Appendix Q

Cleveland Cliffs Steel, LLC - Indiana Harbor East Responses to the FLMs Comments

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Boling, Jean

From: Wolters, Brian <Brian.Wolters@clevelandcliffs.com>
Sent: Tuesday, August 17, 2021 5:23 PM
To: Boling, Jean
Subject: RE: Federal Land Managers Comments Associated with the Cleveland Cliffs East and West Facilities
Attachments: Indiana Harbor (00316) Four Factor Analysis FLM Response Letter 8-17-2021.pdf

Jean,

The attached letter and appendix with revised calculations should provide support or response as need to FLM's comments. Call me with any questions.

CLIFFS
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From: Boling, Jean <JBoling@idem.IN.gov>
Sent: Friday, July 30, 2021 7:15 AM
To: Wolters, Brian <Brian.Wolters@arcelormittal.com>
Subject: [EXTERNAL] Federal Land Managers Comments Associated with the Cleveland Cliffs East and West Facilities

Good afternoon Brian,

IDEM received the Federal Land Manager's (FLMs) comments on July 23, 2021, as expected, so we are now in the process of drafting Indiana's response to comments that will be incorporated into the draft RH SIP that will go out on public notice. As stated in the email I sent out on July 15, 2021, your timely response is needed to provide the additional information the FLMs have requested to address their comments related to the four-factor analysis conducted for the Cleveland Cliffs East Facility. The following bulleted items provide a summary of the detailed comments attached that are specific to this facility.

- We found several errors in the cost analyses provided for this facility and we request that these errors are corrected. Once corrected, we believe controls may be even more cost effective than estimated by IDEM. *Please provide updated cost analyses based on the errors identified or justification for why the recommended correction is not applicable.*

- We recommend the IDEM consider whether SNCR may be feasible for the Lime Plant Nos. 1 and 2 Preheater and Rotary Kilns at the Cleveland Cliffs East Facility.

Since the RH program is an iterative program that provides states with the flexibility to develop a cohesive strategy that demonstrates reasonable progress over time toward natural visibility by 2064, Indiana offered a weight of evidence demonstration consistent with this overarching principle to support the state's decision not to require additional control measures for the selected sources. The state continues to stand behind this decision, however, it is important to address the FLMs comments as thoroughly as possible to show that Indiana has seriously evaluated the selected sources in accordance with the RH Rule and section 169A(g)(1) of the CAA which lists four factors that must be taken into consideration in determining reasonable progress.

Please forward the information requests to me by close of business August 17, 2021 and if either one of you have any questions about the FLMs comments or would like to discuss any of them with us, we would be happy to make ourselves available. Thank you, in advance, for your cooperation and assistance.

Jean Boling
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Office of Air Quality, Air Programs Branch
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Help us improve!
IDEM values your feedback

Cleveland-Cliffs Steel LLC
Indiana Harbor East

CLIFFS
CLEVELAND-CLIFFS INC.

August 17, 2021

Jean Boling, Senior Environmental Engineer
Indiana Department of Environmental Management
Office of Air Quality, Air Programs Branch
100 North Senate Avenue, MC 61-53 IGCN 1003
Indianapolis, IN 46204-2251

Re: Response to Four-Factor Analysis Comments dated July 30, 2021

Ms. Boling:

On September 30, 2020, the Cleveland-Cliffs Indiana Harbor facility (Indiana Harbor) submitted a Regional Haze Four-Factor Analysis (FFA) report in response to a request from the Indiana Department of Environmental Management (IDEM). Indiana Harbor understands that the FFA report, along with FFA reports from other Indiana facilities, is being used by IDEM to inform decisions for the Regional Haze State Implementation Plan (SIP) regarding what emission reductions are necessary to make reasonable progress towards achieving natural visibility in Class I areas by 2064.

This letter is in response to your email dated July 30, 2021 requesting input to respond to comments received from the Federal Land Managers (FLMs) regarding the facility's FFA report. The information below is being provided to addresses these comments.

Comment 1 – General Comments Regarding Control Cost Calculations

The FLMs provided four general comments regarding the control cost calculations. The comments are addressed individually below.

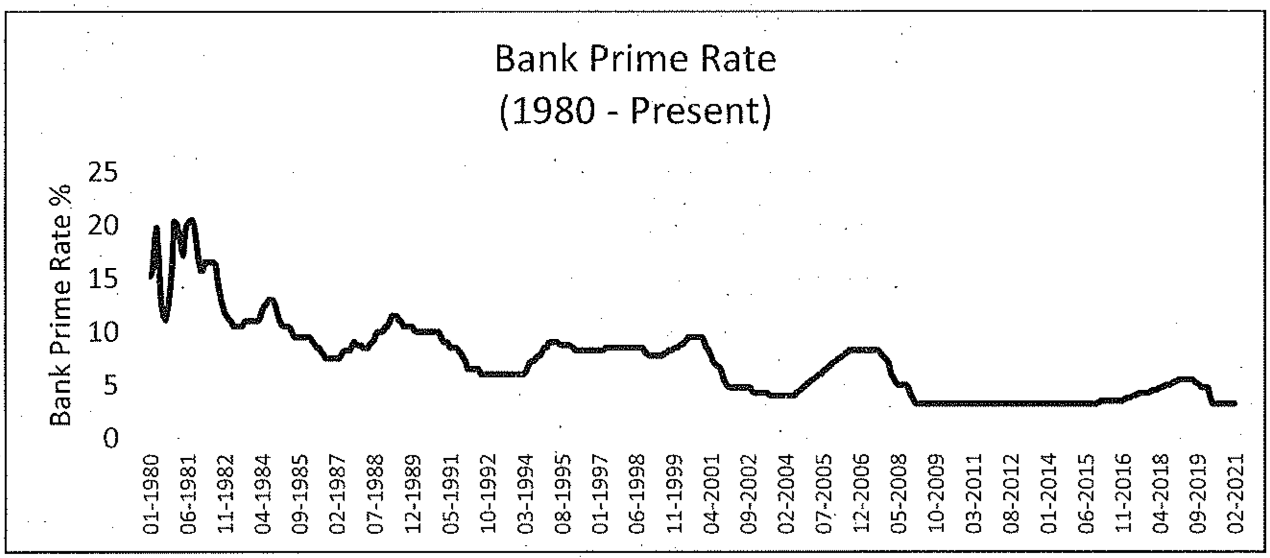
a. Interest Rate

The FLMs stated that the default prime bank rate should be used for the control cost calculations. Indiana Harbor recognizes that the Control Cost Manual states that "*...if firm-specific nominal interest rates are not available, then the bank prime rate can be an appropriate estimate for interest rates....*"[1] The FFA control cost calculations assumed an interest rate of 5.5% which is lower than the Indiana Harbor site-specific interest rate. However, the exact interest rate for the facility is confidential and, therefore, we are providing the following discussion regarding the use of an interest rate which is greater than today's historically low bank prime rate.

[1] USEPA, Control Cost Manual – Chapter 2 – Cost Estimation: Concepts and Methodology, 11/2017, page 15.

The statement in the previous paragraph from the Control Cost Manual regarding the use of the bank prime rate is specific to analyses for permit applications, and when a permit application is submitted, the construction is likely to commence soon after permit issuance. However, the FFA provided by Indiana Harbor was specific to a Regional Haze SIP which, in general, are being developed to require controls by 2028, the end of the second implementation period.

As shown in the figure below, the prime interest rate can frequently change and the current rate of 3.25% is a historic low value. For example, the bank prime rate was at 5.5% as recently as July 2019 and was at 4.75% in February 2020 before dropping to the current 3.25% in April 2020. Although 3.25% may be available today, the historic volatility in the prime interest rate suggests that this value may not be available when financing an emission reduction project for which startup may not be required until 2028. Based on this volatility, uncertainty, and timeline for installing controls, Indiana Harbor is justified in using an interest rate of 5.5% to represent a reasonable estimate for the future financing of a potential emission reduction project for startup by 2028. However, as previously stated, the site-specific interest rate is higher than 5.5% so this value underestimates the cost that would be realized by Indiana Harbor if this project were required.



b. Retrofit Factor

The FLMs stated "*In the absence of documentation justifying the use of a higher retrofit factor, a value of 1 should be used.*"

USEPA's Control Cost Manual states "*Unless the original designers had the foresight to include additional floor space and room between components for new equipment, the installation of retrofitted pollution control devices can impose an additional expense to "shoe-horn" the equipment into the right locations. For example, an SCR reactor can occupy thousands of square feet and... there is often little room for the reactor to fit in the existing space and additional ductwork, fans, and flue gas heaters may be needed to make the system work properly. To* *quantify the additional costs of installation not directly related to the capital cost of the controls themselves, engineers and cost analysts typically multiply the cost of the system by a retrofit factor."*[2] A retrofit factor of 1 (e.g., 0% increase in total capital cost) is typically used for a site that will experience minimal retrofit issues while retrofit factors of 1.5 (e.g.. 50% increase in total capital cost) and 1.6 (e.g., 60% increase in total capital cost) have been used for cost estimates for pollution control equipment installation at older facilities with limited space to accommodate the design and installation of new equipment.

The Indiana Harbor East FFA report included a retrofit factor of 1.5 (e.g., 50% increase in total capital cost) for the Sinter Plant Windbox control cost calculations for spray dryer absorption (SDA) and dry sorbent injection (SDI). This retrofit factor is appropriate. The justification for this value was provided in Section 8.2.3 of the FFA report as follows:

> *To account for the limited space around existing equipment, a 50 percent markup of the total capital investment (i.e., a 1.5 retrofit factor) was included in the costs to account for the installation. Retrofit installations have increased handling and erection difficulty for many reasons. Access for transportation, laydown space, etc. for new equipment is significantly impeded or restricted. As noted above, the spaces surrounding the Sinter Plant are congested, or the areas surrounding the Sinter Plant support frequent vehicle traffic or crane access for maintenance and cannot be used for material staging. Additionally, the emission control measures evaluated in this section are complex and increase the associated installation costs (e.g., ancillary equipment requirements, piping, structural, electrical, demolition, etc.). Finally, the EPA Control Cost Manual*[3] *notes that retrofit installations are subjective because the plant designers may not have had the foresight to include additional floor space and room between components for new equipment. Retrofits impose additional costs to "shoehorn" equipment in existing plant space, which is true for the Sinter Plant.*

The Indiana Harbor East FFA report included a retrofit factor of 1.3 (e.g., 30% increase in total capital cost) for the Walking Beam Furnace #5 and #6 control cost calculations for ultra-low NO_X burners. This retrofit factor is appropriate. Similar to the Sinter Plant, these two sources will have increased handling and erection difficulty for many reasons although the issues at the Walking Beam Furnace #5 and #6 were considered less demanding and, therefore, a lower retrofit factor was used. For example, access for transportation, laydown space, etc. for new equipment is significantly impeded or restricted, and the spaces surrounding Walking Beam Furnace #5 and #6 are congested. Because the furnace wall penetrations would increase, it is anticipated that most if not all of the refractory in the side walls would have to be manually removed and rebuilt which is an intensive labor cost. Additionally, the EPA Control Cost Manual notes that retrofit installations are subjective because the plant designers may not have had the foresight to include additional floor space and room between components for new equipment. Retrofits impose additional costs to "shoehorn" equipment in existing plant space, which is true for the Walking Beam Furnace #5 and #6.

The Indiana Harbor West FFA report did not include any control cost calculations and, therefore, did not use a retrofit factor in the analysis.

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[2] USEPA, Control Cost Manual – Chapter 2 – Cost Estimation: Concepts and Methodology, 11/2017, page 27.
[3] USEPA, Control Cost Manual – Section 1 – Chapter 2.6.4.2 Retrofit Cost Considerations, 2017, page 27.

c. Equipment Life

The FLMs stated that the control cost calculations should use an equipment life longer than 20 years for flue gas desulfurization (FGD) scrubbers and referenced an April 2021 update to the USEPA Control Cost Manual which stated:

> *Equipment useful life: the analyses of costs for spray dry absorbers for the Burns Harbor units assumed a useful life of 20 years. According to the CCM Section 5 Chapter 1, "Acid gas scrubbers are relatively reliable systems that have been demonstrated to be exceedingly durable. In the past, the EPA has generally used equipment life estimates of 20 to 30 years for analyses involving acid gas scrubbers, although these estimates are recognized to be low for many installations. Many FGD systems installed in the 1970s and 1980s have operated for more than 30 years (e.g., Coyote Station; H.L. Spurlock Unit 2 in Maysville, KY; East Bend Unit 2 in Union, KY; and Laramie River Unit 3 in Wheatland, WY) and some scrubbers may have lifetimes that are much longer." Accordingly, a useful life greater than 20 years is appropriate for spray dry absorbers.*[4]

The facilities referenced by EPA in the Control Cost Manual are large coal-fired electric generating units (EGU) which comprise a vast majority of the FGD unit installations and operations in the United States. However, the sources in the Indiana Harbor East FFA report are not large EGUs. Rather this analysis evaluated FGD on the Sinter Plant Windbox which will have different flue gas characteristics as well as design and operating challenges, which were likely not considered by USEPA when developing the updated information in the Control Cost Manual. As such, the general statement by USEPA that the equipment life for a FGD unit should be 30 years may not be appropriate for this application.

The conceptual design for the FGD systems in the Indiana Harbor East FFA report use fabric filters to remove the sorbent from the flue gas and USEPA has provided a different equipment life for this type of control equipment (emphasis added):

> *The Manual methodology treats bags and bag replacement labor as an investment amortized over the useful life of the bags, <u>while the rest of the control system is amortized over its useful life, typically 20 years.</u>*[5]

> *For fabric filters, <u>the system lifetime varies from 5 to 40 years, with 20 years being typical.</u>*[6]

Since the FGD systems that were considered use fabric filters, and because fabric filters are the major portion of the capital cost for these systems, a 20-year equipment life is appropriate for these control cost calculations.

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[4] USEPA, Control Cost Manual – Section 5 – SO2 and Acid Gas Controls, Chapter 1 – Wet and Dry Scrubbers for Acid Gas Control, 04/2021, page 1-8.
[5] USEPA, Control Cost Manual – Section 6 – Particulate Controls, Chapter 1 – Baghouses and Filters, 12/1998, page 1-49.
[6] USEPA, Control Cost Manual – Section 6 – Particulate Controls, Chapter 1 – Baghouses and Filters, 12/1998, page 1-48.

d. The use of an Indiana sales tax for purchased equipment

The FLMs stated that sales tax should not be included in the control cost calculations based on Indiana Code Title 6. Taxation § 6-2.5-5-30 which states that "*Sales of tangible personal property are exempt from the state gross retail tax if... the property constitutes, is incorporated into, or is consumed in the operation of, a device, facility, or structure predominantly used and acquired for the purpose of complying with any state, local, or federal environmental quality statutes, regulations, or standards.*" Thus, the control cost calculations which calculated the sales tax have been updated with the Indiana sale tax line item removed. The updated calculations are attached.

Comment 2 – SNCR Feasibility for Lime Plant Nos. 1 and 2 Preheater and Rotary Kilns

The FLMs stated that IDEM should consider whether SNCR may be feasible for the Lime Plant Nos. 1 and 2 Preheater and Rotary Kilns at the Indiana Harbor East Facility. Although this technology may be in operation at other lime plants, the technology is not feasible at our facility as described below.

For SNCR to be feasible and affective, the reagent (ammonia or urea) must be injected in a suitable location which allows for:

1. Stable operation in the appropriate temperature range for SNCR (1,550 – 1,950°F)[7],
2. Adequate mixing of the reagent and flue gas,
3. Sufficient residence time for the SNCR reactions to occur, and
4. Operation of the injection lances and associated equipment without being damaged, plugged, eroded, or corroded.

Reagent injection could occur in four general locations within each lime plant: directly into the rotary kiln, at the kiln inlet and transfer chutes, in the stone bin and preheater, and at the stone outlet. Two of these of the locations do not meet the temperature requirements, as the lime kiln is too hot (>2,000°F) and the stone outlet is too low (≈430°F). However, two of the locations meet the temperature requirements (kiln inlet and transfer chutes at 1930-1975°F and the stone bin and preheater at 1900-1950°F), so the other requirements for a suitable injection location were evaluated.

As explained below, neither of these sources is a suitable location for reagent injection and, therefore, SNCR was not considered feasible. It may be possible to incorporate a major redesign to the lime plants to overcome the issues described below. However, the redesign on the lime kiln feed system was not further considered because this type of modification is considered beyond the required scope of an evaluation like a four-factor analysis. For example, the New Source Review Workshop Manual states that "[h]*istorically, EPA has not considered the BACT requirement as a means to redefine the design of the source when considering available control alternatives*."[8]

[7] USEPA, "Control Cost Manual – Section 4 – NOX Controls – Chapter 1 – Selective Non-Catalytic Reduction," 04/2019, Page 1-5.
[8] USEPA, "New Source Review Workshop Manual: Prevention of Significant Deterioration and Nonattainment Area Permitting," 10/1990, page B.13.

Stone Bin and Preheater

The stone bin and preheater provides fresh limestone feed to the lime kiln and transfers heat from the flue gas to the incoming stone. The system uses mechanical rams to transfer limestone from the stone bin into the kiln inlet and transfer chutes, transferring heat to the stone from the hot flue gas. This occurs in a cyclic process. First, the ram retracts and fresh limestone drops into the preheating chamber which is warmed by the flue gas. Second, the ram extends and the preheated limestone falls into the transition area and ultimately into kiln inlet and transfer chutes. Then the cycle is repeated with the ram cycling through the retraction and extension. The cycling of the ram retracting and extending produces a corresponding cycling of temperature, as the flue gas flow is immediately restricted upon ram extension and gradually increases until the next ram extension. The cycling temperatures would not be appropriate for SNCR because the stable temperature profile is not available.

In addition, the stone bin and preheater is not a feasible location for an injection lance because the equipment would likely be damaged by the falling stone and/or eroded and plugged by the high dust loading. Further, the falling limestone would inhibit the reagent spray and prevent proper mixing with the flue gas, which would reduce reaction time necessary for SNCR.

Therefore, SNCR is not technically feasible for this injection location.

Kiln Inlet and Transfer Chutes

The kiln inlet and transfer chutes are the final transition for the limestone as it moves into the kiln. This location also has significant technical challenges as an injection point for the SNCR reagent. This area of the kiln is extremely laden with dust from the process, and the kiln internally has ongoing solids accumulation issues. The reason for the high dust rates is multifaceted, but the primary cause is the design of the rectangular stone bin/preheater – note that only a handful of such kilns were built in the 1970s before changing to a much more efficient cylindrical design with a conical feed chute. Because of the rectangular shape, it requires the flue gas duct to be bifurcated, to route the hot gas to two opposing corners of the bin. First, the stone bin configuration captures a significant amount of kiln dust and results in high dust recirculation rates as it is accumulated and pushed back into the kiln feed pipe. Second, the feed pipe keeps the stone separate from the duct/dust on its return to the stone bin, so rather than the stone impact cleaning the walls of a combined feed chute, the dust deposits in the ducts and the stone erodes the feed pipe. The accumulation of dust already requires daily cleaning, and at times becomes unmanageable, which will result in ceased/warped injection lances that cannot be removed for maintenance without a shutdown/burning/welding. These same problems would occur with the SNCR injection system which would significantly limit its effectiveness.

Therefore, as identified above, SNCR is not technically feasible for this injection location without a major redesign on the lime kiln feed system.

We believe that it is also important to repeat the conclusion in our FFA report that, independent of the four-factor analysis, any installation of additional emission control measures at Indiana Harbor is not expected to have a perceptible impact on visibility in affected Class I areas and that no further visibility improvements are necessary to meet the 2028 uniform rate of progress. As stated in our FFA report, the four closest Class I areas and the distances from our facility are:

- Mammoth Cave National Park – Kentucky (499 km)
- Seney National Wildlife Refuge – Michigan (513 km)
- Mingo National Wildlife Refuge – Missouri (561 km)
- Isle Royale National Park – Michigan (699 km)

Thank you for providing us the opportunity to provide this information to support IDEM's response to the comments from the FLMs. Please let us know if you need any additional information or would like to discuss this submittal in more detail.
Sincerely,

Brian Wolters

Brian Wolters
ENV Compliance Manager
Indiana Harbor

Attachments:

- Updated control cost calculations

Appendix C.1

Walking Beam Furnace #5

ArcelorMittal Indiana Harbor East

Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls

Appendix C.1 – Table C.1-1: Cost Summary

Walking Beam Furnace #5

NO_x Control Cost Summary

Control Technology	Control Eff %	Controlled Emissions T/yr	Emission Reduction T/yr	Installed Capital Cost $	Total Annualized Cost $/yr	Pollution Control Cost $/ton
Ultra-Low NOx Burners (ULNB)	39%	131.6	82.4	$5,012,000	$751,800	$9,100

ArcelorMittal Indiana Harbor East

Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls

Appendix C.1 – Table C.1-2: Summary of Utility, Chemical and Supply Costs

Walking Beam Furnace #5

Operating Unit:	Walking Beam Furnace #5	**Study Year**	2020

Item	2020 Unit Cost	Units	Cost	Year	Data Source
Operating Labor	68	$/hr	60	2016	EPA SCR Control Cost Manual Spreadsheet
Maintenance Labor	68	$/hr			Assumed to be equivalent to operating labor
Sales Tax	0%				Sales taxes exempted from pollution control equipment
Interest Rate	5.50%				EPA SCR Control Cost Manual Spreadsheet
Contingencies	20%				Contingency based on study level estimate
Markup on capital investment (retrofit factor)	30%				EPA Cost Control Cost Manual Chapter 2
Operating Information					
Annual Op. Hrs	8,760	Hours			Assumed
Utilization Rate	100%				Assumed
Gross Heat Input from ULNBs	527.8	MMBTU/hr			Vendor estimate
Equipment Life	20	yrs			Assumed
Baseline Emissions	**Lb/Hr**	**Ton/Year**			
Nitrous Oxides (NOx)	48.9	214.0			Estimated annual emissions based on performance test data
ULNB - NO_x Performance	0.12	lb/MMBtu			Vendor guaranteed burner performance
Baseline NOx performance	0.20	lb/MMBtu			2018 performance test data lb/MMBtu average emission factor
Control efficiency	39%				

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.1 – Table C.1-3: NO_X Control - Ultra-Low NO_X Burners (ULNB)
Walking Beam Furnace #5

Operating Unit: Walking Beam Furnace #5

Desgin Capacity	528	MMBtu/hr
Expected Utiliztion Rate	100%	
Expected Annual Hours of Operation	8,760	Hours

CONTROL EQUIPMENT COSTS

Capital Costs								
Direct Capital Costs								
Purchased Equipment								1,047,000
Installation								2,287,000
Total Direct Capital Cost, DC								3,334,000
Total Indirect Capital Costs, IC								521,400
Total Capital Investment (TCI) = DC + IC								3,855,400
Total Capital Investment (TCI) with Retrofit Factor								5,012,000
Operating Costs								
Total Annual Direct Operating Costs		Labor, supervision, materials, replacement parts, utilities, etc.						82,500
Total Annual Indirect Operating Costs		Sum indirect oper costs + capital recovery cost						669,300
Total Annual Cost (Annualized Capital Cost + Operating Cost)								751,800

Emission Control Cost Calculation

Pollutant	Baseline Emis. T/yr	Cont. Emis.	Cont. Emis. lb/MMBtu	Cont Emis T/yr	Reduction T/yr	Cont Cost $/Ton Rem
PM10		-			-	NA
Total Particulates		-			-	NA
Nitrous Oxides (NOx)	214.0		0.12	131.6	82.4	9,100
Sulfur Dioxide (SO_2)		-			-	NA

Notes & Assumptions

1. Equipment costs and emission rates provided by burner vendor
2. Installation costs provided by ArcelorMittal based on projects of similar scope
3. Assumed 0.1 and 0.5 hr/shift respectively for operatior and maintenance labor
4. Controlled emission factor based on vendor guaranteed burner performance

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.1 – Table C.1-3: NO_X Control - Ultra-Low NO_X Burners (ULNB)
Walking Beam Furnace #5

CAPITAL COSTS
(Round to 1000s)

Direct Capital Costs		
Purchased Equipment		
Purchased Equipment Costs (A)		910,000
Instrumentation	10% of purchased equipment costs	91,000
Sales Taxes	0.0% of purchased equipment costs	0
Freight	5% of purchased equipment costs	46,000
Purchased Equipment Total (B)	15%	1,047,000
Installation		
Materials and Refractory	Engineering Estimate	550,000
Mandrels for burner installation	Engineering Estimate	152,000
Scaffolding	Engineering Estimate	175,000
Demolition and Installation Labor	Engineering Estimate	1,400,000
Waste Disposal	Engineering Estimate	10,000
Installation Total		2,287,000
Total Direct Capital Cost, DC		3,334,000
Indirect Capital Costs		
Construction and Field Expenses	10% of purchased equipment total	105,000
Contractor Fees	10% of purchased equipment total	105,000
Start-up	5% of purchased equipment total	52,000
Performance test	Estimate	50,000
Model Studies	NA of purchased equipment total	NA
Contingencies	20% of purchased equipment total	209,400
Total Indirect Capital Costs, IC		521,400
Total Capital Investment (TCI) = DC + IC		3,855,400
Site Preparation, as required	Site Specific	NA
Buildings, as required	Site Specific	NA
Site Specific - Other	Site Specific	NA
Total Site Specific Costs		0
Adjusted TCI for Replacement Parts (Catalyst, Filter Bags, etc) for Capital Recovery Cost		3,855,400
Total Capital Investment (TCI) with Retrofit Factor	30%	5,012,000

OPERATING COSTS
(Round to 100s)

Direct Annual Operating Costs, DC		
Operating Labor		
Operator	67.53 $/Hr, 0.1 hr/8 hr shift, 8760 hr/yr	7,400
Supervisor	15% 15% of Operator Costs	1,100
Maintenance (2)		
Maintenance Labor	67.53 $/Hr, 0.5 hr/8 hr shift, 8760 hr/yr	37,000
Maintenance Materials	100% of maintenance labor costs	37,000
Utilities, Supplies, Replacements & Waste Management		
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
Total Annual Direct Operating Costs		82,500
Indirect Operating Costs		
Overhead	60% of total labor and material costs	49,500
Administration (2% total capital costs)	2% of total capital costs (TCI)	100,200
Property tax (1% total capital costs)	1% of total capital costs (TCI)	50,100
Insurance (1% total capital costs)	1% of total capital costs (TCI)	50,100
Capital Recovery	8% for a 20- year equipment life and a 5.5% interest rate	419,400
Total Annual Indirect Operating Costs	Sum indirect oper costs + capital recovery cost	669,300
Total Annual Cost (Annualized Capital Cost + Operating Cost)		751,800

ArcelorMittal Indiana Harbor East

Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls

Appendix C.1 – Table C.1-3: NO_X Control - Ultra-Low NO_X Burners (ULNB)

Walking Beam Furnace #5

Capital Recovery Factors	
Primary Installation	
Interest Rate	5.5%
Equipment Life	20 years
CRF	0.0837

Replacement Parts & Equipment:

N/A

Replacement Parts & Equipment:

N/A

Electrical Use

N/A

Reagent Use & Other Operating Costs

Operating Cost Calculations

Annual hours of operation: 8,760

Utilization Rate: 100%

Item	Unit Cost $	Unit of Measure	Use Rate	Unit of Measure	Annual Use*	Annual Cost	Comments
Operating Labor							
Op Labor	67.53	$/Hr	0.1	hr/8 hr shift	110	7,395	$/Hr, 0.1 hr/8 hr shift, 8760 hr/yr
Supervisor	15%	of Op.			NA	1,109	15% of Operator Costs
Maintenance							
Maint Labor	67.53	$/Hr	0.5	hr/8 hr shift	548	36,973	$/Hr, 0.5 hr/8 hr shift, 8760 hr/yr
Maint Mtls	100	% of Maintenance Labor			NA	36,973	100% of Maintenance Labor
Utilities, Supplies, Replacements & Waste Management							
Electricity	0.073	$/kwh	0.0	kW-hr	0	0	$/kwh, 0 kW-hr, 8760 hr/yr, 100% utilization
Natural Gas	6.15	$/kscf	0	scfm	0	0	$/kscf, 0 scfm, 8760 hr/yr, 100% utilization
Water	5.13	$/kgal	0.0	gpm	0	0	$/kgal, 0 gpm, 8760 hr/yr, 100% utilization

Appendix C.2

Walking Beam Furnace #6

ArcelorMittal Indiana Harbor East

Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls

Appendix C.2 – Table C.2-1: Cost Summary

Walking Beam Furnace #6

NO_x Control Cost Summary

Control Technology	Control Eff %	Controlled Emissions T/yr	Emission Reduction T/yr	Installed Capital Cost $	Total Annualized Cost $/yr	Pollution Control Cost $/ton
Ultra-Low NOx Burners (ULNB)	46%	127.1	109.5	$5,012,000	$751,800	$6,900

ArcelorMittal Indiana Harbor East

Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls

Appendix C.2 – Table C.2-2: Summary of Utility, Chemical and Supply Costs

Walking Beam Furnace #6

Operating Unit:	Walking Beam Furnace #6	**Study Year**	2020

Item	2020 Unit Cost	Units	Cost	Year	Data Source
Operating Labor	68	$/hr	60	2016	EPA SCR Control Cost Manual Spreadsheet
Maintenance Labor	68	$/hr			Assumed to be equivalent to operating labor
Sales Tax	0%				Sales taxes exempted from pollution control equipment
Interest Rate	5.50%				EPA SCR Control Cost Manual Spreadsheet
Contingencies	20%				Contingency based on study level estimate
Markup on capital investment (retrofit factor)	30%				EPA Cost Control Cost Manual Chapter 2
Operating Information					
Annual Op. Hrs	8,760	Hours			Assumed
Utilization Rate	100%				Assumed
Gross Heat Input from ULNBs	527.8	MMBTU/hr			Vendor estimate
Equipment Life	20	yrs			Assumed
Baseline Emissions	**Lb/Hr**	**Ton/Year**			
Nitrous Oxides (NOx)	54.0	236.6			Estimated annual emissions based on performance test data
ULNB - NO_x Performance	0.12	lb/MMBtu			Vendor guaranteed burner performance
Baseline NOx performance	0.23	lb/MMBtu			2018 performance test data lb/MMBtu average emission factor
Control efficiency	46%				

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.2 – Table C.2-3: NO_X Control - Ultra-Low NO_X Burners (ULNB)
Walking Beam Furnace #6

Operating Unit: Walking Beam Furnace #6

Desgin Capacity	528	MMBtu/hr.
Expected Utiliztion Rate	100%	
Expected Annual Hours of Operation	8,760	Hours

CONTROL EQUIPMENT COSTS

Capital Costs		
Direct Capital Costs		
Purchased Equipment		1,047,000
Installation		2,287,000
Total Direct Capital Cost, DC		3,334,000
Total Indirect Capital Costs, IC		521,400
Total Capital Investment (TCI) = DC + IC		3,855,400
Total Capital Investment (TCI) with Retrofit Factor		5,012,000
Operating Costs		
Total Annual Direct Operating Costs	Labor, supervision, materials, replacement parts, utilities, etc.	82,500
Total Annual Indirect Operating Costs	Sum indirect oper costs + capital recovery cost	669,300
Total Annual Cost (Annualized Capital Cost + Operating Cost)		751,800

Emission Control Cost Calculation

Pollutant	Baseline Emis. T/yr	Cont. Emis.	Cont. Emis. lb/MMBtu	Cont Emis T/yr	Reduction T/yr	Cont Cost $/Ton Rem
PM10		-			-	NA
Total Particulates		-			-	NA
Nitrous Oxides (NOx)	236.6		0.12	127.1	109.5	6,900
Sulfur Dioxide (SO_2)		-			-	NA

Notes & Assumptions

1 Equipment costs and emission rates provided by burner vendor
2 Installation costs provided by ArcelorMittal based on projects of similar scope
3 Assumed 0.1 and 0.5 hr/shift respectively for operator and maintenance labor
4 Controlled emission factor based on vendor guaranteed burner performance

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.2 – Table C.2-3: NO_X Control - Ultra-Low NO_X Burners (ULNB)
Walking Beam Furnace #6

CAPITAL COSTS
(Round to 1000s)

Direct Capital Costs		
Purchased Equipment		
Purchased Equipment Costs (A)		910,000
Instrumentation	10% of purchased equipment costs	91,000
Sales Taxes	0.0% of purchased equipment costs	0
Freight	5% of purchased equipment costs	46,000
Purchased Equipment Total (B)	15%	1,047,000
Installation		
Materials and Refractory	Engineering Estimate	550,000
Mandrels for burner installation	Engineering Estimate	152,000
Scaffolding	Engineering Estimate	175,000
Demolition and Installation Labor	Engineering Estimate	1,400,000
Waste Disposal	Engineering Estimate	10,000
Installation Total		2,287,000
Total Direct Capital Cost, DC		3,334,000
Indirect Capital Costs		
Construction and Field Expenses	10% of purchased equipment total	105,000
Contractor Fees	10% of purchased equipment total	105,000
Start-up	5% of purchased equipment total	52,000
Performance test	Estimate	50,000
Model Studies	NA of purchased equipment total	NA
Contingencies	20% of purchased equipment total	209,400
Total Indirect Capital Costs, IC		521,400
Total Capital Investment (TCI) = DC + IC		3,855,400
Site Preparation, as required	Site Specific	NA
Buildings, as required	Site Specific	NA
Site Specific - Other	Site Specific	NA
Total Site Specific Costs		0
Adjusted TCI for Replacement Parts (Catalyst, Filter Bags, etc) for Capital Recovery Cost		3,855,400
Total Capital Investment (TCI) with Retrofit Factor	30%	5,012,000

OPERATING COSTS
(Round to 100s)

Direct Annual Operating Costs, DC		
Operating Labor		
Operator	67.53 $/Hr, 0.1 hr/8 hr shift, 8760 hr/yr	7,400
Supervisor	15% 15% of Operator Costs	1,100
Maintenance (2)		
Maintenance Labor	67.53 $/Hr, 0.5 hr/8 hr shift, 8760 hr/yr	37,000
Maintenance Materials	100% of maintenance labor costs	37,000
Utilities, Supplies, Replacements & Waste Management		
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
NA	NA	-
Total Annual Direct Operating Costs		82,500
Indirect Operating Costs		
Overhead	60% of total labor and material costs	49,500
Administration (2% total capital costs)	2% of total capital costs (TCI)	100,200
Property tax (1% total capital costs)	1% of total capital costs (TCI)	50,100
Insurance (1% total capital costs)	1% of total capital costs (TCI)	50,100
Capital Recovery	8% for a 20- year equipment life and a 5.5% interest rate	419,400
Total Annual Indirect Operating Costs	Sum indirect oper costs + capital recovery cost	669,300
Total Annual Cost (Annualized Capital Cost + Operating Cost)		751,800

ArcelorMittal Indiana Harbor East

Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls

Appendix C.2 – Table C.2-3: NO_X Control - Ultra-Low NO_X Burners (ULNB)

Walking Beam Furnace #6

Capital Recovery Factors	
Primary Installation	
Interest Rate	5.5%
Equipment Life	20 years
CRF	0.0837

Replacement Parts & Equipment:
N/A

Replacement Parts & Equipment:
N/A

Electrical Use
N/A

Reagent Use & Other Operating Costs

Operating Cost Calculations — Annual hours of operation: 8,760; Utilization Rate: 100%

Item	Unit Cost $	Unit of Measure	Use Rate	Unit of Measure	Annual Use*	Annual Cost	Comments
Operating Labor							
Op Labor	67.53	$/Hr	0.1	hr/8 hr shift	110	7,395	$/Hr, 0.1 hr/8 hr shift, 8760 hr/yr
Supervisor	15%	of Op.			NA	1,109	15% of Operator Costs
Maintenance							
Maint Labor	67.53	$/Hr	0.5	hr/8 hr shift	548	36,973	$/Hr, 0.5 hr/8 hr shift, 8760 hr/yr
Maint Mtls	100	% of Maintenance Labor			NA	36,973	100% of Maintenance Labor
Utilities, Supplies, Replacements & Waste Management							
Electricity	0.073	$/kwh	0.0	kW-hr	0	0	$/kwh, 0 kW-hr, 8760 hr/yr, 100% utilization
Natural Gas	6.15	$/kscf	0	scfm	0	0	$/kscf, 0 scfm, 8760 hr/yr, 100% utilization
Water	5.13	$/kgal	0.0	gpm	0	0	$/kgal, 0 gpm, 8760 hr/yr, 100% utilization

Appendix C.3

Sinter Plant Windbox

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-1: Cost Summary
Sinter Plant Windbox

SO_2 Control Cost Summary

Control Technology	Control Eff %	Controlled Emissions T/yr	Emission Reduction T/yr	Installed Capital Cost* $	Total Annualized Cost $/yr	Pollution Control Cost $/ton
Spray Dry Absorber (SDA)	90%	37.1	333.9	$55,387,154	$9,423,912	$28,224
Dry Sorbent Injection (DSI)	70%	111.3	259.7	$29,663,733	$9,677,857	$37,300

* Total Capital Cost with Reheat and Retrofit Factor

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-2: Summary of Utility, Chemical and Supply Costs
Sinter Plant Windbox

Operating Unit:	Sinter Plant Windbox	**Study Year**	2020
Emission Unit Number			
Stack/Vent Number			

Item	2020 Unit Cost	Units	Cost	Year	Data Source	Notes
Operating Labor	68	$/hr	60	2016	EPA SCR Control Cost Manual Spreadsheet	
Maintenance Labor	68	$/hr			Assumed to be equivalent to operating labor	
Installation Labor	68	$/hr			Assumed to be equivalent to operating labor	
Electricity	0.07	$/kwh			2016-2019 EIA Average prices for the industrial sector in Indiana	
Natural Gas	6.15	$/kscf			2014-2018 EIA Average prices for the Industrial sector in Indiana (latest available 8/20/2020)	
Compressed Air	0.48	$/kscf	0.38	2012	Taconite FIP Docket - Cost estimate for United Taconite	
Chemicals & Supplies						
Lime	163.68	$/ton	145.00	2012	Taconite FIP Docket - Cost estimate for United Taconite	
Trona	285.00	$/ton		2020	Reagent cost for trona from another Barr Engineering Co. Project.	
Fabric Filter Bags	228.02	$/bag	180	2012	Taconite FIP Docket - Cost estimate for United Taconite	
Other						
Sales Tax	0%				Sales taxes exempted from pollution control equipment	
Interest Rate	5.50%			2016	EPA SCR Control Cost Manual Spreadsheet	
Solid Waste Disposal	200.00	$/ton		2020	Solid waste disposal cost estimated by ArcelorMittal. Material captured in baghouse would be hazardous.	
Contingencies	10%	of purchased equip cost (B)			EPA Cost Control Cost Manual Chapter 2	Suggested contingency range of 5% to 15% of total capital investment
Markup on capital investment (retrofit factor)	50%				EPA Cost Control Cost Manual Chapter 2	
Operating Information						
Annual Op. Hrs	6,558	Hours			Emission Inventory Data	
Utilization Rate	100%				Assumed	
Design Capacity		MMBTU/hr			Boiler Design Capacity	
Equipment Life	20	yrs			Assumed	
Temperature	163	Deg F			Performance test data	
Moisture Content	4.2%				Performance test data	
Actual Flow Rate	484,000	acfm			Performance test data	
Standardized Flow Rate	410,196	scfm @ 68° F	382,226	scfm @ 32° F	Calculated Value	
Dry Std Flow Rate	391,000	dscfm @ 68° F			Performance test data	
Plant Elevation	610	Feet above sea level			Plant elevation	
	Baseline Emissions					
Pollutant	**Lb/Hr**	**Ton/Year**				
Sulfur Dioxides (SO2)	113.1	371.0			Emission inventory data	
SDA - SO_2 Control Efficiency	90%				EPA fact sheet for flue gas desulfurization (new installations) https://www3.epa.gov/ttncatc1/dir1/ffdg.pdf	
DSI - SO_2 Control Efficiency	70%				Control efficiency is based on trona as injected reagent.	

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-3: SO_2 Control Spray Dry Absorber (SDA)
Sinter Plant Windbox

Operating Unit: **Sinter Plant Windbox**

Emission Unit Number			Stack/Vent Number		
Design Capacity		MMBtu/hr	Standardized Flow Rate	382,228	scfm @ 32° F
Utilization Rate	100%		Temperature	163	Deg F
Annual Operating Hours	6,558	Hours	Moisture Content	4.2%	
Annual Interest Rate	5.5%		Actual Flow Rate	484,000	acfm
Equipment Life	20	yrs	Standardized Flow Rate	410,196	scfm @ 68° F
			Dry Std Flow Rate	391,000	dscfm @ 68° F

CONTROL EQUIPMENT COSTS

Capital Costs		
Baghouse and ancillaries - Total Direct Capital Cost, DC		13,820,024
Baghouse and ancillaries - Total Indirect Capital Costs, IC		4,130,122
SDA and Slaker Total Installed Cost		18,828,669
Total Capital Investment (TCI) = DC + IC		36,778,815
Total Capital Investment (TCI) = DC + IC		**36,778,815**
Adjusted TCI for Replacment Parts		36,274,612
SDA/Baghouse TCI with Retrofit Factor		**54,411,918**
Reheat TCI		**975,236**
TCI (SDA/Baghouse/Reheat with Retrofit Factor)		**55,387,154**
Operating Costs		
Total Annual Direct Operating Costs (SDA + Reheat)	Labor, supervision, materials, replacement parts, utilities, etc.	2,191,644
Total Annual Indirect Operating Costs (SDA + Reheat)	Sum indirect oper costs + capital recovery cost	7,232,268
Total SDA + Reheat Annual Cost (Annualized Capital Cost + Operating Cost)		**9,423,912**

Emission Control Cost Calculation

Pollutant	Max Emis Lb/Hr	Annual T/Yr	Cont Eff %	Exit Conc.	Conc. Units	Cont Emis T/yr	Reduction T/yr	Cont Cost $/Ton Rem
PM10						0.0	-	NA
PM2.5						0.0	-	NA
Total Particulates						0.0	-	NA
Nitrous Oxides (NOx)						0.0	-	NA
Sulfur Dioxide (SO_2)		371.0	90%			37.1	333.9	28,224
Sulfuric Acid Mist						0.00	-	NA
Fluorides						0.0	-	NA
Volatile Organic Compounds (VOC)						0.0	-	NA
Carbon Monoxide (CO)						0.0	-	NA
Lead (Pb)						0.00	-	NA

Notes & Assumptions

1 SDA cost is installed included in TCI total. Cost from another Barr Engineering project 2011 (712,400 scfm)
2 Baghouse capital cost estimate based on EPA-R05-OAR-2010-0954-0079, ancillary equipment from other Barr Engineering projects
3 Costs scaled to design airflow using the 6/10 power law
4 Cost scaled up for inflation using the Chemical Engineering Plant Cost Index (CEPCI)
5 Calculations per EPA Air Pollution Control Cost Manual 6th Ed 2002, Section 6 Chapter 1
6 The existing flue gas is too moist for spray dryers, reheat is required to prevent condensation on filter bags

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-3: SO2 Control Spray Dry Absorber (SDA)
Sinter Plant Windbox

CAPITAL COSTS		
Direct Capital Costs		
Baghouse and ancillaries - Purchased Equipment (A) [1]		6,906,556
Purchased Equipment Costs (A) - Absorber + packing + auxiliary equipment, EC		
Instrumentation	10% of control device cost (A)	690,656
State Sales Taxes	0.0% of control device cost (A)	0
Freight	5% of control device cost (A)	345,328
Baghouse and ancillaries - Purchased Equipme	15%	7,942,542
Installation		
Foundations & supports	4% of purchased equip cost (B)	317,702
Handling & erection	50% of purchased equip cost (B)	3,971,271
Electrical	8% of purchased equip cost (B)	635,403
Piping	1% of purchased equip cost (B)	79,425
Insulation	7% of purchased equip cost (B)	555,978
Painting	4% of purchased equip cost (B)	317,702
Baghouse and ancillaries - Installation Subtotal	74%	5,877,481
Other Specific Costs	N/A Site Specific	-
	N/A Site Specific	-
	N/A Site Specific	-
		NA
		5,877,481
Baghouse and ancillaries - Total Direct Capital Cost, DC		13,820,024
Baghouse and ancillaries - Indirect Capital Costs		
Engineering, supervision	10% of purchased equip cost (B)	794,254
Construction & field expenses	20% of purchased equip cost (B)	1,588,508
Contractor fees	10% of purchased equip cost (B)	794,254
Start-up	1% of purchased equip cost (B)	79,425
Performance test	1% of purchased equip cost (B)	79,425
Model Studies	N/A of purchased equip cost (B)	-
Contingencies	10% of purchased equip cost (B)	794,254
Baghouse and ancillaries - Total Indirect Capital C	52% of purchased equip cost (B)	4,130,122
SDA and Slaker Total Installed Cost	Scaled from previous cost estimate	18,828,669
Total Capital Investment (TCI) = DC + IC		36,778,815
Adjusted TCI for Replacement Parts (Catalyst, Filter Bags, etc) for Capital Recovery Cost		36,274,612
Total Capital Investment (TCI) with Retrofit Factor	50%	54,411,918
OPERATING COSTS		
Direct Annual Operating Costs, DC		
Operating Labor		
Operator	67.53 \$/Hr, 2.0 hr/8 hr shift, 6558 hr/yr, 100% utilization	110,716
Supervisor	15% of Op., 0.0 , 6558 hr/yr, 100% utilization	16,607
Maintenance		
Maintenance Labor	67.53 \$/Hr, 1.0 hr/8 hr shift, 6558 hr/yr, 100% utilization	55,358
Maintenance Materials	100% of maintenance labor costs	55,358
Utilities, Supplies, Replacements & Waste Management		
Electricity	0.07 \$/kwh, 876.0 kW-hr, 6558 hr/yr, 100% utilization	419,247
Compressed Air	0.48 \$/kscf, 2.0 scfm/kacfm, 6558 hr/yr, 100% utilization	183,349
N/A		-
SW Disposal	200.00 \$/ton, 0.1 ton/hr, 6558 hr/yr, 100% utilization	148,430
Lime	183.68 \$/ton, 153.1 lb/hr, 6558 hr/yr, 100% utilization	92,209
Filter Bags	228.02 \$/bag, 1,925 bags, 6558 hr/yr, 100% utilization	186,885
N/A		
N/A		-
N/A		-
N/A		-
N/A		-
N/A		-
N/A		-
N/A		-
Total Annual Direct Operating Costs		1,268,160
Indirect Operating Costs		
Overhead	60% of total labor and material costs	142,824
Administration (2% total capital costs)	2% of total capital costs (TCI)	1,088,238
Property tax (1% total capital costs)	1% of total capital costs (TCI)	544,119
Insurance (1% total capital costs)	1% of total capital costs (TCI)	544,119
Capital Recovery	0.0837 for a 20- year equipment life and a 5.5% interest rate	4,740,038
Total Annual Indirect Operating Costs	Sum indirect oper costs + capital recovery cost	7,059,338
Total Annual Cost (Annualized Capital Cost + Operating Cost)		8,327,499

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-3: SO2 Control Spray Dry Absorber (SDA)
Sinter Plant Windbox

Capital Recovery Factors

Primary Installation		
Interest Rate	5.50%	
Equipment Life	20	years
CRF	0.0837	

Replacement Parts & Equipment:	Filter Bags		
Equipment Life	3	years	
CRF	0.3707		
Rep part cost per unit	228.02	$/bag	
Amount Required	1925		
Total Rep Parts Cost	460,872	Cost adjusted for freight & sales tax	
Installation Labor	43,331	10 min per bag	EPA Cont Cost Manual 6th ed Section 6 Chapter 1.5.1.4
Total Installed Cost	504,203		
Annualized Cost	186,885		

Electrical Use

	Flow acfm	D P in H2O	Efficiency	Hp	kW	
Blower, Baghouse	484,000	10.00			5,745,070	Incremental electricity increase over with baghouse replacing scrubber including ducting
Total					5,745,070	

Reagents and Other Operating Costs

Lime Use Rate	1.30 lb-mole CaO/lb-mole SO2	153.10 lb/hr Lime
Solid Waste Disposal	742 ton/yr GSA unreacted sorbent and reaction byproducts	

Operating Cost Calculations

Utilization Rate: 100% | Annual Operating Hours: 6,558

Item	Unit Cost $	Unit of Measure	Use Rate	Unit of Measure	Annual Use*	Annual Cost	Comments
Operating Labor							
Op Labor	67.53	$/Hr	2.0	hr/8 hr shift	1,640	$ 110,716	$/Hr, 2.0 hr/8 hr shift, 6558 hr/yr, 100% utilization
Supervisor	15%	of Op.			NA	$ 16,607	of Op., 0.0 , 6558 hr/yr, 100% utilization
Maintenance							
Maint Labor	67.53	$/Hr	1.0	hr/8 hr shift	820	$ 55,358	$/Hr, 1.0 hr/8 hr shift, 6558 hr/yr, 100% utilization
Maint Mtls	100	% of Maintenance Labor			NA	$ 55,358	% of Maintenance Labor, 0.0 , 6558 hr/yr, 100% utilization
Utilities, Supplies, Replacements & Waste Management							
Electricity	0.073	$/kwh	876.0	kW-hr	5,745,070	$ 419,247	$/kwh, 876.0 kW-hr, 6558 hr/yr, 100% utilization
Compressed Air	0.481	$/kscf	2	scfm/kacfm	380,889	$ 183,349	$/kscf, 2.0 scfm/kacfm, 6558 hr/yr, 100% utilization
Water	5.129	$/mgal		gpm			$/mgal, 0 gpm, 6558 hr/yr, 100% utilization
SW Disposal	200.00	$/ton	0.11	ton/hr	742	$ 148,430	$/ton, 0.1 ton/hr, 6558 hr/yr, 100% utilization
Lime	183.68	$/ton	153.1	lb/hr	502	$ 92,209	$/ton, 153.1 lb/hr, 6558 hr/yr, 100% utilization
Filter Bags	228.02	$/bag	1,925	bags	N/A	$ 186,885	$/bag, 1,925 bags, 6558 hr/yr, 100% utilization

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-4: Flue Gas Reheat for SDA
Sinter Plant Windbox

Operating Unit: **Sinter Plant Windbox**

Emission Unit Number			Stack/Vent Number			**Chemical Engineering**	
Desgin Capacity		MMBTU/hr	Standardized Flow Rate	382,228	scfm @ 32º F	**Chemical Plant Cost Index**	
Expected Utilization Rate	100%		Temperature	163	Deg F	1998/1999	390
Expected Annual Hours of Operation	6,558	Hours	Moisture Content	4.2%		2019	607.5
Annual Interest Rate	5.5%		Actual Flow Rate	484,000	acfm	Inflation Adj	1.56
Expected Equipment Life	20	yrs	Standardized Flow Rate	410,196	scfm @ 68º F		
			Dry Std Flow Rate	391,000	dscfm @ 68º F		

CONTROL EQUIPMENT COSTS

Capital Costs			
Direct Capital Costs			
Purchased Equipment (A)			336,520
Purchased Equipment Total (B)	15%	of control device cost (A)	386,998
Installation - Standard Costs	30%	of purchased equip cost (B)	116,100
Installation - Site Specific Costs			NA
Installation Total			116,100
Total Direct Capital Cost, DC			503,098
Total Indirect Capital Costs, IC	38%	of purchased equip cost (B)	147,059
Total Capital Investment (TCI) = DC + IC			**650,157**
TCI with Retrofit Factor			**975,236**
Operating Costs			
Total Annual Direct Operating Costs		Labor, supervision, materials, replacement parts, utilities, etc.	923,484
Total Annual Indirect Operating Costs		Sum indirect oper costs + capital recovery cost	172,930
Total Annual Cost (Annualized Capital Cost + Operating Cost)			**1,096,414**

Notes & Assumptions

1. Equipment cost estimate EPA Air Pollution Control Cost Manual 6th Ed 2002, Section 3.2 Chapter 2.5.1
2. Calculations per EPA Air Pollution Control Cost Manual 6th Ed 2002, Section 3.2 Chapter 2

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-4: Flue Gas Reheat for SDA
Sinter Plant Windbox

CAPITAL COSTS		
Direct Capital Costs		
Purchased Equipment (A) (1)		336,520
Purchased Equipment Costs (A)		
Instrumentation	10% of control device cost (A)	33,652
MN Sales Taxes	0.0% of control device cost (A)	0
Freight	5% of control device cost (A)	16,826
Purchased Equipment Total (B)	15%	386,998
Installation		
Foundations & supports	8% of purchased equip cost (B)	30,960
Handling & erection	14% of purchased equip cost (B)	54,180
Electrical	4% of purchased equip cost (B)	15,480
Piping	2% of purchased equip cost (B)	7,740
Insulation	1% of purchased equip cost (B)	3,870
Painting	1% of purchased equip cost (B)	3,870
Installation Subtotal Standard Expenses	30%	116,100
Site Preparation, as required	Site Specific	NA
Buildings, as required	Site Specific	NA
Site Specific - Other	Site Specific	NA
Total Site Specific Costs		NA
Installation Total		116,100
Total Direct Capital Cost, DC		503,098
Indirect Capital Costs		
Engineering, supervision	10% of purchased equip cost (B)	38,700
Construction & field expenses	5% of purchased equip cost (B)	19,350
Contractor fees	10% of purchased equip cost (B)	38,700
Start-up	2% of purchased equip cost (B)	7,740
Performance test	1% of purchased equip cost (B)	3,870
Model Studies	of purchased equip cost (B)	0
Contingencies	10% of purchased equip cost (B)	38,700
Total Indirect Capital Costs, IC	38% of purchased equip cost (B)	147,059
Total Capital Investment (TCI) = DC + IC		650,157
Adjusted TCI for Replacement Parts (Catalyst, Filter Bags, etc) for Capital Recovery Cost		650,157
Total Capital Investment (TCI) with Retrofit Factor	50%	975,236
OPERATING COSTS		
Direct Annual Operating Costs, DC		
Operating Labor		
Operator	67.53 \$/Hr, 0.5 hr/8 hr shift, 6558 hr/yr	27,679
Supervisor	15% 15% of Operator Costs	4,152
Maintenance		
Maintenance Labor	67.53 \$/Hr, 0.5 hr/8 hr shift, 6558 hr/yr	27,679
Maintenance Materials	100% of maintenance labor costs	27,679
Utilities, Supplies, Replacements & Waste Management		
NA	NA	-
Natural Gas	6.15 \$/mscf, 345 scfm, 6558 hr/yr, 100% utilization	836,294
Total Annual Direct Operating Costs		923,484
Indirect Operating Costs		
Overhead	60% of total labor and material costs	52,313
Administration (2% total capital costs)	2% of total capital costs (TCI)	19,505
Property tax (1% total capital costs)	1% of total capital costs (TCI)	9,752
Insurance (1% total capital costs)	1% of total capital costs (TCI)	9,752
Capital Recovery	0.0837 for a 20- year equipment life and a 5.5% interest rate	81,607
Total Annual Indirect Operating Costs	Sum indirect oper costs + capital recovery cost	172,930
Total Annual Cost (Annualized Capital Cost + Operating Cost)		1,096,414

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-4: Flue Gas Reheat for SDA
Sinter Plant Windbox

Capital Recovery Factors	
Primary Installation	
Interest Rate	5.50%
Equipment Life	20 years
CRF	0.0837

Replacement Catalyst:	Catalyst	
Equipment Life	3 years	
CRF	0.3707	
Rep part cost per unit	0 $/ft^3	
Amount Required	39 ft^3	
Catalyst Cost	0	Cost adjusted for freight & sales tax
Installation Labor	0	Assume Labor = 15% of catalyst cost (basis labor for baghouse replacement)
Total Installed Cost	0	**Zero out if no replacement parts needed**
Annualized Cost	0	

Replacement Parts & Equipment:			
Equipment Life	3		
CRF	0.3707		
Rep part cost per unit	0	$ each	
Amount Required	0	Number	
Total Rep Parts Cost	0	Cost adjusted for freight & sales tax	
Installation Labor	0	10 min per bag (13 hr total) Labor at $29.65/hr	OAQPS list replacement times from 5 - 20 min per bag.
Total Installed Cost	0	**Zero out if no replacement parts needed**	
Annualized Cost	0		

Electrical Use	Flow acfm	ΔP in H2O	Efficiency	Hp	kW	
Blower, Thermal	484,000	19	0.6		1,793.2	EPA Cost Cont Manual 6th ed - Oxidizders Chapter 2.5.2.1
Blower, Catalytic	484,000	23	0.6		2,170.7	EPA Cost Cont Manual 6th ed - Oxidizders Chapter 2.5.2.1
Oxidizer Type	thermal	(catalytic or thermal)			0.0	N/A - Reheat is a duct burner, negligible presssure drop

Reagent Use & Other Operating Costs Oxidizers - NA

Operating Cost Calculations — **Annual hours of operation:** 6,558; **Utilization Rate:** 100%

Item	Unit Cost $	Unit of Measure	Use Rate	Unit of Measure	Annual Use*	Annual Cost	Comments
Operating Labor							
Op Labor	67.53	$/Hr	0.5	hr/8 hr shift	410	27,679	$/Hr, 0.5 hr/8 hr shift, 6558 hr/yr
Supervisor	15%	of Op.			NA	4,152	15% of Operator Costs
Maintenance							
Maint Labor	67.53	$/Hr	0.5	hr/8 hr shift	410	27,679	$/Hr, 0.5 hr/8 hr shift, 6558 hr/yr
Maint Mtls	100	% of Maintenance Labor			NA	27,679	100% of Maintenance Labor
Utilities, Supplies, Replacements & Waste Management							
Electricity	0.073	$/kwh	0.0	kW-hr	0	0	$/kwh, 0 kW-hr, 6558 hr/yr, 100% utilization
Natural Gas	6.15	$/mscf	345	scfm	135,939	836,294	$/mscf, 345 scfm, 6558 hr/yr, 100% utilization

*annual use rate is in same units of measurement as the unit cost factor

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-4: Flue Gas Reheat for SDA
Sinter Plant Windbox

Flue Gas Re-Heat Equipment Cost Estimate Basis Thermal Oxidizer with 70% Heat Recovery

Auxiliary Fuel Use Equation 3.19

T_{wi}	163	Deg F - Temperature of waste gas into heat recovery
T_{fi}	193	Deg F - Temperature of Flue gas into heat recovery
T_{ref}	77	Deg F - Reference temperature for fuel combustion calculations
FER	0%	Factional Heat Recovery % Heat recovery section efficiency
T_{wo}	163	Deg F - Temperature of waste gas out of heat recovery
T_{fo}	193	Deg F - Temperature of flue gas out of heat recovery
$-h_{caf}$	21502	Btu/lb Heat of combustion auxiliary fuel (methane)
$-h_{wg}$	0	Btu/lb Heat of combustion waste gas
$C_{p\,wg}$	0.2400	Btu/lb - Deg F Heat Capacity of waste gas (air)
ρ_{wg}	0.0739	lb/scf - Density of waste gas (air) at 77 Deg F
ρ_{af}	0.0408	lb/scf - Density of auxiliary fuel (methane) at 77 Deg F
Q_{wg}	410,196	scfm - Flow of waste gas
Q_{af}	345	scfm - Flow of auxiliary fuel

Year 2005 Inflation Rate 3.0%

Cost Calculations 410,541 scfm Flue Gas Cost in 1989 $'s $216,038

Current Cost Using CHE Plant Cost Index $336,520

Heat Rec %	A	B	
0	10,294	0.2355	Exponents per equation 3.24
0.3	13,149	0.2609	Exponents per equation 3.25
0.5	17,056	0.2502	Exponents per equation 3.26
0.7	21,342	0.2500	Exponents per equation 3.27

Reference: OAQPS Control Cost Manual 5th Ed Feb 1996 - Chapter 3 Thermal & Catalytic Incinerators (EPA 453/B-96-001)

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-5: SO2 Control Dry Sorbent Injection (DSI)
Sinter Plant Windbox

Operating Unit: Sinter Plant Windbox

Emission Unit Number			Stack/Vent Number		
Design Capacity		MMBtu/hr	Standardized Flow Rate	382,228	scfm @ 32º F
Utilization Rate	100%		Exhaust Temperature	163	Deg F
Annual Operating Hours	6,558	hr/yr	Exhaust Moisture Content	4.2%	
Annual Interest Rate	5.50%		Actual Flow Rate	484,000	acfm
Control Equipment Life	20	yrs	Standardized Flow Rate	410,196	scfm @ 68º F
Plant Elevation	610	ft	Dry Std Flow Rate	391,000	dscfm @ 68º F

CONTROL EQUIPMENT COSTS

Capital Costs			
Direct Capital Costs			
Purchased Equipment (A)			7,552,681
Purchased Equipment Total (B)	15%	of control device cost (A)	8,685,583
Installation - Standard Costs	74%	of purchased equip cost (B)	6,427,331
Installation - Site Specific Costs			N/A
Installation Total			6,427,331
Total Direct Capital Cost, DC			15,112,914
Total Indirect Capital Costs, IC	52%	of purchased equip cost (B)	4,516,503
Total Capital Investment (TCI) = DC + IC			19,125,215
Adjusted TCI for Replacement Parts			19,125,215
DSI TCI with Retrofit Factor			28,687,822
Reheat TCI			975,911
TCI (DSC + Reheat with Retrofit Factor)			29,663,733
Operating Costs			
Total Annual Direct Operating Costs (DSI + Reheat)		Labor, supervision, materials, replacement parts, utilities, etc.	5,627,044
Total Annual Indirect Operating Costs (DSI + Reheat)		Sum indirect oper costs + capital recovery cost	4,050,813
Total DSI + Reheat Annual Cost (Annualized Capital Cost + Operating Cost)			9,677,857

Emission Control Cost Calculation

Pollutant	Lb/Hr	Annual Ton/Yr	Cont Eff %	Cont Emis Ton/Yr	Reduction Ton/Yr	Cont Cost $/Ton Rem
PM10						
PM2.5						
Total Particulates						
Nitrous Oxides (NOx)						
Sulfur Dioxide (SO2)	113.14	371.00	70%	111.30	259.70	$37,300
Sulfuric Acid Mist (H2SO4)						
Fluorides						
Volatile Organic Compounds (VOC)						
Carbon Monoxide (CO)						
Lead (Pb)						

Notes & Assumptions
1 Baghouse capital cost estimate based on EPA-R05-OAR-2010-0954-0079, ancillary equipment from other Barr Engineering projects
2 Costs scaled up to design airflow using the 6/10 power law
3 Cost scaled up for inflation using the Chemical Engineering Plant Cost Index (CEPCI)
4 Calculations per EPA Air Pollution Control Cost Manual 6th Ed 2002, Section 6 Chapter 1
5 Reheat is required to reach DSI reaction temperature

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-5: SO2 Control Dry Sorbent Injection (DSI)
Sinter Plant Windbox

CAPITAL COSTS		
Direct Capital Costs		
Purchased Equipment (A) [1]		7,552,681
Purchased Equipment Costs (A) - Injection System + auxiliary equipment, EC		
Instrumentation	10% Included in vendor estimate	755,268
State Sales Taxes	0.0% of control device cost (A)	-
Freight	5% of control device cost (A)	377,634
Purchased Equipment Total (B)	15%	8,685,583
Installation		
Foundations & supports	4% of purchased equip cost (B)	347,423
Handling & erection	50% of purchased equip cost (B)	4,342,791
Electrical	8% of purchased equip cost (B)	694,847
Piping	1% of purchased equip cost (B)	86,856
Insulation	7% of purchased equip cost (B)	607,991
Painting	4% included in vendor estimate	347,423
Installation Subtotal Standard Expenses	74%	6,427,331
Other Specific Costs (see summary)		
Site Preparation, as required	N/A Site Specific	
Buildings, as required	N/A Site Specific	
Lost Production for Tie-In	N/A Site Specific	
Total Site Specific Costs		N/A
Installation Total		6,427,331
Total Direct Capital Cost, DC		15,112,914
Indirect Capital Costs		
Engineering, supervision	10% of purchased equip cost (B)	868,558
Construction & field expenses	20% of purchased equip cost (B)	1,737,117
Contractor fees	10% of purchased equip cost (B)	868,558
Start-up	1% of purchased equip cost (B)	86,856
Performance test	1% of purchased equip cost (B)	86,856
Model Studies	N/A of purchased equip cost (B)	-
Contingencies	10% of purchased equip cost (B)	868,558
Total Indirect Capital Costs, IC	52% of purchased equip cost (B)	4,516,503
Total Capital Investment (TCI) = DC + IC		19,629,417
Adjusted TCI for Replacement Parts (Catalyst, Filter Bags, etc) for Capital Recovery Cost		19,125,215
Total Capital Investment (TCI) with Retrofit Factor	50%	28,687,822
OPERATING COSTS		
Direct Annual Operating Costs, DC		
Operating Labor		
Operator	67.53 $/Hr	110,716
Supervisor	0.15 of Op Labor	16,607
Maintenance		
Maintenance Labor	67.53 $/Hr	55,358
Maintenance Materials	100 % of Maintenance Labor	55,358
Utilities, Supplies, Replacements & Waste Management		
Electricity	0.07 $/kwh, 525.6 kW-hr, 6558 hr/yr, 100% utilization	251,548
N/A		-
Compressed Air	0.48 $/kscf, 2.0 scfm/kacfm, 6558 hr/yr, 100% utilization	183,349
N/A		-
Solid Waste Disposal	200.00 $/ton, 0.3 ton/hr, 6558 hr/yr, 100% utilization	331,182
Trona	285.00 $/ton, 628.6 lb/hr, 6558 hr/yr, 100% utilization	587,463
Filter Bags	228.02 $/bag, 1,925 bags, 6558 hr/yr, 100% utilization	186,885
N/A		-
N/A		-
N/A		-
N/A		-
Total Annual Direct Operating Costs		1,778,466
Indirect Operating Costs		
Overhead	60% of total labor and material costs	142,824
Administration (2% total capital costs)	2% of total capital costs (TCI)	573,756
Property tax (1% total capital costs)	1% of total capital costs (TCI)	286,878
Insurance (1% total capital costs)	1% of total capital costs (TCI)	286,878
Capital Recovery	0.0837 for a 20-year equipment life and a 5.5% interest rate	2,400,578
Total Annual Indirect Operating Costs	Sum indirect oper costs + capital recovery costs	3,877,799
Total Annual Cost (Annualized Capital Cost + Operating Cost)		5,656,266

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-5: SO2 Control Dry Sorbent Injection (DSI)
Sinter Plant Windbox

Capital Recovery Factors

Primary Installation	
Interest Rate	5.50%
Equipment Life	20 years
CRF	0.0837

Replacement Parts & Equipment: **Filter Bags**

Equipment Life	3	years
CRF	0.3707	
Rep part cost per unit	228.02	$/bag
Amount Required	1925	Bags
Total Rep Parts Cost	460,872	Cost adjusted for freight, sales tax, and bag disposal
Installation Labor	43,331	20 min per bag
Total Installed Cost	504,203	
Annualized Cost	186,885	

Electrical Use

	Flow acfm	D P in H2O	kWhr/yr	
Blower	484,000	6.00	3,447,042	Incremental electricity increase over with baghouse replacing scrubber including ducting
Total			3,447,042	

Reagent Use & Other Operating Costs

Trona use - 1.5 NSR	113.14	lb/hr SO2	628.63	lb/hr Trona
Solid Waste Disposal	1,656	ton/yr DSI unreacted sorbent and reaction byproducts		

Operating Cost Calculations

Utilization Rate: 100% — Annual Operating Hours: 6,558

Item	Unit Cost $	Unit of Measure	Use Rate	Unit of Measure	Annual Use*		Annual Cost	Comments
Operating Labor								
Op Labor	67.53	$/Hr	2.0	hr/8 hr shift	1,640	$	110,716	$/Hr, 2.0 hr/8 hr shift, 1,640 hr/yr
Supervisor	15%	of Op Labor			NA	$	16,607	% of Operator Costs
Maintenance								
Maint Labor	67.53	$/Hr	1.0	hr/8 hr shift	820	$	55,358	$/Hr, 1.0 hr/8 hr shift, 820 hr/yr
Maint Mtls	100%	of Maintenance Labor			NA	$	55,358	100% of Maintenance Labor
Utilities, Supplies, Replacements & Waste Management								
Electricity	0.073	$/kwh	525.6	kW-hr	3,447,042	$	251,548	$/kwh, 525.6 kW-hr, 6558 hr/yr, 100% utilization
Water			N/A	gpm				
Compressed Air	0.481	$/kscf	2.0	scfm/kacfm	380,889	$	183,349	$/kscf, 2.0 scfm/kacfm, 6558 hr/yr, 100% utilization
Cooling Water			N/A	gpm				
Solid Waste Disposal	200.00	$/ton	0.3	ton/hr	1,656	$	331,182	$/ton, 0.3 ton/hr, 6558 hr/yr, 100% utilization
Trona	285.00	$/ton	628.6	lb/hr	2,061	$	587,463	$/ton, 628.6 lb/hr, 6558 hr/yr, 100% utilization
Filter Bags	228.02	$/bag	1,925	bags	N/A	$	186,885	$/bag, 1,925 bags, 6558 hr/yr, 100% utilization

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-6: Flue Gas Reheat for DSI
Sinter Plant Windbox

Operating Unit: Sinter Plant Windbox

						Chemical Engineering Chemical Plant Cost Index	
Emission Unit Number			Stack/Vent Number				
Desgin Capacity		MMBTU/hr	Standardized Flow Rate	382,228	scfm @ 32º F		
Expected Utilization Rate	100%		Temperature	163	Deg F	1998/1999	390
Expected Annual Hours of Operation	6,558	Hours	Moisture Content	4.2%		2019	607.5
Annual Interest Rate	5.5%		Actual Flow Rate	484,000	acfm	Inflation Adj	1.56
Expected Equipment Life	20	yrs	Standardized Flow Rate	410,196	scfm @ 68º F		
			Dry Std Flow Rate	391,000	dscfm @ 68º F		

CONTROL EQUIPMENT COSTS

Capital Costs			
Direct Capital Costs			
Purchased Equipment (A)			336,753
Purchased Equipment Total (B)	15%	of control device cost (A)	387,266
Installation - Standard Costs	30%	of purchased equip cost (B)	116,180
Installation - Site Specific Costs			NA
Installation Total			116,180
Total Direct Capital Cost, DC			503,446
Total Indirect Capital Costs, IC	38%	of purchased equip cost (B)	147,161
Total Capital Investment (TCI) = DC + IC			**650,608**
TCI with Retrofit Factor			**975,911**
Operating Costs			
Total Annual Direct Operating Costs		Labor, supervision, materials, replacement parts, utilities, etc.	3,848,577
Total Annual Indirect Operating Costs		Sum indirect oper costs + capital recovery cost	173,014
Total Annual Cost (Annualized Capital Cost + Operating Cost)			**4,021,591**

Notes & Assumptions
1 Equipment cost estimate EPA Air Pollution Control Cost Manual 6th Ed 2002, Section 3.2 Chapter 2.5.1
2 Calculations per EPA Air Pollution Control Cost Manual 6th Ed 2002, Section 3.2 Chapter 2

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-6: Flue Gas Reheat for DSI
Sinter Plant Windbox

CAPITAL COSTS		
Direct Capital Costs		
Purchased Equipment (A) (1)		336,753
Purchased Equipment Costs (A)		
Instrumentation	10% of control device cost (A)	33,675
MN Sales Taxes	0.0% of control device cost (A)	0
Freight	5% of control device cost (A)	16,838
Purchased Equipment Total (B)	15%	387,266
Installation		
Foundations & supports	8% of purchased equip cost (B)	30,981
Handling & erection	14% of purchased equip cost (B)	54,217
Electrical	4% of purchased equip cost (B)	15,491
Piping	2% of purchased equip cost (B)	7,745
Insulation	1% of purchased equip cost (B)	3,873
Painting	1% of purchased equip cost (B)	3,873
Installation Subtotal Standard Expenses	30%	116,180
Site Preparation, as required	Site Specific	NA
Buildings, as required	Site Specific	NA
Site Specific - Other	Site Specific	NA
Total Site Specific Costs		NA
Installation Total		116,180
Total Direct Capital Cost, DC		503,446
Indirect Capital Costs		
Engineering, supervision	10% of purchased equip cost (B)	38,727
Construction & field expenses	5% of purchased equip cost (B)	19,363
Contractor fees	10% of purchased equip cost (B)	38,727
Start-up	2% of purchased equip cost (B)	7,745
Performance test	1% of purchased equip cost (B)	3,873
Model Studies	of purchased equip cost (B)	0
Contingencies	10% of purchased equip cost (B)	38,727
Total Indirect Capital Costs, IC	38% of purchased equip cost (B)	147,161
Total Capital Investment (TCI) = DC + IC		650,608
Adjusted TCI for Replacement Parts (Catalyst, Filter Bags, etc) for Capital Recovery Cost		650,608
Total Capital Investment (TCI) with Retrofit Factor	50%	975,911
OPERATING COSTS		
Direct Annual Operating Costs, DC		
Operating Labor		
Operator	67.53 $/Hr, 0.5 hr/8 hr shift, 6558 hr/yr	27,679
Supervisor	15% 15% of Operator Costs	4,152
Maintenance		
Maintenance Labor	67.53 $/Hr, 0.5 hr/8 hr shift, 6558 hr/yr	27,679
Maintenance Materials	100% of maintenance labor costs	27,679
Utilities, Supplies, Replacements & Waste Management		
NA	NA	-
Natural Gas	6.15 $/mscf, 1,554 scfm, 6558 hr/yr, 100% utilization	3,761,388
Total Annual Direct Operating Costs		3,848,577
Indirect Operating Costs		
Overhead	60% of total labor and material costs	52,313
Administration (2% total capital costs)	2% of total capital costs (TCI)	19,518
Property tax (1% total capital costs)	1% of total capital costs (TCI)	9,759
Insurance (1% total capital costs)	1% of total capital costs (TCI)	9,759
Capital Recovery	0.0837 for a 20- year equipment life and a 5.5% interest rate	81,664
Total Annual Indirect Operating Costs	Sum indirect oper costs + capital recovery cost	173,014
Total Annual Cost (Annualized Capital Cost + Operating Cost)		4,021,591

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-6: Flue Gas Reheat for DSI
Sinter Plant Windbox

Capital Recovery Factors		
Primary Installation		
Interest Rate	5.50%	
Equipment Life	20	years
CRF	0.0837	

Replacement Catalyst:	**Catalyst**	
Equipment Life	3	years
CRF	0.3707	
Rep part cost per unit	0	$/ft^3
Amount Required	39	ft^3
Catalyst Cost	0	Cost adjusted for freight & sales tax
Installation Labor	0	Assume Labor = 15% of catalyst cost (basis labor for baghouse replacement)
Total Installed Cost	0	**Zero out if no replacement parts needed**
Annualized Cost	0	

Replacement Parts & Equipment:			
Equipment Life	3		
CRF	0.3707		
Rep part cost per unit	0	$ each	
Amount Required	0	Number	
Total Rep Parts Cost	0	Cost adjusted for freight & sales tax	
Installation Labor	0	10 min per bag (13 hr total) Labor at $29.65/hr	OAQPS list replacement times from 5 - 20 min per bag.
Total Installed Cost	0	**Zero out if no replacement parts needed**	
Annualized Cost	0		

Electrical Use	Flow acfm	Δ P in H2O	Efficiency	Hp	kW	
Blower, Thermal	484,000	19	0.6		1,793.2	EPA Cost Cont Manual 6th ed - Oxidizders Chapter 2.5.2.1
Blower, Catalytic	484,000	23	0.6		2,170.7	EPA Cost Cont Manual 6th ed - Oxidizders Chapter 2.5.2.1
Oxidizer Type	thermal	(catalytic or thermal)			0.0	N/A - Reheat is a duct burner, negligible presssure drop

Reagent Use & Other Operating Costs Oxidizers - NA

Operating Cost Calculations — **Annual hours of operation:** 6,558 — **Utilization Rate:** 100%

Item	Unit Cost $	Unit of Measure	Use Rate	Unit of Measure	Annual Use*	Annual Cost	Comments
Operating Labor							
Op Labor	67.53	$/Hr	0.5	hr/8 hr shift	410	27,679	$/Hr, 0.5 hr/8 hr shift, 6558 hr/yr
Supervisor	15%	of Op.			NA	4,152	15% of Operator Costs
Maintenance							
Maint Labor	67.53	$/Hr	0.5	hr/8 hr shift	410	27,679	$/Hr, 0.5 hr/8 hr shift, 6558 hr/yr
Maint Mtls	100	% of Maintenance Labor			NA	27,679	100% of Maintenance Labor
Utilities, Supplies, Replacements & Waste Management							
Electricity	0.073	$/kwh	0.0	kW-hr	0	0	$/kwh, 0 kW-hr, 6558 hr/yr, 100% utilization
Natural Gas	6.15	$/mscf	1,554	scfm	611,409	3,761,388	$/mscf, 1,554 scfm, 6558 hr/yr, 100% utilization

*annual use rate is in same units of measurement as the unit cost factor

ArcelorMittal Indiana Harbor East
Regional Haze Four-Factor Analyses for NO_X and SO_2 Emission Controls
Appendix C.3 - Table C.3-6: Flue Gas Reheat for DSI
Sinter Plant Windbox

Flue Gas Re-Heat Equipment Cost Estimate Basis Thermal Oxidizer with 70% Heat Recovery

Auxiliary Fuel Use Equation 3.19

T_{wi}	163	Deg F - Temperature of waste gas into heat recovery
T_{fi}	325	Deg F - Temperature of Flue gas into heat recovery
T_{ref}	77	Deg F - Reference temperature for fuel combustion calculations
FER	0%	Factional Heat Recovery % Heat recovery section efficiency
T_{wo}	163	Deg F - Temperature of waste gas out of heat recovery
T_{fo}	325	Deg F - Temperature of flue gas out of heat recovery
$-h_{cal}$	21502	Btu/lb Heat of combustion auxiliary fuel (methane)
$-h_{wg}$	0	Btu/lb Heat of combustion waste gas
$C_{p\,wg}$	0.2400	Btu/lb - Deg F Heat Capacity of waste gas (air)
ρ_{wg}	0.0739	lb/scf - Density of waste gas (air) at 77 Deg F
ρ_{al}	0.0408	lb/scf - Density of auxiliary fuel (methane) at 77 Deg F
Q_{wg}	410,196	scfm - Flow of waste gas
Q_{af}	1,554	scfm - Flow of auxiliary fuel

Year	2005	Inflation Rate	3.0%	
Cost Calculations	411,750	scfm Flue Gas	Cost in 1989 $'s	$216,187
			Current Cost Using CHE Plant Cost Index	$336,753

Heat Rec %	A	B	
0	10,294	0.2355	Exponents per equation 3.24
0.3	13,149	0.2609	Exponents per equation 3.25
0.5	17,056	0.2502	Exponents per equation 3.26
0.7	21,342	0.2500	Exponents per equation 3.27

Reference: OAQPS Control Cost Manual 5th Ed Feb 1996 - Chapter 3 Thermal & Catalytic Incinerators (EPA 453/B-96-001)