimated based on the information provided in References 56 and 57. The PM emissions from the furnaces are controlled with multiclones.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Carbon dioxide concentrations in the furnace exhaust were determined by Orsat analysis, and three test runs were conducted. Emission factors were developed for filterable PM and CO_2 for each furnace.

The emission data for filterable PM and CO_2 are rated C. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation for a higher rating.

4.2.13 Reference 13

This report documents measurements of filterable PM and CO_2 emissions from the top gas stack of a natural gas-fired vertical shaft induration furnace processing acid pellets. The purpose of the emission test was to assess control device performance. The test was conducted in December 1981. Other tests conducted at this facility are documented in References 12, 14, 24, 56, and 57. The report specifies only feed rates; production rates were estimated based on the information provided in References 56 and 57. Emissions from the furnace are controlled with a multiclone.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Carbon dioxide concentrations in the furnace exhaust were determined by Orsat analysis, and data from three test runs were reported. Emission factors were developed for filterable PM and CO_2.

The emission data for filterable PM and CO_2 are rated C. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation for a higher rating.

4.2.14 Reference 14

This report documents measurements of filterable PM and CO_2 emissions from the top gas stack of a natural gas-fired vertical shaft induration furnace processing acid pellets. The purpose of the emission test was to assess control system performance. The test was conducted in February 1980. Other tests conducted at this facility are documented in References 12, 13, 24, 56, and 57. The report specifies only feed rates; production rates were estimated based on the information provided in References 56 and 57. Particulate matter emissions from the furnace are controlled with a multiclone in series with a wet scrubber.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. The method used to measure CO_2 concentrations in the furnace exhaust was not specified in the report. Emission factors were developed for filterable PM and CO_2.

The emission data for uncontrolled filterable PM are rated C. The test methodology appears to be sound, and no problems were reported at the inlet, but the report lacked adequate documentation for a higher rating. The emission data for controlled filterable PM are rated C because of the existence of large scale turbulence at the outlet test location, and it was suspected that the results are biased low. The CO_2 data are rated C because the test method was not specified.

4.2.15 Reference 15

This report documents measurements of filterable PM emissions from a taconite ore crusher, a kiln cooler, and an unloader pocket, and emissions of SO_2 from a petroleum coke- and coal-fired grate/kiln induration furnace processing acid pellets. The purpose of the tests was to demonstrate compliance with State regulations. The tests were conducted in October 1987. Other emission tests on this same furnace are documented in References 18, 19, and 29.

The PM emissions from the crusher and kiln cooler are controlled with wet scrubbers. The PM emissions from the unloader pocket are controlled with a fabric filter. Emissions from the grate/kiln induration furnace are controlled with a wet scrubber system. The scrubber system consists of two identical scrubber systems operated in parallel and identified as Side A and Side B. Each side has four venturi scrubbers followed by two drum demisters. Each side has an individual stack. Only Side B was tested in this evaluation.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Sulfur dioxide testing on the induration furnace was performed using the EPA Method 6 large impinger sampling train without the isopropanol impinger, and three test runs were conducted. However, the report indicates that the first run was not valid due to sampling problems. Emission factors were developed for SO_2 from the induration furnace only. No other emission factors were developed due to a lack of process data or volumetric flowrates.

The emission data for SO_2 are rated C. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation for a higher rating. In addition, because only one of the two stacks on the furnace was tested, and volumetric flowrates for the other stack were not reported, emission rates from the untested stack were assumed to be equal to those from the stack tested, thus introducing a significant potential for error.

4.2.16 Reference 16

This report documents measurements of filterable PM emissions from a kiln cooler. The purpose of the test was to demonstrate compliance with State regulations. The test was conducted in July 1981. An emission control device is not specified in the test report. Therefore, it is assumed that the cooler was uncontrolled. Another test on this cooler is documented in Reference 17.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Emission factors were developed for filterable PM. The emission data for filterable PM are rated B. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation to warrant a higher rating.

4.2.17 Reference 17

This report documents measurements of filterable PM emissions from a kiln cooler. The purpose of the test was to demonstrate compliance with State regulations. The test was conducted in March 1980. The cooler tested was the same cooler reported in Reference 16, and, again, a control device was not specified.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Emission factors were developed for filterable PM. The emission data for filterable PM are rated B. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation to warrant a higher rating.

4.2.18 Reference 18

This report documents measurements of filterable PM and CO_2 emissions from a kiln cooler and a coal- and fuel oil-fired grate/kiln indurating furnace processing acid pellets. The purpose of the tests was to demonstrate compliance with State regulations. The tests were conducted in December 1979. Other emission tests on this same furnace are documented in References 15, 19, and 29. The report indicates that the kiln cooler was controlled, but a control device is not specified. Emissions from the furnace are controlled by a wet scrubber system consisting of two essentially identical sides, Side A and Side B. Each side consists of four venturi scrubbers followed by two drum demisters and has an individual stack. Only side A of the grate/kiln scrubber system was tested.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Carbon dioxide concentrations were determined by Orsat analysis, and data from three test runs were reported. Emission factors were developed for filterable PM and CO_2 for the grate/kiln only. No other emission factors were developed due to a lack of process data.

The emission data for filterable PM and CO_2 for the grate/kiln are rated C. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation to warrant a higher rating. In addition, because only one of the two stacks on the furnace was tested and volumetric flowrates for the other stack were not reported, emission rates from the untested stack were assumed to be equal to those from the stack tested, thus introducing a significant potential for error.

4.2.19 Reference 19

This report documents measurements of NO_x emissions from a natural gas-fired grate/kiln induration furnace processing acid pellets. The purpose of the emission test was to assess control device performance. The test was conducted in June 1975. Emissions from the furnace are controlled with a wet scrubber. Other tests on this same furnace are documented in References 15, 18, and 29. The report specified furnace feed rates rather than production rate. However, using the feed-to-production ratio of 1.19 presented in Reference 29 for the same furnace, the production rates for the test were estimated.

The NO_x determinations were carried out in accordance with EPA Method 7, and three test runs were conducted. Emission factors were developed for NO_x and reported as NO_2.

The emission data for NO_x are rated C. The test methodology appears to be sound, and no problems were reported, but the report did not specify production rates and lacked adequate documentation to warrant a higher rating.

4.2.20 Reference 20

This report documents measurements of filterable PM, SO_2, and CO_2 emissions from two grate/kiln induration furnaces processing acid pellets. One of the grate/kilns was fired with natural gas and the other grate/kiln was fired with a combination of natural gas and wood. The purpose of the emission tests was to assess control device performance. The tests were conducted in March and April 1992. Emissions from each grate/kiln are controlled with a multiple throat venturi wet scrubber.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Carbon dioxide concentrations were determined by Orsat analysis, and data from three test runs were reported. The SO_2 determinations were carried out in accordance with EPA Method 6, and three test runs were conducted. Emission factors were developed for filterable PM, SO_2, and CO_2.

The emission data for filterable PM, SO_2, and CO_2 are rated B. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation to warrant a higher rating.

4.2.21 Reference 21

This report documents measurements of filterable PM emissions from two crushed taconite ore conveyor transfer points. The conveyors carry oversize material from the secondary crusher. The purpose of the tests was to demonstrate compliance with State regulations. The tests were conducted in February 1992. Particulate matter emissions from each conveyor are controlled with a multiple throat venturi wet scrubber.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Emission factors were developed for filterable PM. The emission data for filterable PM are rated B. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation to warrant a higher rating.

4.2.22 Reference 22

This report documents measurements of filterable PM emissions from two taconite ore primary crushers. The purpose of the test was to demonstrate compliance with State regulations. The test was conducted in October 1982. Particulate matter emissions from each crusher are controlled with a venturi rod wet scrubber with a design flowrate of 40,000 actual feet per minute (acfm). The exhaust from both scrubbers is ducted to a common stack.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. An emission factor was developed for filterable PM emissions from both crushers. The emission data for filterable PM are rated B. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation to warrant a higher rating.

4.2.23 Reference 23

This report documents measurements of filterable PM emissions from a taconite ore loading pocket, which is a storage bin for fired pellets, and two fired pellet screens. The purpose of the test was to demonstrate compliance with State regulations. The test was conducted in June 1980. Particulate matter emissions from the loading pocket are controlled by a rotoclone wet collector. Particulate matter emissions from the two pellet screens are combined and controlled by a single rotoclone wet collector. Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Emission factors were developed for filterable PM.

The emission data for filterable PM are rated B, with the exception of the inlet data for the pellet screens. The test methodology appears to be sound, and no problems were reported for these runs, but the report lacked adequate documentation to warrant a higher rating. The inlet data for filterable PM emissions from the pellet screens are rated C. Only two test runs were valid because a calculation error by the console operator at the inlet test site resulted in an isokinetic ratio of 119 percent on the first run.

4.2.24 Reference 24

This report documents measurements of filterable PM and CO_2 emissions from the top gas stacks of two natural gas-fired vertical shaft induration furnaces processing acid pellets. Each furnace was tested twice. The purpose of the emission test was to assess control device performance. The test was conducted in June 1984. Particulate matter emissions from each furnace are controlled by a mechanical collector. Other emission tests conducted at this facility are documented in References 12, 13, 14, 56, and 57. The report specifies only feed rates; production rates were estimated based on the information provided in References 56 and 57.

Particulate matter emissions were measured using EPA Method 5, and six test runs were conducted. Carbon dioxide concentrations were determined by Orsat analysis, and data from six test runs were reported. Emission factors were developed for filterable PM and CO_2.

The emission data for filterable PM and CO_2 are rated C. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation to warrant a higher rating.

4.2.25 Reference 25

This report documents measurements of SO_2 and CO_2 emissions from a coal-fired grate/kiln processing flux pellets. The test was conducted in August 1991. Sulfur dioxide emissions are controlled by a wet scrubber. Other tests on this same furnace are documented in References 26 and 27. Process rates are provided in units of feed rate; production rates were estimated as 75 percent of feed rates based on information provided in Reference 53.

Sulfur dioxide determinations were performed in accordance with EPA Method 6 Tester Option No. 2, which uses a Method 5 sampling train in which the water in the impinger train is replaced with 3 percent peroxide solution; three test runs were conducted. Carbon dioxide concentrations were determined by Orsat analysis, and data from three test runs were reported. Emission factors were developed for SO_2 and CO_2.

The emission data for SO_2 and CO_2 are rated C. The test methodology appears to be sound, and no problems were reported, but production rates were not reported and the report lacked adequate documentation to warrant a higher rating.

4.2.26 Reference 26

This report documents measurements of filterable PM, SO_2, and CO_2 emissions from a coke- and coal-fired grate/kiln processing flux pellets. The test was conducted in January 1990. Particulate matter and SO_2 emissions are controlled by a wet scrubber. Other tests on this same furnace are documented in References 25 and 27. Process rates are provided in units of feed rate; production rates were estimated as 75 percent of feed rates based on information provided in Reference 53.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Sulfur dioxide samples were collected in the back half of the Method 5 sampling train in accordance with the large impinger version of Method 6 without the isopropanol, and three test runs were conducted. Carbon dioxide concentrations were determined by Orsat analysis, and data from three test runs were reported. Emission factors were developed for filterable PM, SO_2, and CO_2.

The emission data for filterable PM, SO_2, and CO_2 are rated C. The test methodology appears to be sound, and no problems were reported, but production rates were not reported, and the report lacked adequate documentation to warrant a higher rating.

4.2.27 Reference 27

This report documents measurements of filterable PM, CO, total nonmethane organic compounds (TNMOC), and CO_2 emissions from a coal- and petroleum coke-fired traveling grate/kiln processing flux pellets; filterable PM, NO_x, and CO_2 emissions from a natural gas-fired traveling grate/kiln processing flux pellets; filterable PM and CO_2 emissions from a pellet cooler; filterable PM emissions from a primary gyratory crusher; and filterable PM emissions from a turn bin conveyor, which conveys oversize material back to the crusher. The purpose of the tests was to demonstrate compliance with State regulations. The tests were conducted in March 1989. Other tests on this same furnace are documented in References 25 and 26. Process rates are provided in units of feed rate; production rates were assumed to be 75 percent of feed rates based on information provided in Reference 53.

Particulate matter emissions from each grate/kiln are controlled by an individual wet scrubber; PM emissions from the primary crusher are controlled by a fabric filter, and PM emissions from the turn bin conveyor transfer are controlled by a wet scrubber. No control device is indicated for pellet cooler emissions.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Carbon dioxide concentrations were determined by Orsat analysis, and data from three test runs were reported. Carbon monoxide (CO) content was determined in accordance with EPA Method 10 using a nondispersive infrared analyzer (NDIR), and three test runs were conducted. Oxides of nitrogen samples were collected using the EPA Method 7 absorbing reagent and analyzed per Method 7A by ion chromatography, and three test runs were conducted. Emissions of TNMOC were quantified using EPA Method 25, and three test runs were conducted. The TNMOC results were reported as pounds of carbon per hour and converted to pounds of propane per hour. Emission factors were developed for filterable PM, CO_2, CO, NO_x, and TNMOC.

The emission data for filterable PM, CO_2, NO_x, and TNMOC are rated C. The test methodology appears to be sound, and no problems were reported, but production rates were not reported, and the report lacked adequate documentation to warrant a higher rating. The emission data for CO are rated C because only summary data are available, and process rates are assumed to be the same as those for other test runs.

4.2.28 Reference 28

This report documents measurements of filterable PM emissions from 10 material processing and handling sources. The first test point was the entire secondary crusher line, including conveyors, crusher, screens, and transfer points. The second test was the secondary bins holding the material going to the secondary crusher. The third test point was a conveyor transfer point that transferred the undersize material from the secondary and tertiary crushers to the conveyor leading to the concentrator. The fourth test point was the tertiary crusher line. The fifth test point was the conveyor that transferred the oversize material from the secondary and tertiary crushing to be recrushed. The sixth test point was a conveyor transfer point in the tertiary crushing line prior to the crusher. The seventh test point was the tertiary storage bin, which is used to store material prior to tertiary crushing. The eight test point was the grate-feed end stack. The ninth test point was an entire tertiary crushing line (feeder, crusher, transfers, screens). The tenth test point was another entire tertiary crushing line.

The tests were conducted to demonstrate compliance with State regulations and were conducted in January 1980. Particulate matter emissions from each source are controlled by an individual wet scrubber.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Emission factors were developed for filterable PM. The emission data for filterable PM are rated B. The test methodology appears to be sound and no problems were reported, but the report lacked adequate documentation to warrant a higher rating.

4.2.29 Reference 29

This report documents measurements of filterable PM, SO_2, CO_2, and sulfuric acid (H_2SO_4) emissions from petroleum coke-fired grate/kiln induration furnace processing acid pellets. The purpose of the test was to demonstrate compliance with State regulations. The test was conducted in May 1987. Emissions from the furnace are controlled by a wet scrubber system consisting of two essentially identical sides, Side A and Side B. Each side consists of four venturi scrubbers followed by two drum demisters. Each side has an individual stack, and both sides of the scrubber system were tested. Other tests on this same furnace are documented in References 15, 18, and 19.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Sulfur dioxide and H_2SO_4 mist testing was performed using the EPA Method 8 sampling train, and three test runs were conducted. Carbon dioxide concentrations were determined by Orsat analysis, and data from six test runs were reported for the outlet and from three test runs for the inlet. Emission factors were developed for filterable PM, SO_2, CO_2, and H_2SO_4.

The emission data for filterable PM, SO_2, CO_2, and H_2SO_4 are rated B, with the exception of the inlet CO_2 data. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation to warrant a higher rating. The inlet CO_2 data are rated C because no inlet volumetric flowrates were provided, and the emission factors were developed on the assumption that inlet and outlet flowrates were comparable.

4.2.30 Reference 30

This report documents measurements of filterable PM, SO_2, and CO_2 emissions from a petroleum coke- and natural gas-fired straight grate indurating furnace processing acid pellets. The purpose of the test was to demonstrate compliance with State regulations. The test was conducted in August 1986. Emissions from the furnace are controlled by four wet scrubbers, each with its own stack and identified as stacks A through D, and emissions from each stack were tested.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Sulfur dioxide determinations were performed using the large impinger version of EPA Method 6 via the back half of the Method 5 sampling train, and three test runs were conducted. Carbon dioxide concentrations were determined by Orsat analysis, and data from three test runs were reported. Emission factors were developed for filterable PM, SO_2, and CO_2.

The emission data for filterable PM, SO_2, and CO_2 are rated B. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation to warrant a higher rating.

4.2.31 Reference 31

This report documents measurements of filterable PM, SO_2, NO_x, CO, lead, beryllium, and CO_2 emissions from a natural gas-fired straight grate indurating furnace processing acid pellets and from a petroleum coke- and natural gas-fired straight grate indurating furnace processing acid pellets. The tests were conducted in May 1987. Another emission test on this same furnace is documented in Reference 8.

The emission control system on each indurating machine consists of a multicyclone dust collector followed by four venturi rod wet scrubbers. Each of the scrubbers has a rated flow capacity of 171,675 scfm and has its own stack. All four stacks for both indurating machines were tested.

Particulate matter emissions were measured using EPA Method 5, and three test runs were conducted. Carbon dioxide concentrations were determined by Orsat analysis, and data from three test runs were reported. Carbon monoxide content was determined in accordance with EPA Method 10 using an NDIR analyzer, and three test runs were conducted. Oxides of nitrogen samples were collected using EPA Method 7, and three test runs were conducted. Sulfur dioxide concentrations were determined in accordance with EPA Method 6 using the back half of the EPA Method 5 sampling train, and three test runs were conducted. Lead concentrations were determined in accordance with EPA Method 12, and three test runs were conducted. Beryllium concentrations were determined in accordance with EPA Method 104, and three test runs were conducted. Emission factors were developed for filterable PM, SO_2, NO_x, CO, lead, beryllium, and CO_2.

The emission data for all pollutants are rated B. The test methodology appears to be sound, and no problems were reported, but the report lacked adequate documentation to warrant a higher rating.

4.2.32 References 32 to 35

These references consist of test report summaries for filterable PM emission tests conducted on a natural gas-fired grate/kiln from 1989 to 1992. The source is the same source for which emissions were documented in References 49, 54, and 55, as described below.

Emissions from the grate/kiln are controlled with a multiclone. The type of pellets produced during the tests is not specified; it is assumed that acid pellets were being manufactured during these emission tests. These references document measurements of emissions of filterable PM using Method 5. For the Reference 32, 33, and 34 tests, exhaust gas CO_2 concentrations also are reported, as measured by Orsat. One of two stacks were sampled and total emissions were estimated by doubling the measured emission rates. Emission factors were developed for emissions of filterable PM and CO_2

The data in these summaries are assigned a rating of C. The documentation was incomplete and only one of two stacks were measured.

4.2.33 Reference 46

This report documents measurements of filterable PM, condensible PM, and CO_2 emissions from a natural gas-fired grate/kiln induration furnace processing flux pellets. The purpose of the test was to demonstrate compliance with State regulations. The test was conducted in October 1994. Emissions from the grate/kiln are controlled by multiclones, and one of two identical stacks was sampled during the test program.

Filterable PM emissions were measured using EPA Method 5 (front-half analysis) and condensible PM emissions were quantified using an EPA Method 202 analysis on the back-half of the Method 5 sampling train. Carbon dioxide concentrations were determined by Orsat analysis. Three test runs were conducted for each pollutant.

The emission data are rated B. The test methodology appears to be sound, and no problems were reported. However, only one of the two stacks was tested, and emissions from the untested stack were

assumed equal to the measured emissions. This assumption is supported by historical data (tests on both stacks) that indicate that the emissions from the two stacks are similar.

4.2.34 Reference 47

This report documents measurements of filterable PM, condensible organic PM, and CO_2 emissions from two grate/kiln induration furnaces processing flux pellets. One of the grate kilns was fired with natural gas and the other was fired with a combination of natural gas and fuel oil. The purpose of the emission tests was to demonstrate compliance with State regulations. The tests were conducted in April 1993. Emissions from each grate/kiln are controlled with a multiple throat venturi scrubber (both scrubbers operate with a 6 inch pressure drop).

Filterable and condensible organic PM emissions were measured using EPA Method 5 (front- and back-half analyses), and CO_2 concentrations were determined by Orsat analysis. Three test runs were conducted on each kiln.

The emission data are rated A. The test methodology appears to be sound, adequate detail was provided in the report, and no problems were reported.

4.2.35 Reference 48

This report documents measurements of NO_x emissions from a natural gas-fired straight grate induration furnace processing flux pellets. The purpose of the emission tests was to demonstrate compliance with State regulations. The test was conducted in July 1990. Four stacks vent emissions from the kiln, and each stack is equipped with a venturi rod scrubber.

Nitrogen oxide emissions were measured using EPA Method 7E (instrument analyzer). Three test runs were conducted on each stack, and the emission rates from the four stacks are summed to determine total NO_x emissions from the kiln.

The emission data are rated A. The test methodology appears to be sound, adequate detail was provided in the report, and no problems were reported.

4.2.36 Reference 49

This report documents measurements of filterable PM-10, condensible PM, CO, SO_2, NO_x, TOC, and CO_2 emissions from a natural gas-fired grate/kiln induration furnace processing acid pellets (three tests) and semi-flux pellets (one test). The semi-flux pellets contained 1 percent limestone. The purpose of the test was to compare emissions from acid pellet and flux pellet production. The test was conducted in October 1994. Emissions from the grate/kiln are controlled by multiclones, and one of two identical stacks venting emissions from the kiln was sampled during the test program.

Filterable PM-10 and condensible PM emissions were measured using EPA Methods 201A and 202, respectively. Lead emissions were quantified using mass balance. Sulfur dioxide, NO_x, CO, TOC, and CO_2 concentrations were quantified using EPA Methods 6C, 7E, 10, 25A, and 3 (Orsat analysis), respectively. The TOC concentrations are reported on an "as propane" basis. Nine test runs were conducted for each pollutant during acid pellet production, and three test runs were conducted for each pollutant during flux pellet production. The first three acid pellet tests were anisokinetic (158 percent isokinetic), and the PM-10 and condensible PM measurements from these tests are void. In addition, the

measured flow rates during the first three acid pellet tests are suspect; therefore, the data from these tests is not used for emission factor development.

The emission data, with the exception of the data from the first three acid pellet test runs, are rated B. The test methodology appears to be sound, and no problems were reported. However, only one of the two stacks was tested, and emissions from the untested stack were assumed equal to the measured emissions. This assumption is supported by historical data (tests on both stacks) that indicate that the emissions from the two stacks are similar. The data from the first three acid pellet test runs are not rated for the reasons discussed in the previous paragraph.

4.2.37 Reference 52

This report documents measurements of filterable PM and PM-10, condensible PM and PM-10, SO_2, and CO_2 emissions from a natural gas-fired grate/kiln processing acid pellets. The purpose of the test was to demonstrate compliance with State regulations. The test was conducted in March 1994. Emissions from the grate/kiln are uncontrolled. Additional process data for this report are presented in Attachment No. 1 of Reference 53.

Filterable PM emissions were measured using EPA Method 5 (front-half analysis) and PM-10 emissions were measured using EPA Method 201A. Condensible PM emissions were quantified using EPA Method 202 (back-half analysis). Sulfur dioxide emissions were measured using EPA Method 6 and CO_2 emissions quantified using Orsat analysis. Emission factors were developed for filterable PM, condensible PM, filterable PM-10, condensible organic PM-10, condensible inorganic PM-10, SO_2, and CO_2. Three test runs were conducted for each pollutant. Two tests of three runs each were conducted for CO_2.

The emission data are rated A. The test methodology appears to be sound, adequate detail was provided in the report, and no problems were reported.

4.2.38 Reference 53

This reference consists of a letter and attachments from the Minnesota Pollution Control Agency with comments on the previous draft of the background report for AP-42 Section 11.23. The attachments include several test report summaries and supplemental information for some of the test reports described previously in this chapter. The attachments also contain test report summaries that provide additional emission data. For the purposes of this report, these new test report summaries are treated as separate references (References 54 to 57), as described below.

4.2.39 References 54 and 55

These references consist of test report summaries for filterable PM emission tests conducted on a natural gas-fired grate/kiln in 1993 and 1995. The source is the same source for which emissions were documented in References 32 to 35 and 49, as described previously.

Emissions from the grate/kiln are controlled with a multiclone. The type of pellets produced during the tests is not specified; it is assumed that acid pellets were being manufactured during these emission tests. These references document measurements of emissions of filterable PM using Method 5. For the Reference 54 test, exhaust gas CO_2 concentrations also are reported, as measured by Orsat. One

of two stacks were sampled and total emissions were estimated by doubling the measured emission rates. Emission factors were developed for emissions of filterable PM and CO_2.

The data in these summaries are assigned a rating of C. The documentation was incomplete and only one of two stacks were measured.

4.2.40 References 56 and 57

These references consist of test report summaries for two emission tests conducted on a natural gas-fired vertical shaft indurating furnace during 1994 and 1995. Other tests conducted on this facility are documented in References 12, 13, 14, and 24.

The furnace has two stacks: a top gas stack and a bottom gas stack. Emissions from the top gas stack are controlled with a heat recuperation unit that acts as a wet scrubber; emissions from the bottom gas stack are controlled with a rotoclone. The type of pellets produced during the tests is not specified; it is assumed that acid pellets were being manufactured during these emission tests.

Reference 56 includes results of total PM (filterable plus condensible) and TOC from the bottom gas stack, and total PM (filterable plus condensible), NO_x, SO_2, CO, and TOC from the top gas stack. Data also are provided on CO_2 concentrations in the exhaust stream from the top gas stack. Reference 57 includes results of filterable PM and condensible PM from the bottom gas stack and the top gas stack. Data also are provided on CO_2 concentrations in the exhaust stream from the top and bottom gas stacks. The test methods are not specified, but it is assumed that EPA reference methods were used to quantify the emissions. Emission factors were developed for all the pollutants sampled.

The emission data are rated C. The references lacked adequate documentation for a higher rating.

4.2.41 Review of FIRE, XATEF, and SPECIATE Data Base Emission Factors

No new information was found in these data bases.

4.2.42 Review of Test Data in AP-42 Background File

The test reports in the background file (References 1 through 4) contained information that was not used previously in Section 11.23. References 1, 2, and 3 include emission data for CO_2, SO_2, and asbestos. The asbestos emission factors developed from Reference 3 are not included in AP-42 Section 11.23. Evidence related to mineralogy, animal testing, and human health effects, all point to the conclusion that the fibers generated from ore mined at the east end of the Biwabik iron formation (as reported in Reference 3) are not the same, in form or carcinogenicity, as true asbestos. Reference 4 contains summaries of controlled emission tests for several taconite ore processing emission sources and controls. These data summaries are considered useful only for order-of-magnitude estimates for sources for which no other emission test data are available.

As explained previously, the previous AP-42 section on taconite ore processing also includes emission factors for uncontrolled fugitive dust emissions from unpaved roads. These emission factors are based on one study (Reference 45). The results of this study are presented in Table 4-3. Because the predictive emission factor equations presented in AP-42 Section 13.2 are based on more data and are considered to provide more reliable estimates of fugitive dust emissions, the fugitive dust emission

factors presented in Reference 45 were not incorporated into the revised AP-42 section for taconite ore processing.

TABLE 4-3. EMISSION FACTORS FOR UNCONTROLLED PARTICULATE EMISSIONS FROM HEAVY DUTY VEHICLE TRAFFIC ON HAUL ROADS AT TACONITE MINES[a]

Aerodynamic diameter, μm	Crushed rock and glacial till		Crushed taconite and waste	
	kg/VKT	lb/VMT	kg/VKT	lb/VMT
2.5	0.62	2.2	0.54	1.9
5.0	1.1	3.9	0.90	3.2
10.0	1.7	6.2	1.5	5.2
15.0	2.2	7.9	1.9	6.6
30.0	3.1	11	2.6	9.3
Emission factor rating:	C	C	D	D

[a]Reference 45.
VKT = vehicle kilometers traveled. VMT = vehicle mile traveled.

4.3 DEVELOPMENT OF CANDIDATE EMISSION FACTORS

Table 4-4 summarizes the test data from References 1 through 35, 46 through 49, 52, 54 to 57. Table 4-5 presents the candidate emission factors for taconite ore indurating furnaces; and Table 4-6 presents the candidate emission factors for other sources associated with taconite ore processing. Appendix A presents a summary of the data from Table 4-4 that were used and how the data were combined to calculate the emission factors in Tables 4-5 and 4-6.

Candidate emission factors generally were developed by grouping the data from similar combinations of source, pollutant, and control device, discarding the inferior data sets, and averaging the emission factor derived from each data set. For indurating furnace emissions, the data for pollutants other than PM also were segregated according to pellet type (acid or flux). In some cases, data were available from multiple tests on the same source. In such cases, the emission factors from the tests on that source were averaged first, and the resulting factor was then averaged with the factors from the other similar sources.

The emission factor ratings assigned to the factors for the revised AP-42 section are based on the guidelines presented in Section 3.3 of this report. All candidate emission factors were developed from some combination of A-, B-, and C-rated data. As a result, none of the factors were assigned a rating higher than C. In addition to the guidelines in Section 3.3, the following the criteria were used in establishing the emission factor ratings in the revised AP-42 section:

1. Factors based on a combination of A-, B-, or C-rated data sets from five or more sources were assigned a rating of C;

2. Factors based on a combination of A-, B-, or C-rated data sets from two to four sources were assigned a rating of D;

TABLE 4-4. SUMMARY OF TEST DATA FOR TACONITE ORE PROCESSING

Source	Control	Pollutant	No. of runs	Emission factor, kg/Mg (lb/ton)[a]		Data rating	Ref. No.
				range	average		
Grate/kiln processing acid pellets (natural gas-fired)	None	Filterable PM	2	6.5 - 9 (13 - 18)	7.5 (15)	B	1
	None	Condensible inorganic PM	2	0.003 - 0.012 (0.006 - 0.024)	0.0075 (0.015)	C	1
	Venturi scrubber	Filterable PM	3	0.175 - 0.36 (0.35 - 0.72)	0.29 (0.58)	B	1
	Venturi scrubber	Condensible inorganic PM	3	0.0015 - 0.007 (0.003 - 0.014)	0.0035 (0.0070)	C	1
Grate/kiln discharge, natural gas-fired	None	Filterable PM	3	0.65 - 0.8 (1.3 - 1.6)	0.7 (1.4)	B	1
	None	Condensible inorganic PM	3	1.5×10^{-5} - 6.5×10^{-5} (3.0×10^{-5} - 1.3×10^{-4})	4.5×10^{-5} (9.0×10^{-5})	C	1
	Wet scrubber	Filterable PM	3	0.0006 - 0.0014 (0.0012 - 0.0028)	0.00095 (0.0019)	B	1
	Wet scrubber	Condensible inorganic PM	3	4.0×10^{-5} - 0.0001 (7.0×10^{-5} - 0.0002)	6.0×10^{-5} (0.00012)	C	1
Grate/kiln processing acid pellets (natural gas-fired)	None[b]	SO_2	2	0.042-0.047 (0.084-0.093)	0.045 (0.089)	B	1
Grate/kiln processing acid pellets (natural gas-fired)	Venturi scrubber	SO_2	3	0.0005-0.068 (0.001-0.135)	0.027 (0.053)	B	1
Grate/kiln processing acid pellets (natural gas- and oil-fired)	None[c]	CO_2	3	52-59 (104-117)	55 (110)	A	2
Grate/kiln processing acid pellets (natural gas- and fuel oil-fired)	None	Filterable PM	4	0.6 - 1.6 (1.2 - 3.2)	1.1 (2.2)	A	2
	None	Condensible PM	4	0.14 - 0.02 (0.028 - 0.040)	0.018 (0.035)	B	2
	ESP	Filterable PM	3	0.005 - 0.0115 (0.010 - 0.023)	0.0085 (0.017)	A	2
	ESP	Condensible PM	3	0.0125 - 0.034 (0.025 - 0.068)	0.023 (0.045)	B	2
Grate/kiln pellet discharge	None	Filterable PM	3	0.12-0.12 (0.24-0.25)	0.12 (0.24)	A	2
		Condensible PM	3	8.5×10^{-5} - 0.00028 (0.00017-0.00055)	0.00018 (0.00035)	B	2
Fine crusher	Rotoclone	Filterable PM	1	NA	0.00064 (0.0013)	D	3
Straight grate processing acid pellets (oil-fired)[e]	None[d]	Filterable PM	1	NA	0.60 (1.2)	D	3
Fine crushing	Rotoclone	Asbestos	1	NA	4.0×10^{-5} (7.9×10^{-5})	NR	3

TABLE 4-4. (Continued)

Source	Control	Pollutant	No. of runs	Emission factor, kg/Mg (lb/ton)[a]		Data rating	Ref. No.
				range	average		
Straight grate processing acid pellets (oil-fired)	None[c]	Asbestos	1	NA	1.3×10^{-3} (2.6×10^{-3})	NR	3
Straight grate dry hood exhaust (oil-fired)	None[d]	Asbestos	1	NA	4.9×10^{-4} (9.7×10^{-4})	NR	3
Straight grate processing acid pellets (petroleum coke- and natural gas-fired)[f]	Multiclone and wet venturi scrubber	Filterable PM	3	0.038 - 0.069 (0.077 - 0.14)	0.052 (0.10)	D	5
	Multiclone and wet venturi scrubber	SO_2	3	0.56 - 0.57 (1.1 - 1.1)	0.56 (1.1)	D	5
	Multiclone and wet venturi scrubber	CO_2	3	48 - 48 (96 - 97)	48 (96)	D	5
Straight grate processing flux pellets (petroleum coke- and coal-fired)[g]	Wet scrubber	Filterable PM	3	0.050 - 0.18 (0.10 - 0.36)	0.10 (0.19)	D	6
	Wet scrubber	SO_2	3	0.23 - 0.34 (0.46 - 0.67)	0.28 (0.57)	D	6
	Wet scrubber	CO_2	3	39 - 40 (78 - 80)	40 (79)	D	6
Grinder feed	Wet scrubber	Filterable PM	3	0.00049 - 0.0012 (0.0010 - 0.0024)	0.00076 (0.0015)	B	7
Grinder feed	Wet scrubber	Filterable PM	3	0.00028 - 0.00041 (0.00056 - 0.00082)	0.00035 (0.00071)	B	7
Grinder feed	Wet scrubber	Filterable PM	3	0.00019 - 0.00025 (0.00038 - 0.00049)	0.00023 (0.00045)	B	7
Grinder feed	Wet scrubber	Filterable PM	3	0.00030 - 0.00032 (0.00060 - 0.00064)	0.00031 (0.00062)	B	7
Hearth layer feed	Wet scrubber	Filterable PM	3	0.0093 - 0.014 (0.019 - 0.029)	0.011 (0.022)	B	8
Straight grate processing acid pellets (No. 6 fuel oil-fired)[f]	Wet venturi scrubber	Filterable PM	2	0.029 - 0.033 (0.058 - 0.067)	0.031 (0.062)	D	8
Straight grate processing acid pellets (No. 6 fuel oil-fired)[h]	Wet venturi scrubber	Filterable PM	3	0.041 - 0.060 (0.081 - 0.120)	0.048 (0.096)	D	8
Straight grate discharge	Wet scrubber	Filterable PM	3	0.0090 - 0.010 (0.018 - 0.021)	0.0095 (0.019)	B	8
Hearth layer screen	Wet scrubber	Filterable PM	3	0.016 - 0.022 (0.032 - 0.044)	0.019 (0.038)	B	8
Product conveyor transfer	Wet scrubber	Filterable PM	3	0.0017 - 0.0019 (0.0034 - 0.0038)	0.0018 (0.0036)	B	8
Bentonite storage bin loading	Fabric filter	Filterable PM	3	1.0 - 1.5 (2.1 - 3.0)	1.2 (2.4)	B	8
Hearth layer feed	Wet scrubber	Filterable PM	3	0.0057 - 0.0059 (0.011 - 0.012)	0.0058 (0.012)	B	9

TABLE 4-4. (Continued)

Source	Control	Pollutant	No. of runs	Emission factor, kg/Mg (lb/ton)[a]		Data rating	Ref. No.
				range	average		
Straight grate processing acid pellets (No. 6 fuel oil-fired)[g]	Wet scrubber	Filterable PM	3	0.036 - 0.048 (0.073 - 0.096)	0.043 (0.086)	D	9
	Wet scrubber	CO_2	3	7.6 - 22 (15 - 44)	14 (27)	D	9
Straight grate discharge	Wet scrubber	Filterable PM	3	0.0017 - 0.0024 (0.0033 - 0.0048)	0.0020 (0.0040)	B	9
Grinder feed	Wet scrubber	Filterable PM	3	0.0011 - 0.0012 (0.0022 - 0.0024)	0.0011 (0.0023)	B	9
Primary crusher, first stage	Cyclone and multiclone	Filterable PM	3	0.016 - 0.023 (0.033 - 0.045)	0.019 (0.038)	B	10
Primary crusher, first stage	Cyclone	Filterable PM	3	0.042 - 0.058 (0.083 - 0.12)	0.050 (0.10)	B	10
Primary crusher, second stage	Cyclone and multiclone	Filterable PM	3	0.008 - 0.013 (0.017 - 0.026)	0.011 (0.022)	B	11
Primary crusher, second stage	Cyclone	Filterable PM	3	0.055 - 0.090 (0.11 - 0.18)	0.075 (0.15)	B	11
Vertical shaft processing acid pellets, top gas stack only (natural gas-fired)[j]	None	Filterable PM	3	5.3 - 16 (11 - 33)	9.0 (18)	C	12
	None	CO_2	3	30 - 37 (60 - 73)	34 (68)	C	12
Vertical shaft processing acid pellets, top gas stack only (natural gas-fired)[k]	Multiclone	Filterable PM	3	0.47 - 2.1 (0.93 - 4.1)	1.0 (2.1)	C	12
	Multiclone	CO_2	3	33 - 34 (65 - 67)	33 (66)	C	12
Vertical shaft processing acid pellets, top gas stack only (natural gas-fired)[k]	None	Filterable PM	3	8.5 - 18 (17 - 35)	13 (25)	C	12
	None	CO_2	3	35 - 37 (70 - 74)	36 (72)	C	12
Vertical shaft processing acid pellets, top gas stack only (natural gas fixed[k]	Multiclone	Filterable PM	3	0.65 - 1.4 (1.3 - 2.8)	1.0 (2.0)	C	12
	Multiclone	CO_2	3	31 - 37 (62 - 73)	35 (69)	C	12
Vertical shaft processing acid pellets, top gas stack only (natural gas-fired)[k]	Multiclone	Filterable PM	3	0.26 - 0.32 (0.52 - 0.64)	0.29 (0.57)	C	13
	Multiclone	CO_2	3	26 - 27 (52 - 54)	27 (53)	C	13
Vertical shaft processing acid pellets, top gas stack only (natural gas-fired)[k]	None	Filterable PM	3	2.5 - 5.4 (5.0 - 11)	3.5 (7.1)	C	13
	None	CO_2	3	39 - 40 (78 - 79)	39 (79)	B	13
Vertical shaft processing acid pellets, top gas stack only (natural gas-fired)	Multiclone and wet scrubber	Filterable PM	3	0.25 - 0.49 (0.49 - 0.98)	0.33 (0.66)	C	14
	Multiclone and wet scrubber	CO_2	3	33 - 37 (67 - 74)	35 (70)	C	14

TABLE 4-4. (Continued)

Source	Control	Pollutant	No. of runs	Emission factor, kg/Mg (lb/ton)[a]		Data rating	Ref. No.
				range	average		
Vertical shaft processing acid pellets, top gas stack only (natural gas-fired)	None	Filterable PM	3	10 - 12 (20 - 25)	11 (22)	C	14
	None	CO_2	3	31 - 34 (61 - 67)	32 (63)	C	14
Grate/kiln processing acid pellets (petroleum coke- and coal-fired)[m]	Wet scrubber	SO_2	2	0.79 - 0.80 (1.6 - 1.6)	0.80 (1.6)	C	15
Grate/kiln processing acid pellets (petroleum coke- and coal-fired)	None	SO_2	2	1.1 - 1.1 (2.3 - 2.3)	1.1 (2.3)	C	15
Pellet cooler[n]	None	Filterable PM	3	0.018 - 0.032 (0.037 - 0.065)	0.027 (0.055)	B	16
Pellet cooler[n]	None	Filterable PM	3	0.052 - 0.090 (0.10 - 0.18)	0.073 (0.15)	B	17
Grate/kiln processing acid pellets (coal- and fuel oil-fired)[m]	Wet scrubber	Filterable PM	3	0.069 - 0.14 (0.14 - 0.28)	0.095 (0.19)	C	18
	Wet scrubber	CO_2	3	34 - 36 (68 - 73)	35 (70)	C	18
Grate/kiln processing acid pellets (natural gas-fired)[m]	Wet scrubber	NO_x	3	0.75 - 0.82 (1.5 - 1.6)	0.79 (1.6)	C	19
Grate/kiln processing acid pellets (natural gas-fired)[m]	None	NO_x	3	0.84 - 1.1 (1.7 - 2.3)	1.0 (2.0)	C	19
Grate/kiln processing flux pellets (natural gas- and wood-fired)	Wet venturi scrubber	Filterable PM	3	0.039 - 0.043 (0.077 - 0.086)	0.040 (0.081)	B	20
	Wet venturi scrubber	SO_2	3	0.066 - 0.072 (0.13 - 0.14)	0.069 (0.14)	B	20
	Wet venturi scrubber	CO_2	3	61 - 69 (123 - 138)	66 (130)	B	20
Grate/kiln processing flux pellets (natural gas-fired)	Wet venturi scrubber	Filterable PM	3	0.026 - 0.030 (0.053 - 0.060)	0.028 (0.057)	B	20
	Wet venturi scrubber	SO_2	3	0.058 - 0.070 (0.12 - 0.14)	0.063 (0.13)	B	20
	Wet venturi scrubber	CO_2	3	62 - 63 (123 - 125)	62 (120)	B	20
Secondary crusher oversize material conveyor transfer	Wet venturi scrubber	Filterable PM	3	0.00029 - 0.00053 (0.00059 - 0.0011)	0.00039 (0.00078)	B	21
Secondary crusher oversize material conveyor transfer	Wet venturi scrubber	Filterable PM	3	0.0014 - 0.0020 (0.0029 - 0.0040)	0.0017 (0.0034)	B	21
Primary crusher	Wet venturi scrubber	Filterable PM	3	0.00049 - 0.00080 (0.0010 - 0.0016)	0.00061 (0.0012)	B	22
Pellet screen	Rotoclone	Filterable PM	3	0.010 - 0.028 (0.021 - 0.056)	0.019 (0.037)	B	23

TABLE 4-4. (Continued)

Source	Control	Pollutant	No. of runs	Emission factor, kg/Mg (lb/ton)[a]		Data rating	Ref. No.
				range	average		
Pellet screen	None	Filterable PM	2	3.2 - 7.1 (6.4 - 14.2)	5.2 (10.3)	C	23
Pellet storage bin	Rotoclone	Filterable PM	3	0.034 - 0.039 (0.068 - 0.078)	0.036 (0.071)	B	23
Pellet storage bin	None	Filterable PM	3	1.8 - 1.9 (3.6 - 3.8)	1.9 (3.7)	B	23
Vertical shaft processing acid pellets, top gas stack only (natural gas-fired)[j]	Multiclone	Filterable PM	3	0.52 - 0.62 (1.0 - 1.2)	0.56 (1.1)	C	24
	Multiclone	CO_2	3	31 - 37 (63 - 75)	34 (68)	C	24
Vertical shaft processing acid pellets, top gas stack only (natural gas-fired)[j]	None	Filterable PM	3	5.0 - 7.2 (10 - 14)	5.8 (12)	C	24
	None	CO_2	3	28 - 38 (55 - 75)	32 (64)	C	24
Vertical shaft processing acid pellets, top gas stack only (natural gas-fired)[j]	Multiclone	Filterable PM	3	0.70 - 0.89 (1.4 - 1.8)	0.79 (1.6)	C	24
	Multiclone	CO_2	3	33 - 36 (67 - 71)	35 (70)	C	24
Vertical shaft processing acid pellets, top gas stack only (natural gas-fired)[j]	None	Filterable PM	3	6.5 - 8.6 (13 - 17)	7.8 (16)	C	24
	None	CO_2	3	38 - 41 (76 - 82)	40 (79)	C	24
Vertical shaft processing acid pellets, top gas stack only (natural gas-fired)[k]	Multiclone	Filterable PM	3	0.44 - 0.60 (0.87 - 1.2)	0.53 (1.1)	C	24
	Multiclone	CO_2	3	29 - 30 (58 - 61)	30 (60)	C	24
Vertical shaft processing acid pellets, top gas stack only (natural gas-fired)[k]	None	Filterable PM	3	5.6 - 8.7 (11 - 17)	7.5 (15)	C	24
	None	CO_2	3	25 - 30 (50 - 59)	27 (54)	C	24
Vertical shaft processing acid pellets, top gas stack only (natural gas-fired)[k]	Multiclone	Filterable PM	3	0.60 - 0.84 (1.2 - 1.7)	0.74 (1.5)	C	24
	Multiclone	CO_2	3	24 - 32 (48 - 63)	28 (56)	C	24
Vertical shaft processing acid pellets, top gas stack only (natural gas-fired)[k]	None	Filterable PM	3	8.0 - 11 (16 - 22)	9.8 (20)	C	24
	None	CO_2	3	24 - 27 (49 - 53)	26 (51)	C	24
Grate/kiln processing flux pellets (coal-fired)[p]	Wet scrubber	SO_2	3	0.64 - 0.88 (1.3 - 1.8)	0.74 (1.5)	C	25
	Wet scrubber	CO_2	3	100 - 120 (210 - 240)	110 (220)	C	25
Grate/kiln processing flux pellets (coke- and coal-fired)[p]	Wet scrubber	Filterable PM	3	0.056 - 0.062 (0.11 - 0.12)	0.060 (0.12)	C	26

TABLE 4-4. (Continued)

Source	Control	Pollutant	No. of runs	Emission factor, kg/Mg (lb/ton)[a]		Data rating	Ref. No.
				range	average		
	Wet scrubber	SO_2	3	0.024 - 0.031 (0.048 - 0.063)	0.028 (0.057)	C	26
	Wet scrubber	CO_2	3	100 - 110 (200 - 220)	100 (200)	C	26
Grate/kiln processing flux pellets (coal- and petroleum coke-fired)	Wet scrubber	Filterable PM	3	0.067 - 0.089 (0.13 - 0.18)	0.077 (0.15)	C	27
	Wet scrubber	TNMOC as propane	3	0.0047 - 0.10 (0.0093 - 0.20)	0.038 (0.075)	C	27
	Wet scrubber	CO	3	0.047 - 0.057 (0.094 - 0.11)	0.051 (0.10)	C	27
	Wet scrubber	CO_2	3	94 - 100 (190 - 210)	97 (210)	C	27
Pellet cooler	None	Filterable PM	3	0.072 - 0.089 (0.14 - 0.18)	0.080 (0.16)	B	27
	None	CO_2	3	2.5 - 3.9 (5.0 - 7.8)	3.2 (6.4)	B	27
Grate/kiln processing flux pellets (natural gas-fired)[p]	Wet scrubber	Filterable PM	3	0.049 - 0.093 (0.097 - 0.19)	0.069 (0.14)	C	27
	Wet scrubber	NO_x	3	0.61- 0.81 (1.2 - 1.6)	0.69 (1.4)	C	27
	Wet scrubber	CO_2	3	61- 86 (120 - 170)	77 (150)	C	27
Primary crusher	Fabric filter	Filterable PM	3	0.00071 - 0.0015 (0.0014 - 0.0029)	0.0010 (0.0019)	B	27
Primary crusher return conveyor	Wet scrubber	Filterable PM	3	0.00012 - 0.00019 (0.00025 - 0.00037)	0.00015 (0.00031)	B	27
Secondary crushing line	Wet scrubber	Filterable PM	3	0.0011 - 0.0017 (0.0022 - 0.0035)	0.0014 (0.0027)	B	28
Secondary bin loading	Wet scrubber	Filterable PM	3	8.6×10^{-5} - 0.00011 (0.00017 - 0.00022)	9.4×10^{-5} (0.00019)	B	28
Conveyor transfer to concentrator[r]	Wet scrubber	Filterable PM	3	0.00010 - 0.00021 (0.00020 - 0.00042)	0.00014 (0.00028)	B	28
Tertiary crusher	Wet scrubber	Filterable PM	3	0.00088 - 0.0017 (0.0018 - 0.0033)	0.0013 (0.0027)	B	28
Secondary crusher return conveyor transfer[s]	Wet scrubber	Filterable PM	3	0.00073 - 0.014 (0.0015 - 0.027)	0.0067 (0.013)	B	28
Tertiary crushing line conveyor transfer[t]	Wet scrubber	Filterable PM	3	0.00036 - 0.0018 (0.00071 - 0.0036)	0.00085 (0.0017)	B	28
Tertiary storage bin loading	Wet scrubber	Filterable PM	3	0.0012 - 0.0016 (0.0024 - 0.0033)	0.0014 (0.0027)	B	28
Grate/kiln feed	Wet scrubber	Filterable PM	3	2.4E-05 - 4.3E-05 (4.8E-05 - 8.6E-05)	3.3E-05 (6.6E-05)	B	28

TABLE 4-4. (Continued)

Source	Control	Pollutant	No. of runs	Emission factor, kg/Mg (lb/ton)[a]		Data rating	Ref. No.
				range	average		
Tertiary storage bin loading[u]	Wet scrubber	Filterable PM	3	0.00038 - 0.00043 (0.00076 - 0.00086)	0.00041 (0.00082)	B	28
Tertiary crushing line[q]	Wet scrubber	Filterable PM	3	0.00017 - 0.00022 (0.00034 - 0.00044)	0.00020 (0.00040)	B	28
Grate/kiln processing acid pellets (petroleum coke-fired)[m]	None	SO_2	3	0.90 - 0.97 (1.8 - 1.9)	0.95 (1.9)	B	29
	None	CO_2	3	53 - 55 (107 - 110)	54 (110)	C	29
	None	H_2SO_4	3	0.080 - 0.089 (0.16 - 0.18)	0.085 (0.17)	B	29
Grate/kiln processing acid pellets (petroleum coke-fired)[m]	Wet scrubber	SO_2	3	0.63 - 0.67 (1.3 - 1.3)	0.65 (1.3)	B	29
	Wet scrubber	CO_2	6	51 - 52 (103 - 104)	52 (100)	B	29
	Wet scrubber	Filterable PM	3	0.049 - 0.052 (0.10 - 0.10)	0.051 (0.10)	B	29
	Wet scrubber	H_2SO_4	3	0.047 - 0.051 (0.094 - 0.10)	0.049 (0.099)	B	29
Straight grate processing acid pellets (petroleum coke- and natural gas-fired)	Wet scrubber	Filterable PM	3	0.056 - 0.061 (0.11 - 0.12)	0.058 (0.12)	B	30
	Wet scrubber	SO_2	3	0.62 - 0.64 (1.2 - 1.3)	0.63 (1.3)	B	30
	Wet scrubber	CO_2	3	36 - 39 (73 - 78)	38 (76)	B	30
Straight grate processing acid pellets (natural gas-fired)	Multicyclone and wet scrubber	Filterable PM	3	0.049 - 0.050 (0.10 - 0.10)	0.049 (0.10)	B	31
	Multicyclone and wet scrubber	SO_2	3	0.046 - 0.060 (0.091 - 0.12)	0.052 (0.10)	B	31
	Multicyclone and wet scrubber	NO_x	3	0.28 - 0.31 (0.57 - 0.61)	0.30 (0.60)	B	31
	Multicyclone and wet scrubber	CO	3	0.019 - 0.020 (0.038 - 0.041)	0.019 (0.039)	B	31
	Multicyclone and wet scrubber	Lead	3	3.3E-05 - 3.5E-05 (6.5E-05 - 7.0E-05)	3.4E-05 (6.8E-05)	B	31
	Multicyclone and wet scrubber	Beryllium	3	7.7E-08 - 1.4E-07 (1.5E-07 - 2.9E-07)	1.1E-07 (2.2E-07)	B	31
	Multicyclone and wet scrubber	CO_2	3	23 - 26 (45 - 53)	25 (50)	B	31

TABLE 4-4. (Continued)

Source	Control	Pollutant	No. of runs	Emission factor, kg/Mg (lb/ton)[a]		Data rating	Ref. No.
				range	average		
Straight grate processing acid pellets (petroleum coke- and natural gas-fired)[f]	Multicyclone and wet scrubber	Filterable PM	3	0.052 - 0.057 (0.10 - 0.11)	0.054 (0.11)	B	31
	Multicyclone and wet scrubber	SO_2	3	0.30 - 0.36 (0.59 - 0.72)	0.34 (0.68)	B	31
	Multicyclone and wet scrubber	NO_x	3	0.13 - 0.15 (0.26 - 0.30)	0.14 (0.28)	B	31
	Multicyclone and wet scrubber	CO	3	0.074 - 0.079 (0.15 - 0.16)	0.077 (0.15)	B	31
	Multicyclone and wet scrubber	Lead	3	2.9E-05 - 5.5E-05 (5.8E-05 - 1.1E-04)	3.8E-05 (7.6E-05)	B	31
	Multicyclone and wet scrubber	Beryllium	3	8.1E-08 - 2.3E-07 (1.6E-07 - 4.6E-07)	1.5E-07 (2.9E-07)	B	31
	Multicyclone and wet scrubber	CO_2	3	30 - 31 (60 - 62)	31 (61)	B	31
Grate/kiln firing acid pellets (natural gas-fired)[v]	Multicyclone	Filterable PM	3	0.11 - 0.18 (0.22 - 0.37)	0.15 (0.31)	C	32
	Multicyclone	CO_2	3	23 - 28 (46 - 55)	25 (50)	C	32
Grate/kiln firing acid pellets (natural gas-fired)[v]	Multicyclone	Filterable PM	3	0.19 - 0.23 (0.37 - 0.47)	0.21 (0.42)	C	33
	Multicyclone	CO_2	3	16 - 24 (33 - 49)	22 (43)	C	33
Grate/kiln firing acid pellets (natural gas-fired)[v]	Multicyclone	Filterable PM	3	0.39 - 0.66 (0.79 - 1.3)	0.53 (1.1)	C	34
	Multicyclone	CO_2	3	33 - 36 (66 - 73)	35 (70)	C	34
Grate/kiln firing acid pellets (natural gas-fired)[v]	Multicyclone	Filterable PM	3	0.36 - 0.41 (0.73 - 0.82)	0.38 (0.77)	C	35
Grate/kiln processing flux pellets (natural gas-fired)	Multicyclone	Filterable PM	3	0.14 - 0.17 (0.29 - 0.35)	0.16 (0.32)	B	46
	Multicyclone	Condensible PM	3	0.0059 - 0.0073 (0.012 - 0.015)	0.0068 (0.014)	B	46
	Multicyclone	CO_2	3	21 - 31 (43 - 61)	25 (50)	B	46
Grate/kiln processing flux pellets (natural gas and fuel oil-fired)	Venturi scrubber	Filterable PM	3	0.026 - 0.043 (0.052 - 0.087)	0.032 (0.065)	A	47
	Venturi scrubber	Condensible organic PM	3	0.00026 - 0.0011 (0.00053 - 0.0022)	0.00077 (0.0015)	A	47

TABLE 4-4. (Continued)

Source	Control	Pollutant	No. of runs	Emission factor, kg/Mg (lb/ton)[a]		Data rating	Ref. No.
				range	average		
	Venturi scrubber	CO_2	3	55 - 63 (110 - 130)	60 (120)	A	47
Grate/kiln processing flux pellets (natural gas-fired)	Venturi scrubber	Filterable PM	3	0.030 - 0.036 (0.061 - 0.073)	0.032 (0.065)	A	47
	Venturi scrubber	Condensible organic PM	3	0.0026 - 0.0043 (0.0052 - 0.0086)	0.0033 (0.0066)	A	47
	Venturi scrubber	CO_2	3	59 - 68 (120 - 140)	62 (120)	A	47
Straight grate processing flux pellets (natural gas-fired)	Venturi scrubber	NO_x	3	1.2 - 1.3 (2.5 - 2.6)	1.3 (2.5)	A	48
Grate/kiln processing processing acid pellets (natural gas-fired)[v]	Multicylone	Filterable PM	6	0.14 - 0.18 (0.27 - 0.37)	0.16 (0.33)	B	49
	Multicyclone	Filterable PM-10	6	0.063 - 0.070 (0.13 - 0.14)	0.068 (0.14)	B	49
	Multicyclone	Condensible PM	6	0.011 - 0.024 (0.022 - 0.048)	0.018 (0.035)	B	49
	Multicyclone	CO_2	6	18 - 28 (37 - 56)	23 (45)	B	49
	Multicyclone	CO	6	0.0044 - 0.012 (0.0088 - 0.024)	0.0072 (0.014)	B	49
	Multicyclone	SO_2	6	0.082 - 0.091 (0.16 - 0.18)	0.086 (0.17)	B	49
	Multicyclone	NO_x	6	0.67 - 0.84 (1.3 - 1.7)	0.74 (1.5)	B	49
	Multicyclone	TOC as propane	6	0.00033 - 0.0028 (0.00066 - 0.0056)	0.0019 (0.0039)	B	49
	Multicyclone	Lead	2	9.9×10^{5} - 0.00040 (0.00020 - 0.00080)	0.00025 (0.00050)	B	49
Grate/kiln processing semi-flux pellets (natural gas-fired)	Multicyclone	Filterable PM	3	0.15 - 0.18 (0.30 - 0.35)	0.16 (0.32)	B	49
	Multicyclone	Filterable PM-10	3	0.054 - 0.075 (0.11 - 0.15)	0.062 (0.12)	B	49
	Multicyclone	Condensible PM	3	0.0099 - 0.028 (0.020 - 0.055)	0.016 (0.032)	B	49
	Multicyclone	CO_2	3	29 - 32 (58 - 65)	31 (61)	B	49
	Multicyclone	CO	3	0.0064 - 0.0068 (0.013 - 0.014)	0.0066 (0.013)	B	49
	Multicyclone	SO_2	3	0.093 - 0.096 (0.19 - 0.19)	0.094 (0.19)	B	49
	Multicyclone	NO_x	3	0.59 - 0.62 (1.2 - 1.2)	0.61 (1.2)	B	49

TABLE 4-4. (Continued)

Source	Control	Pollutant	No. of runs	Emission factor, kg/Mg (lb/ton)[a]		Data rating	Ref. No.
				range	average		
	Multicyclone	TOC as propane	3	0.0016 - 0.0020 (0.0032 - 0.0040)	0.0017 (0.0035)	B	49
Grate/kiln processing acid pellets (natural gas-fired)	None	Filterable PM	3	2.3 - 2.9 (4.6 - 5.8)	2.6 (5.1)	A	52
	None	Condensible PM	3	0.0045 - 0.0078 (0.0089 - 0.016)	0.0063 (0.013)	A	52
	None	Filterable PM-10	3	0.28 - 0.34 (0.57 - 0.67)	0.31 (0.63)	A	52
	None	Condensible organic PM	3	0.0081 - 0.012 (0.016 - 0.024)	0.0097 (0.019)	A	52
	None	Condensible inorganic PM	3	0.036 - 0.080 (0.072 - 0.16)	0.052 (0.10)	A	52
	None	SO_2	3	0.34 - 0.38 (0.68 - 0.75)	0.36 (0.71)	A	52
	None	CO_2	3	60 - 65 (120 - 130)	62 (120)	A	52
	None	CO_2	3	60 - 65 (120 - 130)	62 (120)	A	52
Grate/kiln firing acid pellets (natural gas-fired)[v]	Multicyclone	Filterable PM	3	0.20 - 0.25 (0.40 - 0.49)	0.22 (0.43)	C	54
	Multicyclone	CO_2	3	27 - 27 (53 - 54)	27 (54)	C	54
Grate/kiln firing acid pellets (natural gas-fired)[v]	Multicyclone	Filterable PM	3	0.40 - 0.46 (0.80 - 0.91)	0.42 (0.84)	C	55
Vertical shaft firing acid pellets, bottom gas stack (natural gas-fired)[w]	Rotoclone	Total PM (filt. + cond.)	3	0.010 - 0.014 (0.020 - 0.028)	0.011 (0.022)	C	56
	Rotoclone	TOC, as propane	3	0.0092 - 0.032 (0.018 - 0.064)	0.023 (0.046)	C	56
Vertical shaft firing acid pellets, top gas stack only (natural gas-fired)[w]	Wet scrubber	Total PM (filt. + cond.)	3	0.052 -0.11 (0.10 - 0.21)	0.072 (0.14)	C	56
	Wet scrubber	NO_x	3	0.096 - 0.10 (0.19 - 0.20)	0.098 (0.20)	C	56
	Wet scrubber	SO_2	3	0.13 - 0.14 (0.26 - 0.28)	0.14 (0.28)	C	56
	Wet scrubber	CO	3	0.038 - 0.039 (0.077 - 0.078)	0.039 (0.077)	C	56
	Wet scrubber	TOC, as propane	3	0.0032 - 0.0098 (0.0064 - 0.020)	0.0065 (0.013)	C	56
	Wet scrubber	CO_2	3	100 - 110 (200 - 220)	110 (210)	C	56

TABLE 4-4. (Continued)

Source	Control	Pollutant	No. of runs	Emission factor, kg/Mg (lb/ton)[a]		Data rating	Ref. No.
				range	average		
Vertical shaft firing acid pellets, bottom gas stack only (natural gas-fired)[w]	Rotoclone	Filterable PM	3	0.014 - 0.018 (0.029 - 0.037)	0.016 (0.031)	C	57
	Rotoclone	Condensible PM	3	0.00060 - 0.011 (0.0012 - 0.022)	0.0043 (0.0086)	C	57
Vertical shaft firing acid pellets, top gas stack only (natural gas-fired)[w]	Wet scrubber	Filterable PM	3	0.030 -0.057 (0.059 - 0.11)	0.046 (0.92)	C	57
	Wet scrubber	Condensible PM	3	0.021 - 0.029 (0.042 - 0.047)	0.025 (0.050)	C	57
	Wet scrubber	CO_2	3	100 - 100 (200 - 200)	100 (200)	C	57

TABLE 4-5. SUMMARY OF CANDIDATE EMISSION FACTORS FOR TACONITE ORE INDURATING FURNACES.

				Pellet	Number of		Emission factor, lb/ton				
Type	Fuel	Control (a)	Pollutant	type (b)	tests	sources	Min.	Max.	Ave.	Rating	References
grate/kiln	gas	none	filt. PM	A/F	3	3	2.2	15	7.4	D	12, 52
grate/kiln	gas	WS	filt. PM	A/F	5	5	0.057	0.14	0.082	C	20, 27, 47
grate/kiln	coal/oil	WS	filt. PM	A/F	1	1			0.19	E	18
grate/kiln	coke	WS	filt. PM	A/F	1	1			0.10	E	29
grate/kiln	coke/coal	WS	filt. PM	A/F	2	2	0.12	0.15	0.14	D	26, 27
grate/kiln	gas/oil	ESP	filt. PM	A/F	1	1			0.017	E	2
grate/kiln	gas	MC	filt. PM	A/F	9	2	0.31	1.1	0.44	D	32-35, 46, 49, 54-55
grate/kiln	gas	none	filt. PM-10	A/F	1	1			0.63	E	52
grate/kiln	gas	MC	filt. PM-10	A/F	2	1	0.12	0.14	0.13	E	49
grate/kiln	gas	none	cond. PM	A/F	5	4	0.013	0.035	0.022	D	1, 46, 49, 52
grate/kiln	gas/oil	none	cond. PM	A/F	2	2	0.035	0.045	0.040	D	2
grate/kiln	gas	WS	cond. PM	A/F	3	3	0.002	0.0083	0.0055	D	1, 47
grate/kiln	gas	none	SO2	acid	4	3	0.089	0.71	0.29	D	1, 49, 52
grate/kiln	coke	none	SO2	acid	1	1			1.9	E	29
grate/kiln	coke/coal	none	SO2	acid	1	1			2.3	E	15
grate/kiln	gas	WS	SO2	acid	1	1			0.053	E	1
grate/kiln	gas	WS	SO2	flux	2	2	0.13	0.14	0.14	D	20
grate/kiln	coal/coke	WS	SO2	A/F	3	2	1.3	1.6	1.5	D	15, 25, 29
grate/kiln	gas	NA	NOx	A/F	5	3	1.2	2.0	1.5	D	19, 27, 49
grate/kiln	gas	NA	CO	acid	2	1	0.013	0.014	0.014	E	49
grate/kiln	gas	NA	CO	flux	1	1			0.10	E	27
grate/kiln	NA	NA	CO2	acid	12	5	43	120	99	C	2, 18, 29, 32-34, 49, 52,54
grate/kiln	NA	NA	CO2	flux	9	7	50	220	130	C	20, 25-27, 46-47
grate/kiln	gas	NA	VOC (c)	acid	2	1	0.0035	0.0038	0.0037	D	49
grate/kiln	gas	NA	VOC (d)	flux	1	1			0.075	E	27
grate/kiln	gas	MC	lead	acid	1	1			0.00050	E	49
grate/kiln	coke	none	H2SO4	acid	1	1			0.17	E	29
grate/kiln	coke	WS	H2SO4	acid	1	1			0.099	E	29

TABLE 4-5. (Continued)

Type	Fuel	Control (a)	Pollutant	Pellet type (b)	Number of tests	Number of sources	Emission factor, lb/ton Min.	Max.	Ave.	Rating	References
vertical shaft-top	gas	none	filt. PM	A/F	8	3	7.1	25	16	D	12-14, 24
vertical shaft-top	gas	MC	filt. PM	A/F	7	3	0.57	2.1	1.4	D	12, 13, 24
vertical shaft-top	gas	WS	filt. PM	A/F	1	1			0.92	E	57
vertical shaft-top	gas	MC/WS	filt. PM	A/F	1	1			0.66	E	14
vertical shaft-bot.	gas	RC	filt. PM	A/F	1	1			0.031	E	57
vertical shaft-top	gas	WS	cond. PM	A/F	1	1			0.050	E	57
vertical shaft-bot.	gas	RC	cond. PM	A/F	1	1			0.0086	E	57
vertical shaft-top	gas	WS	SO2	acid	1	1			0.28	E	56
vertical shaft-top	gas	NA	NOx	acid	1	1			0.20	E	56
vertical shaft-top	gas	NA	CO	acid	1	1			0.077	E	56
vertical shaft-top	gas	NA	CO2	acid	18	5	51	210	94	C	12-14, 24, 56-57
vertical shaft-top	gas	NA	VOC (c)	acid	1	1			0.013	E	56
vertical shaft-bot.	gas	NA	VOC (c)	acid	1	1			0.046	E	56
straight grate	oil	none	filt. PM	A/F	1	1			1.2	E	3
straight grate	coke/gas	WS	filt. PM	A/F	3	3	0.10	0.12	0.11	D	30, 31
straight grate	coke	MC/WS	SO2	acid	2	2	0.68	1.3	0.99	D	30, 31
straight grate	gas	WS	SO2	acid	1	1			0.10	E	31
straight grate	coke/gas	NA	NOx	acid	2	2	0.28	0.60	0.44	D	31
straight grate	gas	NA	NOx	flux	1	1			2.5	E	48
straight grate	gas	NA	CO	acid	1	1			0.039	E	31
straight grate	coke/gas	NA	CO	acid	1	1			0.15	E	31
straight grate	coke/gas	NA	CO2	acid	3	3	50	76	62	D	30, 31
straight grate	gas	MC/WS	lead	acid	1	1			0.000068	E	31
straight grate	coke/gas	MC/WS	lead	acid	1	1			0.000076	E	31
straight grate	gas	MC/WS	beryllium	acid	1	1			2.20e-07	E	31
straight grate	coke/gas	MC/WS	beryllium	acid	1	1			2.90e-07	E	31

(a) NA = not applicable. WS = wet scrubber. MC = multiclone. RC = rotoclone. ESP = electrostatic precipitator.
(b) A/F = acid or flux.
(c) Based on Method 25A data.
(d) Based on Method 25 data.

TABLE 4-6. SUMMARY OF CANDIDATE EMISSION FACTORS FOR TACONITE ORE PROCESSING--OTHER SOURCES

Source	Control (a)	Pollutant	No. of tests	Emission factor, lb/ton			Rating	References
				Minimum	Maximum	Average		
Primary crusher	C	filterable PM	1			0.25	E	10,11
Primary crusher	C/MC	filterable PM	1			0.060	E	10,11
Primary crusher	WS	filterable PM	1			0.0012	E	22
Primary crusher	FF	filterable PM	1			0.0019	E	27
Secondary crushing line	WS	filterable PM	1			0.0027	E	28
Fine crusher	RC	filterable PM	1			0.0013	E	3
Tertiary crushing line	WS	filterable PM	2	0.0004	0.00270	0.0016	D	28
Grinder feed	WS	filterable PM	5	0.00045	0.0023	0.0011	C	7,9
Hearth layer feed	WS	filterable PM	2	0.012	0.022	0.017	D	8,9
Grate/kiln feed	WS	filterable PM	1			0.000066	E	28
Hearth layer screen	WS	filterable PM	1			0.038	E	8
Grate/kiln discharge	none	filterable PM	2	0.24	1.4	0.82	D	1,2
Grate/kiln discharge	WS	filterable PM	1			0.0019	E	1
Grate/kiln discharge	none	condensible inorg. PM	1			9.0e-05	E	1
Grate/kiln discharge	none	condensible PM	1			0.00035	E	2
Grate/kiln discharge	WS	condensible inorg. PM	1			0.00012	E	1
Straight grate feed	none	filterable PM	(b)			0.63	E	4
Straight grate discharge	none	filterable PM	(b)			1.4	E	4
Straight grate discharge	WS	filterable PM	2	0.0040	0.019	0.012	D	8,9
Pellet cooler	none	filterable PM	3	0.055	0.16	0.12	D	16,17,27
Pellet cooler	none	CO2	1			6.4	E	27
Pellet screen	none	filterable PM	1			10	E	23
Pellet screen	RC	filterable PM	1			0.037	E	23
Primary crusher return conveyor transfer	WS	filterable PM	1			0.00031	E	27
Secondary crusher return conveyor transfer	WS	filterable PM	3	0.00078	0.013	0.0057	D	2128
Product conveyor transfer	WS	filterable PM	1			0.0036	E	8
Conveyor transfer to concentrator	WS	filterable PM	1			0.00028	E	28
Tertiary crusher line conveyor transfer	WS	filterable PM	1			0.0017	E	28

TABLE 4-6. (Continued)

Source	Control (a)	Pollutant	No. of tests	Emission factor, lb/ton			Rating	References
				Minimum	Maximum	Average		
Bentonite storage bin	WS	filterable PM	1			2.4	E	8
Bentonite transfer	none	filterable PM	(b)			3.2	E	4
Bentonite transfer	WS	filterable PM	(b)			0.11	E	4
Bentonite blending	none	filterable PM	(b)			19	E	4
Bentonite blending	WS	filterable PM	(b)			0.25	E	4
Bentonite blending	FF	filterable PM	(b)			0.11	E	4
Pellet storage bin loading	none	filterable PM	1			3.7	E	23
Pellet storage bin loading	RC	filterable PM	1			0.071	E	23
Secondary storage bin loading	WS	filterable PM	1			0.00019	E	28
Tertiary storage bin loading	WS	filterable PM	2	0.00082	0.0027	0.0018	D	28

(a) WS = wet scrubber. RC = rotoclone. MC = multiclone. C = cyclone. FF = fabric filter.
(b) Based on secondary reference.

3. Factors based on two data sets from the same source also were rated D; and

4. Factors based on only C- or D-rated data sets, or factors based on a single emission test, were assigned a rating of E.

The following paragraphs describe how the data presented in Table 4-4 were used to develop the candidate emission factors. The development of average emission factors for taconite ore indurating furnaces is discussed first, followed by a discussion of how the candidate emission factors for other sources were derived.

4.3.1 Indurating Furnaces

As explained previously, emission data for indurating furnaces were grouped according to the type fuel, pollutant, and control device. For pollutants other than PM, the data also were grouped by pellet type (acid or flux). After grouping the data sets, the majority of candidate emission factors were determined as the arithmetic mean of the factors developed from each available data set in the group. However, for several groups of data, it was necessary to make additional assumptions about the data in order to arrive at a reasonable result. The following paragraphs describe the development of candidate emission factors for those groups and data sets for which the arithmetic mean of the data did not appear to provide a reasonable or consistent result. The development of factors for grate/kilns is presented first, followed by explanations of how the factors for vertical kilns and straight grates were developed.

4.3.1.1 Grate/Kiln Furnaces

For grate/kilns, data were available on emissions of a wide variety of pollutants from the production of both acid pellets and flux pellets. The following paragraphs first describe how the candidate emission factors for grate/kiln furnaces were developed.

4.3.1.1.1 Filterable PM

Three data sets were available for uncontrolled filterable PM from grate/kilns. Two of the data sets were derived from tests on gas-fired grate/kilns, and the third data set from a test on a grate/kiln fired with a combination of gas and oil. It would be expected for the factor for the gas/oil-fired furnace to be higher than the factors for furnaces fired with gas only. However, the factor for the gas/oil-fired furnace was the lowest of the three. Therefore, all three data sets were combined to yield a candidate emission factor for gas-fired grate/kilns.

Six data sets were available for wet scrubber-controlled filterable PM emissions from grate/kilns. Four of the data sets were from tests on grate/kilns fired with natural gas, and the other two data sets were for furnaces fired with combinations of either gas and oil (0.065 lb/ton) or gas and wood (0.081 lb/ton). One of the data sets for a gas-fired furnace (0.58 lb/ton) was discarded because the emission factor for the test was an order of magnitude higher than the factors from the other tests in this group. In addition, if this emission factor were included in the calculation, the resulting candidate emission factor would be inconsistent with the factors for grate/kilns fired with coal or coke. The tests on furnaces with gas in combination with other fuels resulted in emission factors that fell within the range of the factors for the remaining three tests (0.065 to 0.14 lb/ton). Therefore, the data for the combination fuels were included in the candidate emission factor calculation.

Separate candidate emission factors also were developed from either one or two data sets for wet scrubber-controlled filterable PM emissions from grate/kilns fired with a combination of coal and oil (0.19 lb/ton), coke (0.10 lb/ton), and a combination of coke and coal (0.14 lb/ton). A factor also was developed from a single test for emission from a gas- and oil-fired grate/kiln controlled with an ESP (0.017 lb/ton).

4.3.1.1.2 Filterable PM-10. One data set was available for uncontrolled filterable PM-10 emissions from a grate/kiln (0.63 lb/ton). Two data sets were for multiclone-controlled filterable PM-10 emissions from gas-fired grate/kilns. The factors ranged from 0.12 lb/ton to 0.14 lb/ton and averaged 0.13 lb/ton.

4.3.1.1.3 Condensible PM. For emissions of condensible PM from grate/kilns producing acid pellets, eight data sets were identified. The grate/kilns tested were fired either with gas or a combination of gas and oil. For two of the data sets, emissions were controlled with venturi scrubbers, and the emission factors (0.0066 and 0.0015 lb/ton) were significantly lower than the factors for the other tests. Therefore, it was assumed that the scrubbers had a significant effect on emissions, and these two data sets were grouped separately. For one of the tests (Reference 52), the inorganic and organic fractions of the condensibles were quantified. These fractions are provided in the footnote to the emission factor table in the revised AP-42 section. In addition, data were available from two tests in which only the inorganic fraction of the condensibles were quantified. The data for these two tests were scaled up using the ratio of condensible organic PM to condensible inorganic PM derived from Reference 52. For the remaining two gas- and oil-fired grate/kilns, the candidate factor was calculated as 0.040 lb/ton. The resulting candidate emission factors were 0.022 lb/ton for uncontrolled, gas-fired grate/kilns and 0.00055 lb/ton for wet scrubber-controlled, gas-fired grate/kilns.

4.3.1.1.4 SO_2. For SO_2 emissions from grate/kilns producing acid pellets, data sets were grouped according to fuel types. In addition, the data for emissions controlled with scrubbers were grouped separately; the other controls (multiclones) were assumed to have no effect on SO_2 emissions. For gas-fired grate/kilns, four data sets were available. The candidate emission factor developed from these data is 0.29 lb/ton. Separate emission factors also were developed for uncontrolled SO_2 emissions from coke-fired grate/kilns (1.9 lb/ton) and for coke- and coal-fired grate/kilns (2.3 lb/ton) firing acid pellets.

For wet scrubber-controlled SO_2 emissions, a candidate emission factor was developed for gas-fired grate/kilns (0.053 lb/ton) based on the results of one test. Data also were available from one test on a coke-fired grate/kiln (1.3 lb/ton) and one test on a coke- and coal-fired grate/kiln (1.6 lb/ton).

For emissions for SO_2 from grate/kilns producing flux pellets, data were available for four emission tests, all of which were conducted on wet scrubber-controlled furnaces: one test on a gas-fired furnace (0.13 lb/ton), one test on a gas- and wood-fired furnace (0.14 lb/ton), one test on a coal-fired furnace (1.5 lb/ton), and one test on a coke- and coal-fired furnace (0.057 lb/ton). The data for the gas-fired and the gas- and wood-fired grate/kilns were comparable and were combined (0.14 lb/ton). The factor for the coal-fired furnace fell within the range spanned by the data for wet scrubber-controlled SO_2 from grate/kilns firing acid pellets. Therefore, the data for flux pellets were combined with acid pellet data to yield a candidate emission factor of 1.5 lb/ton. The data for the coke- and coal-fired grate/kiln producing flux pellets were inconsistent with the other SO_2 data and were discarded.

4.3.1.1.5 NO_x. For NO_x emissions from grate/kilns producing acid pellets, data sets were identified from four tests, all of which were conducted on gas-fired furnaces. The control devices for the furnaces tested were assumed to have negligible effects on NO_x emissions and the data sets were combined. For NO_x emissions from flux pellet production, data were available from one test on a gas-fired grate/kiln (1.4 lb/ton). Because the flux pellet data fell within the range spanned by the acid pellet data, all NO_x data were combined to yield a candidate emission factor of 1.5 lb/ton.

4.3.1.1.6 CO. For CO emissions from grate/kilns producing acid pellets, data were available from two tests on gas-fired grate/kilns. The candidate emission factor developed from these data is 0.014 lb/ton. For flux pellet production, data were available for one test of CO emissions from a coal- and coke-fired grate/kiln (0.10 lb/ton).

4.3.1.1.7 CO_2. For CO_2 emissions from grate/kilns producing acid pellets, data were available from 12 tests on 5 furnaces. Most of the tests were conducted on gas-fired grate/kilns; other fuels used included gas/oil, coke, and coal/oil. Because the range of the gas-fired furnace data encompassed the data for the furnaces fired with the other fuels, fuel type was ignored. Control devices also were assumed to have negligible effects on CO_2 emissions. The data ranged from 43 to 120 lb/ton, and the candidate emission factor was calculated as 99 lb/ton.

For CO_2 emissions from grate/kilns producing flux pellets, data were available from nine tests on seven furnaces. Both fuel type and emission control again were assumed to have no significant effects on CO_2 emissions and the data were all combined. The data ranged from 50 to 220 lb/ton, and the candidate emission factor was calculated as 130 lb/ton.

4.3.1.1.8 Other Pollutants. Emission factors also were developed for emissions of the following from grate/kiln furnaces: VOC as propane, lead, and sulfuric acid. For each of these, the emission factor was derived from one or two emission tests.

4.3.1.2 Vertical Shaft Furnaces. Most of the data on emissions from vertical shaft furnaces were based on tests conducted on the top gas stack only. All of the data pertain to gas-fired furnaces producing acid pellets. Factors were developed for the following pollutants: filterable PM, condensible PM, SO_2, NO_x, CO, CO_2, and VOC. Separate factors were developed for top gas stacks and for bottom gas stacks. For uncontrolled filterable PM (8 tests), test-specific factors for top gas stacks ranged from 7.1 to 25 lb/ton and averaged 16 lb/ton. For multiclone-controlled filterable PM (7 tests), the factors for top gas stacks ranged from 0.57 to 2.1 lb/ton and averaged 1.4 lb/ton. For CO_2 emissions from top gas vertical shaft furnace stacks (18 tests), the factors ranged from 51 to 210 lb/ton and averaged 94 lb/ton. The remaining factors all are based on a single emission test each and are presented in Table 4-5.

4.3.1.3 Straight Grate Furnaces. For straight grate furnaces, data were available for one test of NO_x emissions from the production of flux pellets; all other data were from tests on furnaces firing acid pellets. Data were available for emissions of filterable PM, SO_2, NO_x, CO, CO_2, lead, and beryllium emissions. Several data sets for filterable PM, SO_2, and CO_2 emissions were rated D and were discarded because data of higher quality were available. For each pollutant, one to three high quality data sets were remained. The candidate emission factors were developed from these data using the procedures described previously.

4.3.2 Other Sources

Data also were available for emissions (primarily, filterable PM) from several other taconite ore processing sources, including crushing, grinder feeding, hearth layer feeding, hearth layer screening, grate/kiln discharging, straight grate discharging, pellet cooling, conveyor transfer, and material storage bin loading. Appendix A (Table A-2) lists the data sets used for each candidate emission factor determination. The emission factors were determined using the procedures discussed in Section 3 of this report. These candidate emission factors are presented in Table 4-6.

4.4 SUMMARY OF CHANGES TO AP-42 SECTION

4.4.1 Section Narrative

Only minor changes were made to the narrative of Section 11.23. The description of the industry structure was expanded. The process description also was expanded slightly to account for emission sources not previously addressed in the AP-42 section. In addition, the process flow diagram was modified to be consistent with the process description, and SCC's were added to the figure.

4.4.2 Emission Factors

The emission factor tables for the AP-42 section were completely revised to incorporate the emission factors developed from the additional test data. The previous versions of the section presented emission factors for PM emissions only; the revised section includes factors for filterable PM, PM-10, PM-2.5, SO_2, NO_x, CO, CO_2, and other pollutants. The previous AP-42 section presented factors for uncontrolled emissions only, but included a table of control device efficiencies; the revised section includes factors for both controlled and uncontrolled emissions. In addition, the table of control efficiencies was eliminated because the table was based on old data that may not be representative of the control efficiencies achieved currently, and because many of the efficiencies in the table were not based on emission test data. The other major change to the emission factors was that the factors for fugitive dust emissions from haul road traffic were eliminated because the predictive emission factor equations presented in AP-42 Section 13.2 are based on more data and are considered to provide more reliable estimates of emissions than the fugitive dust factors presented previously in the taconite ore processing AP-42 section.

4.5 CROSS-REFERENCE OF DOCUMENTS REVIEWED

Table 4-7 presents a cross-reference of the documents reviewed as part of this study, with the reference numbers that correspond to each document in this background report and the AP-42 section. It should be noted that many of the references used in the revised AP-42 section have different reference numbers where they are discussed in Chapters 2 and 4 of this background report.

4.6 NEW SOURCE CLASSIFICATION CODES FOR TACONITE ORE PROCESSING

During the process of revising the AP-42 section on taconite ore processing, several new SCCs were assigned. Table 4-8 presents a complete list of SCCs for this source category.

TABLE 4-7. CROSS-REFERENCE OF DOCUMENTS REVIEWED

Background report		AP-42 section Ref. No.
Chapter	Ref. No.	
2	1	1
2	2	2
2	3	3
2	4	5
2	5	Not used
2	6	41
4	1	4
4	2	5
4	3	6
4	4	2
4	5, 6	Not used
4	7	7
4	8	8
4	9	9
4	10	10
4	11	11
4	12	12
4	13	13
4	14	14
4	15	15
4	16	16
4	17	17
4	18	18
4	19	19
4	20	20
4	21	21

Background report		AP-42 section Ref. No.
Chapter	Ref. No.	
4	22	22
4	23	23
4	24	24
4	25	25
4	26	26
4	27	27
4	28	28
4	29	29
4	30	30
4	31	31
4	32	32
4	33	33
4	34	34
4	35	35
4	36 to 45	Not used
4	46	36
4	47	37
4	48	38
4	49	39
4	50, 51	Not used
4	52	40
4	53	41
4	54	42
4	55	43
4	56	44
4	57	45

TABLE 4-8. SOURCE CLASSIFICATION CODES FOR TACONITE ORE PROCESSING

SCC	Descripton	Units
3-03-023-01	Primary crushing	lb/ton material crushed
3-03-023-02	Fines crushing	lb/ton material crushed
3-03-023-03	Ore screening	lb/ton material screened
3-03-023-04	Ore transfer	lb/ton material transferred
3-03-023-05	Ore storage	lb/ton material stored
3-03-023-06	Dry grinding/milling	lb/ton material ground
3-03-023-07	Bentonite storage	lb/ton bentonite stored
3-03-023-08	Bentonite blending	lb/ton bentonite added
3-03-023-09	Traveling grate feed	lb/ton pellets produced
3-03-023-10	Traveling grate discharge	lb/ton pellets produced
3-03-023-11	Chip regrinding	lb/ton material reground
3-03-023-12	Indurating furnace: gas-fired	lb/ton pellets produced
3-03-023-13	Indurating furnace: oil-fired	lb/ton pellets produced
3-03-023-14	Indurating furnace: coal-fired	lb/ton pellets produced
3-03-023-15	Pellet cooler	lb/ton pellets produced
3-03-023-16	Pellet transfer to storage	lb/ton pellets produced
3-03-023-17	Magnetic separation	lb/ton material fed
3-03-023-18	Non-magnetic separation	lb/ton material fed
3-03-023-19	Kiln	lb/ton pellets produced
3-03-023-20	Conveyors, transfer, and loading	lb/ton pellets produced
3-03-023-21	Haul road: rock	lb/vehicle-mile travelled
3-03-023-22	Haul road: taconite	lb/vehicle-mile travelled
3-03-023-25	Primary crusher return conveyor transfer	lb/ton material transferred
3-03-023-27	Secondary crushing line (includes feed and discharge points)	lb/ton material crushed
3-03-023-28	Secondary crusher return conveyor transfer	lb/ton material transferred
3-03-023-30	Tertiary crushing line (includes feed and discharge points)	lb/ton material crushed
3-03-023-31	Tertiary crushing line discharge conveyor	lb/ton material transferred
3-03-023-34	Grinder feed	lb/ton material ground
3-03-023-36	Classification	lb/ton material fed
3-03-023-38	Secondary grinding	lb/ton material ground
3-03-023-40	Tailings basin	lb/ton pellets produced
3-03-023-41	Conveyor transfer to concentrator	lb/ton material transferred
3-03-023-44	Concentrate storage	lb/ton material stored

TABLE 4-8. (continued)

SCC	Descripton	Units
3-03-023-45	Bentonite transfer to blending	lb/ton material transferred
3-03-023-47	Green pellet screening	lb/ton material fed
3-03-023-48	Hearth layer feed to furnace	lb/ton pellets produced
3-03-023-49	Grate/kiln furnace feed	lb/ton pellets produced
3-03-023-50	Grate/kiln furnace discharge	lb/ton pellets produced
3-03-023-51	Induration: grate/kiln, gas-fired, acid pellets	lb/ton pellets produced
3-03-023-52	Induration: grate/kiln, gas-fired, flux pellets	lb/ton pellets produced
3-03-023-53	Induration: grate/kiln, gas- and oil-fired, acid pellets	lb/ton pellets produced
3-03-023-54	Induration: grate/kiln, gas- and oil-fired, flux pellets	lb/ton pellets produced
3-03-023-55	Induration: grate/kiln, coke-fired, acid pellets	lb/ton pellets produced
3-03-023-56	Induration: grate/kiln, coke-fired, flux pellets	lb/ton pellets produced
3-03-023-57	Induration: grate/kiln, coke- and coal-fired, acid pellets	lb/ton pellets produced
3-03-023-58	Induration: grate/kiln, coke- and coal-fired, flux pellets	lb/ton pellets produced
3-03-023-59	Induration: grate/kiln, coal-fired, acid pellets	lb/ton pellets produced
3-03-023-60	Induration: grate/kiln, coal-fired, flux pellets	lb/ton pellets produced
3-03-023-61	Induration: grate/kiln, coal- and oil-fired, acid pellets	lb/ton pellets produced
3-03-023-62	Induration: grate/kiln, coal- and oil-fired, flux pellets	lb/ton pellets produced
3-03-023-69	Vertical shaft furnace feed	lb/ton pellets produced
3-03-023-70	Vertical shaft furnace discharge	lb/ton pellets produced
3-03-023-71	Induration: vertical shaft, gas-fired, acid pellets, top gas stack	lb/ton pellets produced
3-03-023-72	Induration: vertical shaft, gas-fired, flux pellets, top gas stack	lb/ton pellets produced
3-03-023-73	Induration: vertical shaft, gas-fired, acid pellets, bottom gas stack	lb/ton pellets produced
3-03-023-74	Induration: vertical shaft, gas-fired, flux pellets, bottom gas stack	lb/ton pellets produced
3-03-023-79	Straight grate furnace feed	lb/ton pellets produced
3-03-023-80	Straight grate furnace discharge	lb/ton pellets produced
3-03-023-81	Induration: straight grate, gas-fired, acid pellets	lb/ton pellets produced
3-03-023-82	Induration: straight grate, gas-fired, flux pellets	lb/ton pellets produced
3-03-023-83	Induration: straight grate, oil-fired, acid pellets	lb/ton pellets produced
3-03-023-84	Induration: straight grate, oil-fired, flux pellets	lb/ton pellets produced
3-03-023-85	Induration: straight grate, coke-fired, acid pellets	lb/ton pellets produced
3-03-023-86	Induration: straight grate, coke-fired, flux pellets	lb/ton pellets produced

TABLE 4-8. (continued)

SCC	Descripton	Units
3-03-023-87	Induration: straight grate, coke- and gas-fired, acid pellets	lb/ton pellets produced
3-03-023-88	Induration: straight grate, coke- and gas-fired, flux pellets	lb/ton pellets produced
3-03-023-93	Hearth layer screen	lb/ton pellets produced
3-03-023-95	Pellet screen	lb/ton pellets produced
3-03-023-96	Pellet storage bin loading	lb/ton pellets produced
3-03-023-97	Secondary storage bin loading	lb/ton pellets produced
3-03-023-98	Tertiary storage bin loading	lb/ton pellets produced
3-03-023-99	Other not classified	lb/ton pellets produced

REFERENCES FOR SECTION 4

1. *Air Pollution Emissions Test, Eveleth Taconite, Eveleth, MN*, EMB 76-IOB-3. U. S. Environmental Protection Agency, Research Triangle Park, NC, November 1975.

2. *Air Pollution Emission Test, Empire Mining Company, Palmer, MI*, EMB 76-IOB-2, U. S. Environmental Protection Agency, Research Triangle Park, NC, November 1975.

3. *Emission Testing Report, Reserve Mining Company, Silver Bay, MN*, EMB 74-HAS-1, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1974.

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6. *Results of the April 30, 1985, Particulate and SO_2 Emission Test on the No. 3 Machine Wind Box and Hood Exhaust No. 4 Scrubber Stack at the Hibbing Taconite Company Plant*, Hibbing, MN, Interpoll, Inc., Circle Pines, MN, May 16, 1985.

7. *Results of the January 1977 Particulate Emission Testing of Crusher Feed Mill Scrubbers Nos. 2, 3, 5, and 6 Conducted at the Hibbing Taconite Company*, Hibbing, MN, Interpoll, Inc., St. Paul, MN, June 8, 1977.

8. *Results of the June 27-July 1, 1977 Particulate Emission Tests Conducted on Selected Sources in the Pelletizer Building at the Hibbing Taconite Company Plant*, Hibbing, MN, Interpoll, Inc., St. Paul, MN, August 16, 1977.

9. *Phase II Particulate Emissions Compliance Testing*, Hibbing Taconite Company, Hibbing, MN, September 4-6, 1979.

10. *Results of the March 15, 1990 Dust Collector Performance Test on the No. 1 Crusher Primary Dust Collector at the Cyprus Northshore Mining Facility in Babbitt, MN*, Interpoll Laboratories, Inc., Circle Pines, MN, April 19, 1990.

11. *Results of the March 9, 1990 Dust Collector Performance Test on the No. 1 Crusher Secondary Collector at the Cyprus Northshore Mining Facility in Babbitt, MN*, Interpoll Laboratories, Inc., Circle Pines, MN, April 18, 1990.

12. *Results of the May 22 and 23, 1984, Dust Collection Efficiency Tests on the D-2 and E-2 Furnace Top Gas Mechanical Collectors at the Erie Mining Company Pellet Plant Near Hoyt Lakes, MN*, Interpoll, Inc., Circle Pines, MN, May 29, 1984.

13. *Results of the December 17, 1981 Compliance Test on the D-2 Furnace Dust Control System at the Erie Mining Company Pellet Plant Near Hoyt Lakes, MN*, Interpoll, Inc., St. Paul, MN, December 22, 1981.

14. *Results of the February 20, 1980 Particulate Emission Test on the D-1 Furnace Top Gas Wet Collector at the Erie Mining Company Plant Near Hoyt Lakes, MN*, Interpoll, Inc., St. Paul, MN, March 4, 1980.

15. *Results of the October 12-15, 1987 Air Emission Compliance Tests at the Eveleth Taconite Plant in Eveleth, MN*, Interpoll Laboratories, Inc., Circle Pines, MN, December 18, 1987.

16. *Results of the July 9, 1981 Particulate Emission Compliance Test on the Kiln Cooler Exhaust Stack at Eveleth Mines, Eveleth, MN*, Interpoll Laboratories, Inc., St. Paul, MN, July 22, 1981.

17. *Results of the March 11, 1980 Particulate Emission Compliance Test on the Kiln Cooler Exhaust Stack at Eveleth Mines, Eveleth, MN*, Interpoll, Inc., St. Paul, MN, April 18, 1980.

18. *Results of the December 13 and 14, 1979 Particulate Emission Compliance Tests on the Kiln Cooler Exhaust and the 2A Waste Gas Stacks at the Eveleth Expansion Company Plant Near Eveleth, MN*, Interpoll, Inc., St. Paul, MN, January 22, 1980.

19. *Results of the June 12, 1975 Oxides of Nitrogen Determinations at the Fairlane Plant Pellet Furnace Wet Scrubber Inlet and Outlet*, Eveleth Taconite Company, Eveleth, MN, Interpoll, Inc., St. Paul, MN, June 30, 1975.

20. *Results of the March/April 1992 Emission Performance Tests on the Nos. 4 and 5 Scrubber Stacks at the USS Minnesota Ore Operations Facility in Mountain Iron, MN*, Interpoll Laboratories, Inc., Circle Pines, MN, April 23, 1992.

21. *Results of the February 18 and 19, 1992 Particulate Emission Performance Testing on Two SEI Multiple Throat Venturi Type Wet Scrubber Systems at the USS Minnesota Ore Operations Facility, Mountain Iron, MN*, Interpoll Laboratories, Inc., Circle Pines, MN, March 11, 1992.

22. *Crusher Environeering Wet Scrubber Dust Collectors Particulate Emissions Compliance Testing Hibbing Taconite Company*, Hibbing, MN, October 18, 1982.

23. *Results of the June 25 and 26, 1980 Particulate Emission Compliance Tests on the No. 2 Loading Pocket Collector and the Nos. 7 and 8 Pellet Screen Collector at the Erie Mining Company Plant Near Hoyt Lakes, MN*, Interpoll, Inc., St. Paul, MN, July 7, 1980.

24. *Results of the June 12-15, 1984, Dust Collection Efficiency Tests on the D-2 and E-2 Furnace Top Gas Mechanical Collectors at the Erie Mining Company Pellet Plant Near Hoyt Lakes, MN*, Interpoll, Inc., Circle Pines, MN, June 22, 1984.

25. *Results of the August 6, 1991 SO_2 Emission Engineering Tests at the USX Minnesota Ore Operation Facility in Mountain Iron, MN*, Interpoll Laboratories, Inc., Circle Pines, MN, August 15, 1991.

26. *Results of the January 25, 1990 Particulate and Sulfur Dioxide Engineering Emission Test on the Line 7 Grate Kiln at the USX Minnesota Ore Operation Facility*, Mountain Iron, MN, Interpoll Laboratories, Inc., Circle Pines, MN, March 7, 1990.

27. *Results of the March 28-31, 1989 Air Emission Compliance Testing at the USS Plant in Mountain Iron, MN*, Interpoll Laboratories, Inc., Circle Pines, MN, April 21, 1989.

28. *Results of the January 8-10, 1980 Particulate Emission Compliance Tests on Emission Source Nos. 6.39, 6.40, 6.34, 6.44, 6.41, 6.56, 6.43, 8.43, 8.47, and 8.49 at the U.S. Steel Minntac Plant in Mountain Iron, MN*, Interpoll, Inc., St. Paul, MN, February 8, 1980.

29. *Results of the May 21 and 22, 1987 Particulate and SO_2/SO_3 Emission Compliance Tests on the Line 2 Induration Furnace Waste Gas Systems at the Eveleth Taconite Plant in Eveleth, MN*, Interpoll Inc., Circle Pines, MN, June 25, 1987.

30. *Results of the August 6-8, 1986, Particulate and SO_2 Compliance Tests on the Indurating Gas Wet Scrubber Stacks at the Inland Steel Mining Company in Virginia, MN*, Interpoll Inc., Circle Pines, MN, August 19 1986.

31. *Results of the May 5-7, 1987, Atmospheric Emission Tests on the Induration Furnaces at the Hibbing Taconite Company in Hibbing, MN*, Interpoll, Inc., Circle Pines, MN, May 14, 1987.

32. *Particulate Emissions Testing for National Steel Pellet Company*, Keewatin, MN, Waste Gas Stack No. 2B, June 17, 1992, Shell Engineering and Associates, Inc., Columbia, MO, July 17, 1992.

33. *Particulate Emissions Testing for National Steel Pellet Company*, Keewatin, MN, Waste Gas Stack No. 2A, June 5, 1991, Shell Engineering and Associates, Inc. Columbia, MO, June 28, 1991.

34. *Particulate Emissions Testing for National Steel Pellet Company*, Keewatin, MN, Waste Gas Stack No. 2B, May 16, 1990, Shell Engineering and Associates, Inc., Columbia, MO, May 30, 1990.

35. *Particulate Emissions Testing for National Steel Pellet Company*, Keewatin, MN, Waste Gas Stack No. 2A, June 7, 1989, Shell Engineering and Associates, Inc., Columbia, MO, June 14, 1989.

36. *Particulate Emissions Testing for National Steel Pellet Company*, Keewatin, MN, Six Sources, July and August, 1988.

37. *Results of the April 17-19, 1990, Particulate Emission Compliance Tests on Four Sources at the Cyprus Northshore Mining Facility in Silver Bay, MN*, Interpoll Laboratories, Inc., Circle Pines, MN, May 4, 1990.

38. *Results of the January 23 and 24, 1979 Particulate Emission Compliance Tests on the 2A Waste Gas, The Kiln Cooler and the Grate Feed End Stacks at the Eveleth Expansion Company Plant*, Eveleth, MN, Interpoll Inc., St. Paul, MN, February 9, 1979.

39. *Results of the August 20, 1985, Particulate and SO_2 Emission Test on the No. 1 Machine Wind Box and Hood Exhaust No. 3 Scrubber Stack at the Hibbing Taconite Company Plant*, Hibbing, MN, Interpoll, Inc., Circle Pines, MN, August 30, 1985.

40. *Results of the October 23, and 24, 1979, Particulate Emission Compliance Tests on the Coarse Crusher Discharge, Crusher Dump Pocket Discharge and North Loading Tunnel at the Eveleth Taconite Company Thunderbird Mine*, Eveleth, MN, Interpoll, Inc., Circle Pines, MN, November 28, 1979.

41. *Results of the January 7-9, 1992 Engineering Scrubber Performance Tests at the Cyprus Northshore Mining Facility in Silver Bay, MN*, Interpoll Laboratories, Inc., Circle Pines, MN, February 6, 1992.

42. *Results of the July 24-27, 1990 Air Emission Compliance Tests on the Nos. 11 and 12 Pelletizers and the No. 2 Power Boiler at the Cyprus Northshore Mining Facility in Silver Bay, MN*, Interpoll Laboratories, Inc., Circle Pines, MN, October 21, 1990.

43. *Results of the September NO_x Emission Tests on the Induration Furnace Scrubbers, Inland Steel Mining Company*, Virginia, MN, Interpoll Laboratories, Inc., Circle Pines, MN, October 18, 1991.

44. *Results of the March 12, 1991 Efficiency Test on the No. 1 Primary Crusher Dust Collector at the Cyprus Northshore Mining Facility in Babbitt, MN*, Interpoll Laboratories, Inc., Circle Pines, MN, April 9, 1991.

45. T. R. Cuscino, *et al*., *Taconite Mining Fugitive Emissions Study,* Minnesota Pollution Control Agency, Roseville, MN, June 1979.

46. *Results of the October 13, 1994 National Steel Pellet Company Particulate and Visible Waste Gas Stack 2B Emissions Compliance Test*, Barr Engineering Company, Minneapolis, MN, November 1994.

47. *Results of the April 28, 1993 State Air Emission Compliance Testing on the No. 4 and 5 Pelletizers at the U.S. Steel Plant in Mountain Iron, MN*, Interpoll Laboratories, Inc., Circle Pines, MN, June 10, 1993.

48. *Results of the July 31 and August 1, 1990 NO_x Emission Compliance Test on the Flux Pellet Induration Furnace at the Inland Steel Mining Plant*, Interpoll Laboratories, Inc., Circle Pines, MN, October 10, 1990.

49. *Results of the September 12, 16, 23, and October 12, 1994 National Steel Pellet Company Waste Gas Stack 2B Emission Tests*, Barr Engineering Company, Minneapolis, MN, November 1994.

50. *Results of the January 10-13, 1995 Air Emission Compliance Testing at the Northshore Mining Facility in Silver Bay, Minnesota*, Interpoll Laboratories, Inc., Circle Pines, MN, January 25, 1995.

51. *Results of the May 24-27, 1994 Air Emission Testing at the Northshore Mining Facility in Silver Bay, Minnesota*, Interpoll Laboratories, Inc., Circle Pines, MN, July 6, 1994.

52. *Results of the March 25, 1994 Air Emission Engineering Tests on the No. 3 Waste Gas Stack at the US Steel Plant in Mountain Iron, Minnesota*, Interpoll Laboratories, Inc., Circle Pines, MN, April 1994.

53. Written communication from P. O'Neill, Minnesota Pollution Control Association, Minneapolis, MN, to R. E. Myers, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 20, 1996.

54. *Results of the June 22, 1993 Particulate and Opacity Compliance Tests Conducted on the No. 2A Waste Gas Stack at the National Steel Pellet Plant in Keewatin, Minnesota*, Interpoll Laboratories, Inc., Circle Pines, MN, July 26, 1993.

55. *Results of the June 6, 1995 National Steel Pellet Company Particulate Emission Compliance Test Waste Gas Stack 2A (Emission Point 30)*, Barr Engineering Company, Minneapolis, MN, June 1995.

56. Written Communication from D. Koschak, LTV Steel Mining Company, Hoyt Lakes, MN, to S. Arkley, Minnesota Pollution Control Association, Minneapolis, MN. October 31, 1995.

57. *Results of the July 11 - 13, 1995 State Air Emission Performance Testing at the LTV Steel Mining Plant Company Pellet Plant in Hoyt Lakes, Minnesota (Permit No. 48B-95-1/O-1)*, Interpoll Laboratories, Inc., Circle Pines, MN, August 28, 1995.

5. REVISED AP-42 SECTION 11.23

The revised AP-42 Section 11.23, Taconite Ore Processing, is presented in the following pages as it appears in the document.

APPENDIX A.

SUMMARY OF CANDIDATE EMISSION FACTOR CALCULATIONS FOR AP-42 SECTION 11.23, TACONITE ORE PROCESSING

SUMMARY OF CANDIDATE EMISSION FACTOR CALCULATIONS FOR AP-42 SECTION 11.23, TACONITE ORE PROCESSING

The following tables summarize the calculations that were used to develop the candidate emission factors for taconite ore processing. Table A-1 summarizes the calculations for indurating furnace emission factors, and Table A-2 summarizes the calculations for emission factors for other taconite ore processing sources.

The candidate emission factors generally were calculated as the mean of the test-specific emission factors for each emission factor category. However, several of the candidate emission factors for indurating furnaces (Table A-1) are based on multiple tests on the same furnace. In such cases, the mean emission factor for each furnace was calculated first, followed by the mean of the factors across all of the furnaces for which data were available. The entry in the comment column indicates the furnaces for which there were multiple data points.

Table A-1 can be found in spreadsheet file TAC_TA-1.wk3

TABLE A-1. CALCULATION OF CANDIDATE EMISSION FACTORS FOR TACONITE ORE INDURATING FURNACES.

Type	Fuel	Control	Pollutant	Pellet type	No. of tests	Emission factor, lb/ton			Data rat.	Ref.	Comment
						Minimum	Maximum	Average			
grate/kiln	gas	none	filt. PM	acid				5.1	A	52	
grate/kiln	gas	none	filt. PM	acid				15	B	1	
grate/kiln	gas/oil	none	filt. PM	acid				2.2	A	2	
Gas-fired grate/kiln					3	2.2	15	7.4			
grate/kiln	gas	VS	filt. PM	acid				0.58	B	1	Discarded; factor order of magnitude higher than others
grate/kiln	gas	VS	filt. PM	flux				0.057	B	20	
grate/kiln	gas	WS	filt. PM	flux				0.14	C	27	Furnace P
grate/kiln	gas	VS	filt. PM	flux				0.065	A	47	
grate/kiln	gas/oil	VS	filt. PM	flux				0.065	A	47	
grate/kiln	gas/wood	VS	filt. PM	flux				0.081	B	20	
Gas-fired grate/kiln with scrubber					5	0.057	0.14	0.082			
grate/kiln	coal/oil	WS	filt. PM	acid				0.19	C	18	Furnace M
Coal/oil-fired grate/kiln with scrubber					1	NA	NA	0.19			
grate/kiln	coke	WS	filt. PM	acid				0.10	B	29	Furnace M
Coke-fired grate/kiln with scrubber					1	NA	NA	0.10			
grate/kiln	coke/coal	WS	filt. PM	flux				0.12	C	26	Furnace P
grate/kiln	coke/coal	WS	filt. PM	flux				0.15	C	27	
Coke/coal-fired grate/kiln with scrubber					2	0.12	0.15	0.14			
grate/kiln	gas/oil	ESP	filt. PM	acid				0.017	A	2	
Gas/oil-fired grate/kiln with ESP					1	NA	NA	0.017			
grate/kiln	gas	MC	filt. PM	acid				1.1	C	34	Furnace V
grate/kiln	gas	MC	filt. PM	acid				0.33	B	49	Furnace V
grate/kiln	gas	MC	filt. PM	acid				0.77	C	35	Furnace V
grate/kiln	gas	MC	filt. PM	acid				0.43	C	54	Furnace V
grate/kiln	gas	MC	filt. PM	acid				0.42	C	33	Furnace V
grate/kiln	gas	MC	filt. PM	acid				0.84	C	55	Furnace V
grate/kiln	gas	MC	filt. PM	acid				0.31	C	32	Furnace V
grate/kiln	gas	MC	filt. PM	semi-flux				0.32	B	49	Furnace V
grate/kiln	gas	MC	filt. PM	flux				0.32	B	46	
Gas-fired grate/kiln with multiclone					9	0.31	1.1	0.44			
grate/kiln	gas	none	filt. PM-10	acid				0.63	A	52	
Gas-fired grate/kiln					1	NA	NA	0.63			

TABLE A-1. (Continued)

Type	Fuel	Control	Pollutant	Pellet type	No. of tests	Emission factor, lb/ton			Data rat.	Ref.	Comment
						Minimum	Maximum	Average			
grate/kiln	gas	MC	filt. PM-10	acid				0.14	B	49	Furnace V
grate/kiln	gas	MC	filt. PM-10	semi-flux				0.12	B	49	Furnace V
Gas-fired grate/kiln with multiclone					2	0.12	0.14	0.13			
grate/kiln	gas	none	cond. PM	acid				0.013	A	52	
grate/kiln	gas	MC	cond. PM	acid				0.035	B	49	Furnace V
grate/kiln	gas	MC	cond. PM	semi-flux				0.032	B	49	Furnace V
grate/kiln	gas	MC	cond. PM	flux				0.014	B	46	
grate/kiln	gas	none	cond. PM	acid				0.018	C	1	Scaled up using Ref. 52 data
Gas-fired grate/kiln					4	0.013	0.035	0.022			
grate/kiln	gas/oil	none	cond. PM	acid				0.035	B	2	
grate/kiln	gas/oil	ESP	cond. PM	acid				0.045	B	2	
Gas/oil-fired grate/kiln					2	0.035	0.045	0.040			
grate/kiln	gas	VS	cond. PM	flux				0.0066	A	47	
grate/kiln	gas/oil	VS	cond. PM	flux				0.0015	A	47	
grate/kiln	gas	VS	cond. PM	acid				0.0083	C	1	Scaled up using Ref. 52 data
Gas-fired grate/kiln with scrubber					2	0.0015	0.0066	0.0055			
grate/kiln	gas	none	cond. inorg. l	acid				0.10	A	52	Data used to estimate
grate/kiln	gas	none	con. org. PM	acid				0.019	A	52	organic/inorg. fractions
grate/kiln	gas	none	cond. inorg. l	acid				0.015	C	1	Used to estimate cond. PM
grate/kiln	gas	VS	cond. inorg. l	acid				0.0070	C	1	Used to estimate cond. PM
grate/kiln	gas	none	SO2	acid				0.71	A	52	
grate/kiln	gas	none	SO2	acid				0.089	B	1	
grate/kiln	gas	MC	SO2	semi-flux				0.19	B	49	Furnace V
grate/kiln	gas	MC	SO2	acid				0.17	B	49	Furnace V
Gas-fired grate/kiln, acid pellets					4	0.089	0.71	0.29			
grate/kiln	coke	none	SO2	acid				1.9	B	29	
Coke-fired grate/kiln, acid pellets					1	NA	NA	1.9			
grate/kiln	coke/coal	none	SO2	acid				2.3	C	15	
Coke/coal-fired grate/kiln, acid pellets					1	NA	NA	2.3			
grate/kiln	gas	VS	SO2	acid				0.053	B	1	
Gas-fired grate/kiln, acid pellets, with scrubber					1	NA	NA	0.053			
grate/kiln	gas	VS	SO2	flux				0.13	B	20	
grate/kiln	gas/wood	VS	SO2	flux				0.14	B	20	
Gas-fired grate/kiln, flux pellets, with scrubber					2	0.13	0.14	0.14			

TABLE A-1. (Continued)

Type	Fuel	Control	Pollutant	Pellet type	No. of tests	Emission factor, lb/ton			Data rat.	Ref.	Comment
						Minimum	Maximum	Average			
grate/kiln	coal	WS	SO2	flux				1.5	C	25	Furnace P
grate/kiln	coke	WS	SO2	acid				1.3	B	29	Furnace M
grate/kiln	coke/coal	WS	SO2	acid				1.6	C	15	Furnace M
Coal and/or coke-fired grate/kiln, acid/flux pellets, with scrubber					1	1.3	1.6	1.5			
grate/kiln	coke/coal	WS	SO2	flux				0.057	C	26	Discarded; results inconsistent
Coke/coal-fired grate/kiln, flux pellets, with scrubber					1	NA	NA	0.057			
grate/kiln	gas	none	NOx	acid				2.0	C	19	Furnace M
grate/kiln	gas	WS	NOx	acid				1.6	C	19	Furnace M
grate/kiln	gas	MC	NOx	semi-flux				1.2	B	49	Furnace V
grate/kiln	gas	MC	NOx	acid				1.5	B	49	Furnace V
grate/kiln	gas	WS	NOx	flux				1.4	C	27	Furnace P
Gas-fired grate/kiln, acid/flux pellets					1	1.2	2.0	1.5			
grate/kiln	gas	MC	CO	acid				0.014	B	49	Furnace V
grate/kiln	gas	MC	CO	semi-flux				0.013	B	49	Furnace V
Gas-fired grate/kiln, acid pellets					2	0.013	0.014	0.014			
grate/kiln	coke/coal	WS	CO	flux				0.10	C	27	
Coal/coke-fired grate/kiln, flux pellets					1	NA	NA	0.10			
grate/kiln	gas	none	CO2	acid				120	A	52	
grate/kiln	gas	none	CO2	acid				120	A	52	
grate/kiln	gas/oil	none	CO2	acid				110	A	2	
grate/kiln	coke	none	CO2	acid				110	C	29	Furnace M
grate/kiln	coal/oil	WS	CO2	acid				70	C	18	Furnace M
grate/kiln	coke	WS	CO2	acid				100	B	29	Furnace M
grate/kiln	gas	MC	CO2	acid				50	C	32	Furnace V
grate/kiln	gas	MC	CO2	acid				70	C	34	Furnace V
grate/kiln	gas	MC	CO2	acid				54	C	54	Furnace V
grate/kiln	gas	MC	CO2	acid				45	B	49	Furnace V
grate/kiln	gas	MC	CO2	semi-flux				61	B	49	Furnace V
grate/kiln	gas	MC	CO2	acid				43	C	33	Furnace V
Grate/kiln, acid pellets					12	43	120	99			

TABLE A-1. (Continued)

Type	Fuel	Control	Pollutant	Pellet type	No. of tests	Emission factor, lb/ton			Data rat.	Ref.	Comment
						Minimum	Maximum	Average			
grate/kiln	gas	VS	CO2	flux				120	B	20	
grate/kiln	gas	WS	CO2	flux				150	C	27	Furnace P
grate/kiln	gas	VS	CO2	flux				120	A	47	
grate/kiln	gas/oil	VS	CO2	flux				120	A	47	
grate/kiln	gas/wood	VS	CO2	flux				130	B	20	
grate/kiln	coal	WS	CO2	flux				220	C	25	Furnace P
grate/kiln	coke/coal	WS	CO2	flux				210	C	27	
grate/kiln	coke/coal	WS	CO2	flux				200	C	26	Furnace P
grate/kiln	gas	MC	CO2	flux				50	B	46	
Grate/kiln, flux pellets					9	50	220	130			
grate/kiln	gas	MC	VOC	semi-flux				0.0035	B	49	Furnace V, Method 25A data
grate/kiln	gas	MC	VOC	acid				0.0038	B	49	Furnace V, Method 25A data
Gas-fired grate/kiln, acid pellets					2	0.0035	0.0038	0.0037			
grate/kiln	gas	MC	lead	acid				0.00050	B	49	Furnace V
Gas-fired grate/kiln					1	NA	NA	0.00050			
grate/kiln	coke	none	H2SO4	acid				0.17	B	29	
Coke-fired grate/kiln					1	NA	NA	0.17			
grate/kiln	coke	WS	H2SO4	acid				0.099	B	29	
Coke-fired grate/kiln, with scrubber					1	NA	NA	0.099			
grate/kiln	coke/coal	WS	VOC	flux				0.075	C	27	As measured by Method 25
Coke/coal-fired grate/kiln					1	NA	NA	0.075			
vertical shaft-t	gas	none	filt. PM	acid				18	C	12	Furnace J
vertical shaft-t	gas	none	filt. PM	acid				7.1	C	13	Furnace K
vertical shaft-t	gas	none	filt. PM	acid				12	C	24	Furnace J
vertical shaft-t	gas	none	filt. PM	acid				15	C	24	Furnace K
vertical shaft-t	gas	none	filt. PM	acid				16	C	24	Furnace J
vertical shaft-t	gas	none	filt. PM	acid				22	C	14	
vertical shaft-t	gas	none	filt. PM	acid				25	C	12	Furnace K
vertical shaft-t	gas	none	filt. PM	acid				20	C	24	Furnace K
Gas-fired vertical furnace, top gas stack					8	7.1	25	16			

TABLE A-1. (Continued)

Type	Fuel	Control	Pollutant	Pellet type	No. of tests	Emission factor, lb/ton			Data rat.	Ref.	Comment
						Minimum	Maximum	Average			
vertical shaft-t	gas	MC	filt. PM	acid				2.1	C	12	Furnace K
vertical shaft-t	gas	MC	filt. PM	acid				0.57	C	13	
vertical shaft-t	gas	MC	filt. PM	acid				1.6	C	24	Furnace J
vertical shaft-t	gas	MC	filt. PM	acid				1.1	C	24	Furnace K
vertical shaft-t	gas	MC	filt. PM	acid				1.1	C	24	Furnace J
vertical shaft-t	gas	MC	filt. PM	acid				1.5	C	24	Furnace K
vertical shaft-t	gas	MC	filt. PM	acid				2.0	C	12	Furnace J
Gas-fired vertical furnace, top gas stack, with multiclone					7	0.57	2.1	1.4			
vertical shaft-t	gas	WS	filt. PM	acid				0.92	C	57	Furnace W
Gas-fired vertical furnace, top gas stack, with scrubber					1	NA	NA	0.92			
vertical shaft-t	gas	MC/WS	filt. PM	acid				0.66	C	14	
Gas-fired vertical furnace, top gas stack, with multiclone/scrubber					1	NA	NA	0.66			
vertical shaft-b	gas	RC	filt. PM	acid				0.031	C	57	Furnace W
Gas-fired vertical furnace, bottom gas stack, with rotoclone					1	NA	NA	0.031			
vertical shaft-t	gas	WS	cond. PM	acid				0.050	C	57	Furnace W
Gas-fired vertical furnace, top gas stack, with scrubber					1	NA	NA	0.050			
vertical shaft-t	gas	WS	total PM	acid				0.14	C	56	Discarded; results inconsistent with filt. and cond. PM totals
vertical shaft-b	gas	RC	cond. PM	acid				0.0086	C	57	Furnace W
Gas-fired vertical furnace, bottom gas stack, with rotoclone					1	NA	NA	0.0086			
vertical shaft-b	gas	RC	total PM	acid				0.022	C	56	Discarded; results inconsistent with filt. and cond. PM totals
vertical shaft-t	gas	WS	SO2	acid				0.28	C	56	Furnace W
Gas-fired vertical furnace, top gas stack, acid pellets, with scrubber					1	NA	NA	0.28			
vertical shaft-t	gas	WS	NOx	acid				0.20	C	56	Furnace W
Gas-fired vertical furnace, top gas stack, acid pellets					1	NA	NA	0.20			
vertical shaft-t	gas	WS	CO	acid				0.077	C	56	Furnace W
Gas-fired vertical furnace, top gas stack, acid pellets					1	NA	NA	0.077			

TABLE A-1. (Continued)

Type	Fuel	Control	Pollutant	Pellet type	No. of tests	Emission factor, lb/ton			Data rat.	Ref.	Comment
						Minimum	Maximum	Average			
vertical shaft-t	gas	none	CO2	acid				72	C	12	Furnace K
vertical shaft-t	gas	none	CO2	acid				64	C	24	Furnace J
vertical shaft-t	gas	none	CO2	acid				54	C	24	Furnace K
vertical shaft-t	gas	none	CO2	acid				79	C	13	Furnace K
vertical shaft-t	gas	none	CO2	acid				79	C	24	Furnace J
vertical shaft-t	gas	none	CO2	acid				63	C	14	
vertical shaft-t	gas	none	CO2	acid				51	C	24	Furnace K
vertical shaft-t	gas	none	CO2	acid				68	C	12	Furnace J
vertical shaft-t	gas	WS	CO2	acid				210	C	56	Furnace W
vertical shaft-t	gas	WS	CO2	acid				200	C	57	Furnace W
vertical shaft-t	gas	MC/WS	CO2	acid				70	C	14	
vertical shaft-t	gas	MC	CO2	acid				66	C	12	Furnace K
vertical shaft-t	gas	MC	CO2	acid				56	C	24	Furnace K
vertical shaft-t	gas	MC	CO2	acid				68	C	24	Furnace J
vertical shaft-t	gas	MC	CO2	acid				60	C	24	Furnace K
vertical shaft-t	gas	MC	CO2	acid				70	C	24	Furnace J
vertical shaft-t	gas	MC	CO2	acid				53	C	13	Furnace K
vertical shaft-t	gas	MC	CO2	acid				69	C	12	Furnace J
Gas-fired vertical furnace, top gas stack, acid pellets					18	51	210	94			
vertical shaft-t	gas	WS	TOC	acid				0.013	C	56	Furnace W
Gas-fired vertical furnace, top gas stack, acid pellets					1	NA	NA	0.013			
vertical shaft-t	gas	RC	TOC	acid				0.046	C	56	Furnace W
Gas-fired vertical furnace, bottom gas stack, acid pellets					1	NA	NA	0.046			
straight grate	oil	none	filt. PM	acid				1.2	D	3	
Oil-fired straight grate					1	NA	NA	1.2			
straight grate	oil	WS	filt. PM	acid				0.086	D	9	Discarded
straight grate	oil	VS	filt. PM	acid				0.062	D	8	Discarded
straight grate	oil	VS	filt. PM	acid				0.096	D	8	Discarded

TABLE A-1. (Continued)

Type	Fuel	Control	Pollutant	Pellet type	No. of tests	Emission factor, lb/ton			Data rat.	Ref.	Comment
						Minimum	Maximum	Average			
straight grate	coke/coal	WS	filt. PM	acid				0.19	D	6	Discarded
straight grate	coke/gas	WS	filt. PM	acid				0.12	B	30	
straight grate	gas	MC/WS	filt. PM	acid				0.10	B	31	Furnace H
straight grate	coke/gas	MC/WS	filt. PM	acid				0.11	B	31	Furnace F
straight grate	coke/gas	MC/VS	filt. PM	acid				0.10	D	5	Discarded
Coke/gas-fired straight grate, with scrubber					3	0.10	0.12	0.11			
straight grate	coke/coal	WS	SO2	acid				0.57	D	6	Discarded
straight grate	coke/gas	WS	SO2	acid				1.3	B	30	
straight grate	coke/gas	MC/WS	SO2	acid				0.68	B	31	Furnace F
straight grate	coke/gas	MC/VS	SO2	acid				1.1	D	5	Discarded
Coke/gas-fired straight grate, acid pellets, with scrubber					2	0.68	1.3	0.99			
straight grate	gas	MC/WS	SO2	acid				0.10	B	31	
Gas-fired straight grate, acid pellets, with scrubber					1	NA	NA	0.10			
straight grate	gas	MC/WS	NOx	acid				0.60	B	31	
straight grate	coke/gas	MC/WS	NOx	acid				0.28	B	31	
Coke/gas-fired straight grate, acid pellets					2	0.28	0.60	0.44			
straight grate	gas	VS	NOx	flux				2.5	A	48	
Gas-fired straight grate, flux pellets					1	NA	NA	2.5			
straight grate	gas	MC/WS	CO	acid				0.039	B	31	
Gas-fired straight grate, acid pellets					1	NA	NA	0.039			
straight grate	coke/gas	MC/WS	CO	acid				0.15	B	31	
Coke/gas-fired straight grate, acid pellets					1	NA	NA	0.15			
straight grate	oil	WS	CO2	acid				27	D	9	Discarded
straight grate	coke/coal	WS	CO2	acid				79	D	6	Discarded
straight grate	coke/gas	WS	CO2	acid				76	B	30	
straight grate	gas	MC/WS	CO2	acid				50	B	31	Furnace H
straight grate	coke/gas	MC/VS	CO2	acid				96	D	5	Discarded
straight grate	coke/gas	MC/WS	CO2	acid				61	B	31	Furnace F
Coke/gas-fired straight grate, acid pellets					3	50	76	62			
straight grate	gas	MC/WS	lead	acid				0.000068	B	31	
Gas-fired straight grate					1	NA	NA	6.8E-005			

TABLE A-1. (Continued)

Type	Fuel	Control	Pollutant	Pellet type	No. of tests	Emission factor, lb/ton			Data rat.	Ref.	Comment
						Minimum	Maximum	Average			
straight grate	coke/gas	MC/WS	lead	acid				0.000076	B	31	
Coke/gas-fired straight grate					1	NA	NA	7.6E-005			
straight grate	gas	MC/WS	beryllium	acid				0.00000022	B	31	
Gas-fired straight grate					1	NA	NA	2.2E-007			
straight grate	coke/gas	MC/WS	beryllium	acid				0.00000029	B	31	
Coke/gas-fired straight grate					1	NA	NA	2.9E-007			

WS = wet scrubber.
VS = venturi scrubber.
MC = multiclone.
ESP = electrostatic precipitator.
RC = rotoclone.

Table A-2 can be found in spreadsheet file TAC_TA-2.wk3

TABLE A-2. CALCULATION OF CANDIDATE EMISSION FACTORS FOR TACONITE ORE PROCESSING--OTHER SOURCES

Source	Control	Pollutant	Emission factor, lb/ton	Data rat.	Ref.	Candidate emission factor, lb/ton	Rating	Comments
crusher, primary (1st stage)	C	filt. PM	0.10	B	10			
crusher, primary (2nd stage)	C	filt. PM	0.15	B	11			
Primary crusher, with cyclone						0.25	E	2-stage crushing, both stages
crusher, primary (1st stage)	C/MC	filt. PM	0.038	B	10			
crusher, primary (2nd stage)	C/MC	filt. PM	0.022	B	11			
Primary crusher, with cyclone and multiclone						0.060	D	2-stage crushing, both stages
crusher, primary	WS	filt. PM	0.0012	B	22			
Primary crusher, with wet scrubber						0.0012	E	
crusher, primary	FF	filt. PM	0.0019	B	27			
Primary crusher, with fabric filter						0.0019	E	
secondary crushing line	WS	filt. PM	0.0027	B	28			
Secondary crushing line, with wet scrubber						0.0027	E	Entire crushing line
crusher, fine	RC	filt. PM	0.0013	D	3			
Fine crusher, with rotoclone						0.0013	E	
crusher, tertiary	WS	filt. PM	0.0027	B	28			
tertiary crushing line	WS	filt. PM	0.00040	B	28			
Tertiary crushing line, with wet scrubber						0.0016	D	Entire crushing line
feed, grinder	WS	filt. PM	0.00062	B	7			
feed, grinder	WS	filt. PM	0.00045	B	7			
feed, grinder	WS	filt. PM	0.00071	B	7			
feed, grinder	WS	filt. PM	0.0015	B	7			
feed, grinder	WS	filt. PM	0.0023	B	9			
Grinder feed, with wet scrubber						0.0011	C	
feed, hearth layer	WS	filt. PM	0.022	B	8			
feed, hearth layer	WS	filt. PM	0.012	B	9			
Hearth layer feed, with wet scrubber						0.017	D	
feed, grate/kiln	WS	filt. PM	0.000066	B	28			
Grate/kiln feed, with wet scrubber						0.000066	E	
screen, hearth layer	WS	filt. PM	0.038	B	8			
Hearth layer screen, with wet scrubber						0.038	E	

TABLE A-2. (continued)

Source	Control	Pollutant	Emission factor, lb/ton	Data rat.	Ref.	Candidate emission factor, lb/ton	Rating	Comments
discharge, grate/kiln	none	filt. PM	1.4	B	1			
discharge, grate/kiln	none	filt. PM	0.24	A	2			
Grate/kiln discharge, uncontrolled						0.82	D	
discharge, grate/kiln	WS	filt. PM	0.0019	B	1			
Grate/kiln discharge, with wet scrubber						0.0019	E	
discharge, straight grate	WS	filt. PM	0.019	B	8			
discharge, straight grate	WS	filt. PM	0.0040	B	9			
Straight grate discharge, with wet scrubber						0.012	D	
discharge, grate/kiln	none	con. inorg. PM	9.0E-005	C	1			
Grate/kiln discharge, uncontrolled						9.0E-005	E	
discharge, grate/kiln	none	cond. PM	0.00035	B	2			
Grate/kiln discharge, uncontrolled						0.00035	E	
discharge, grate/kiln	WS	con. inorg. PM	0.00012	C	1			
Grate/kiln discharge, with wet scrubber						0.00012	E	
cooler, pellet	none	filt. PM	0.055	B	16			
cooler, pellet	none	filt. PM	0.15	B	17			
cooler, pellet	none	filt. PM	0.16	B	27			
Pellet cooler, uncontrolled						0.12	D	
cooler, pellet	none	CO2	6.4	B	27			
Pellet cooler, uncontrolled						6.4	E	
screen, pellet	none	filt. PM	10	C	23			
Pellet screen, uncontrolled						10	E	
screen, pellet	RC	filt. PM	0.037	B	23			
Pellet screen, with rotoclone						0.037	E	
conveyor transfer, primary crusher return	WS	filt. PM	0.00031	B	27			
Primary crusher return conveyor transfer, with wet scrubber						0.00031	E	
conveyor transfer, secondary crusher return	WS	filt. PM	0.013	B	28			
conveyor transfer, secondary crusher return	WS	filt. PM	0.00078	B	21			
conveyor transfer, secondary crusher return	WS	filt. PM	0.0034	B	21			
Secondary crusher return conveyor transfer, with wet scrubber						0.0057	D	
conveyor transfer, product	WS	filt. PM	0.0036	B	8			
Product conveyor transfer, with wet scrubber						0.0036	E	

TABLE A-2. (continued)

Source	Control	Pollutant	Emission factor, lb/ton	Data rat.	Ref.	Candidate emission factor, lb/ton	Rating	Comments
conveyor transfer to concentrator	WS	filt. PM	0.00028	B	28			
Conveyor transfer to concentrator, with wet scrubber						0.00028	E	
conveyor transfer, tertiary crusher	WS	filt. PM	0.0017	B	28			
Tertiary crusher line conveyor transfer, with wet scrubber						0.0017	E	
storage bin, bentonite	WS	filt. PM	2.4	B	8			
Bentonite storage bin, with wet scrubber						2.4	E	
storage bin loading, pellet	none	filt. PM	3.7	B	23			
Pellet storage bin loading, uncontrolled						3.7	E	
storage bin loading, pellet	RC	filt. PM	0.071	B	23			
Pellet storage bin loading, with rotoclone						0.071	E	
storage bin loading, secondary	WS	filt. PM	0.00019	B	28			
Secondary storage bin loading, with wet scrubber						0.00019	E	
storage bin loading, tertiary	WS	filt. PM	0.0027	B	28			
storage bin loading, tertiary	WS	filt. PM	0.00082	B	28			
Tertiary storage bin loading, with wet scrubber						0.0018	D	

WS = wet scrubber.
RC = rotoclone.
MC = multiclone.
C = cyclone.
FF = fabric filter.

Ms. Lisa J. Thorvig
Manager, Air Quality Division
Minnesota Air Pollution Control Agency
520 Lafayette Road
St. Paul, Minnesota 55155

Dear Ms. Thorvig:

Enclosed is one copy each of the final AP-42 section 11.23, Taconite Ore Processing (Enclosure 1), and corresponding background documentation report (Enclosure 2). The AP-42 section and background report have been revised to incorporate comments submitted by the Minnesota Pollution Control Agency (MPCA) in their June 20, 1996 letter from Patrick O'Neill to me. Also enclosed (Enclosure 3) is a copy of a memorandum, dated February 13, 1997, from Midwest Research Institute to me that explains how MPCA's comments were addressed in the final taconite ore processing report.

If you have any questions concerning the final AP-42 section or background report, please contact me at (919) 541-5407. Please also note that copies of the final AP-42 section and report may be downloaded from the U. S. Environmental Protection Agency's (EPA's) CHIEF web site WWW.EPA.GOV/TTN/CHIEF/. For questions or assistance in obtaining copies of these documents through CHIEF, contact the Info CHIEF Help Desk at (919) 541-1000.

Sincerely,

Ronald E. Myers
Emission Factor and Inventory Group

3 Enclosures
OAQPS/EMAD/EFIG:RMyers, rm 455B, 4201 Bldg., 541-5407, MD-14
(MRI/BLShrager/LKaufman/677-0249/02/20/97)

Mr. George F. Ryan
Executive Director
American Iron Ore Association
614 Superior Avenue, West
915 Rockefeller Building
Cleveland, Ohio 44133-1383

Dear Mr. Ryan:

Enclosed is one copy each of the final AP-42 section 11.23, Taconite Ore Processing (Enclosure 1), and corresponding background documentation report (Enclosure 2). The AP-42 section and background report have been revised to incorporate comments submitted by the Minnesota Pollution Control Agency (MPCA) in their June 20, 1996 letter from Patrick O'Neill to me. Also enclosed (Enclosure 3) is a copy of a memorandum, dated February 13, 1997, from Midwest Research Institute to me that explains how MPCA's comments were addressed in the final taconite ore processing report.

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Sincerely,

Ronald E. Myers
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OAQPS/EMAD/EFIG:RMyers, rm 455B, 4201 Bldg., 541-5407, MD-14
(MRI/BLShrager/LKaufman/677-0249/02/20/97)

Mr. Chuck Hoffman
Iron Mining Association of Minnesota
c/o Cliffs Mining Services Company
Suite 811-200 West Superior Street
Duluth, Minnesota 55802

Dear Mr. Hoffman:

Enclosed is one copy each of the final AP-42 section 11.23, Taconite Ore Processing (Enclosure 1), and corresponding background documentation report (Enclosure 2). The AP-42 section and background report have been revised to incorporate comments submitted by the Minnesota Pollution Control Agency (MPCA) in their June 20, 1996 letter from Patrick O'Neill to me. Also enclosed (Enclosure 3) is a copy of a memorandum, dated February 13, 1997, from Midwest Research Institute to me that explains how MPCA's comments were addressed in the final taconite ore processing report.

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