NUCOR
BAR MILL GROUP

PLYMOUTH DIVISION

March 22, 2017

Bryce Bird –Director
Utah Division of Air Quality
P.O. Box 144820
Salt Lake City, Utah 84114-4820

Document Date: 03/22/2017

DAQ-2017-003841

Attn: Nando Meli

Re: BACM/BACT Response Nucor Steel Utah

Dear Mr. Bird:

Enclosed is Nucor's response to your letter dated January 23, 2017 requesting that we provide information to address BACM/BACT for our emission sources of PM2.5 and the precursors.

If you need any further information please do not hesitate to contact me at 435-458-2415.

Sincerely,

Douglas Jones
Environmental Manager
Nucor Steel Utah, Kingman Arizona

attachment

BEST AVAILABLE CONTROL TECHNOLOGY (BACT) DEMONSTRATIONS

Nucor's steel mill is subject to the PSD regulations for SO_2, NO_2, PM_{10}, CO, VOC, and Pb, which mandate that a case-by-case Best Available Control Technology (BACT) analysis be performed to obtain a PSD permit. Nucor last received an updated PSD permit for all emission sources at the mill in 2013 where a BACT analysis was completed as if the facility were an entirely new source.

A review of the BACT analysis finds that the recently completed BACT analysis for the existing PSD permit remains unchanged, and that all necessary controls have been incorporated in to Nucor's Approval Order's, Title V Permit, and the Moderate SIP Nucor source specific limits. For development of the Serious Nonattainment area SIP for the pollutant PM 2.5, it is required that the pollutants of direct PM 2.5, and the precursor (SO2, NOx, VOC, and Ammonia) emissions, be examined for BACT applicability. This document includes a review of the analysis for these (only) pollutants that has already been incorporated into Nucor's permits

BACT Definition and Applicability

The definition of BACT may be found in Section 165(a)(4) of the Clean Air Act or in the PSD regulations under 40 CFR 52.21(j). BACT is defined as:

"...an emissions limitation (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to regulation under the Clean Air Act which would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant. In no event shall application of best available control technology result in emissions of any pollutant which would exceed the emissions allowed by any applicable standard under 40 CFR Parts 60 and 61. If the Administrator determines that technological or economic limitations on the application of the measurement methodology to a particular emissions unit would make the imposition of an emissions standard infeasible, a design, equipment, work practice, operational standard, or combination thereof, may be prescribed instead to satisfy the requirement for the application of best available control technology. Such standard shall, to the degree possible, set forth the emissions reduction achievable by the implementation of such design, equipment, work practice or operation, and shall provide for compliance by means which achieve equivalent results."

The present BACT analysis follows USEPA's top-down approach. In the top-down approach, progressively less stringent control technologies are analyzed until a level of control considered BACT is reached on the basis of environmental, energy and economic impacts. The key steps in the top-down process are:

- Identify viable options;

- Eliminate technically infeasible options;

- Rank remaining alternatives by control effectiveness;

- Evaluate most effective controls; and

- Select BACT.

The sources of information on control alternatives vary for the emission sources being analyzed. The following information resources may be consulted in searching for the alternatives:

1. Downloadable USEPA RACT/BACT Clearinghouse (RBLC) System;

2. USEPA/State/Local Air Quality Permits;

3. Federal/State/Local Permit Engineers;

4. Control Technology Vendors; and

5. Inspection/Performance Test Reports.

Once the technically feasible control alternatives have been identified, they should be ranked in order of control effectiveness, with the most effective control alternative at the top. The ranked alternatives are reviewed with respect to environmental, energy, and economic considerations specific to the proposed steel mill. However, an applicant proposing the top-rated control alternative need not provide costs and other economic information relative to the other control options (refer, "New Source Review Workshop Manual", USEPA, October 1990). If the analysis determines that the examined alternative is not appropriate as BACT due to any of these considerations, then the next most stringent alternative is subjected to the same review. This process is repeated until a control alternative is justified to represent BACT. The proposed BACT must provide emission limitations which are at least as stringent as the applicable federally-approved State Implementation Plan (SIP) or the federal NSPS and National Emission Standards for Hazardous Air Pollutants (NESHAP) emission standards.

The impact analysis of the BACT review focuses on environmental, energy, and economic impacts. The net environmental impact associated with the control alternative should be reviewed. This is generally satisfied with the dispersion modeling which is performed as a part of PSD review. The dispersion modeling normally considers a "worst-case" scenario, thus constituting an assessment of the maximum environmental impacts. The energy impact analysis estimates the direct energy impacts of the control alternatives in units of energy consumption. If possible, the energy requirements of the control option is assessed in terms of total and incremental (units of energy per ton of reduction) energy costs. The economic impact of a control option is typically assessed in terms of cost-effectiveness and ultimately whether the option is economically reasonable. Normally, the economic impacts are reviewed on a cost per ton of pollutant removed basis.

Several sources were consulted regarding recent steel mill operations and the associated control implemented. These sources included the RBLC database, recent permit applications, USEPA air permitting authorities, and equipment vendors.

Table 2-2 presents a summary of the BACT determinations for recent applications for new and modified electric arc furnaces. This list separates EAF that use the CONSTEEL process versus those using the traditional batch process. The CONSTEEL process consists of loading scrap onto a conveyor that continuously feeds the electric arc furnace (EAF). Lime and carbon are continuously added to the scrap prior to entering the EAF. Other alloys are added to the EAF using a conveyor from the alloy bin storage area. After initial charging by a charge bucket to develop a molten heel, the EAF will continuously receive scrap metal and other scrap substitutes, lime, carbon, and carbon units by the CONSTEEL process where the raw materials are melted into molten steel. The CONSTEEL process is a unique method of charging steel, where the scrap steel is conveyed into the EAF while the hot off-gases from the furnace are sent counter currently, thus preheating the scrap. The Utah mill EAF is the traditional bucket charged EAF.

BACT/LAER Analysis for Electric Arc Furnaces

The existing electric arc furnaces (EAFs) operate in a batch mode whereby the scrap steel and potentially scrap substitutes are charged, melted, and tapped. During normal operation, cold scrap metal and scrap substitutes, carbon and fluxing agents are charged into the EAF shell, powered by a high-powered transformer. A large electrical potential is applied to the carbon electrodes. The combination of the heat from the arcing process, burners, and carbon sources melt the scrap and scrap substitutes into molten steel. As the scrap begins to melt, the temperature of the exhaust gas from the EAF increases appreciably. As melting progresses, oxygen lancing and carbon injection are performed, the temperature of the exhaust gas stream can approach 3,000 °F, which is approximately the temperature of molten steel. This operational cycle is repeated for each batch, which can take up to one hour to complete.

The capture system for exhaust gases from the EAF is a direct evacuation control (DEC) and an overhead roof exhaust system consisting of a canopy hood. The DEC duct locally evacuates the exhaust gases directly from the furnace to the main duct system directed to the EAF baghouse. The roof exhaust system evacuates fugitive fumes from the closed roof plenums located over the EAF and direct them through the main duct system directed to the EAF baghouse.

The dust collection equipment for the EAF baghouse consists of a reverse-air type multi-compartment positive pressure baghouse. Each module currently contains multiple bags, with all necessary bag cleaning mechanisms, gas flow control, and collected material transfer and removal equipment. The design of the multi-compartment EAF baghouse will allow for on-line maintenance and cleaning. The air moving mechanism for the system consists of multiple blowers. Nucor Steel has installed a Continuous Emissions Monitoring System (CEMS) for the pollutants CO, NO_x, and SO_2 and a bag leak detection system (BLDS) for particulates.

EAF BACT Control of Oxides of Nitrogen (NO_x) Emissions

NO_x is formed from the chemical reaction between nitrogen and oxygen at high temperatures. NO_x formation occurs by different mechanisms. In the case of EAF, NO_x predominantly forms from thermal dissociation and subsequent reaction of nitrogen and oxygen molecules in the combustion air. This mechanism of NO_x formation is referred to as thermal NO_x. The other mechanisms of NO_x formation such as fuel NO_x (due to the evolution and reaction of fuel-bound nitrogen compounds with oxygen) and prompt NO_x (due to the formation of HCN followed by oxidation to NO_x) are thought to have lesser contributions to NO_x emissions from EAFs.

Based on a review of the RBLC database and discussions with various individuals knowledgeable about steel mill operations, it was revealed that control technologies for NO_x abatement have not been successfully implemented for EAF emissions. However, NO_x control technologies are currently available for fossil-fueled boilers, stationary combustion engines and turbines. Thus, these control alternatives are potentially available to control NO_x from an EAF. These control options have been reviewed for technical feasibility in this BACT analysis. Due to the lack of successful application of such controls to an EAF, they are considered a "technology transfer". The present limit (about 0.32 lb/ton) is at the lower end of the BACT range for electric arc furnaces.

Potential EAF NO_x Control Alternatives

The alternatives available to control NO_x emissions from the existing EAF include the following:

1. Combustion Controls;

2. Selective Catalytic Reduction (SCR);

3. Non-Selective Catalytic Reduction (NSCR);

4. $SCONO_x$ Catalytic Oxidation/Absorption;

5. Shell $DeNO_x$ System (modified SCR);

6. Selective Non-Catalytic Reduction (SNCR) options -

   - Exxon's Thermal $DeNO_x$®

   - Nalco Fuel Tech's NO_xOUT®

   - Low Temperature Oxidation (LTO)

Technical Feasibility of NO_x Control Alternatives

The test for technical feasibility of any control option is whether it is both available and applicable to reducing NO_x emissions from the existing EAF. The previously listed information resources were consulted to determine the extent of applicability of each identified control alternative.

(1) Combustion Controls -- There is an entire family of combustion controls for NO_x reduction from various combustion units as follows:

a. Low Excess Air (LEA);

b. Oxyfuel Burner;

c. Overfire Air (OFA);

d. Burners Out Of Service (BOOS);

e. Reduced Combustion Air Temperature;

f. Load Reduction; and

g. Flue Gas Recirculation (FGR)

The **LEA option** is typically used in conjunction with some of the other options. The use of this option will result in the generation of additional CO emissions. In addition, LEA is not very effective for implementation in electric arc furnaces which do not

operate with combustion air feeds, since the combustion process is not modulated with the near-atmospheric furnace conditions. Thus, this option is considered technically infeasible for this application and will not be considered any further in this BACT analysis.

The **OFA option** is geared primarily for fuel NO_x reduction. Fuel NOx is not a significant portion of the total NOx generated in a furnace. Overfire Air is not feasible in an electric arc furnace because of the high turbulence in the furnace environment.

The **BOOS and Load Reduction (or Deration) options** incorporate a reduction in furnace load, thereby, potentially reducing NO_x formation. This reduction must be balanced, however, against a longer period of NO_x generation resulting from the furnace's inability to efficiently melt scrap and scrap substitutes. Furthermore, both BOOS and Load Reduction are fundamentally inconsistent with the design criterion for the furnace, which is to increase furnace loadings to achieve enhanced production. In addition, adverse capital and installation costs would be realized in over-designing the furnace to allow this technology to operate. Accordingly, these options are judged technically infeasible for this particular application and will not be considered any further in this BACT analysis.

The **Reduced Combustion Air Temperature option** inhibits thermal NO_x production. However, the option is limited to equipment with combustion air preheaters which are not applicable to EAFs. Thus, this option is considered technically infeasible for this application and will not be considered any further in this BACT analysis.

The **FGR option** involves recycling a portion of the cooled exit flue gas back into the primary combustion zone. Typically, FGR is useful in reducing thermal NO_x formation by lowering the oxygen concentration in the combustion zone. The primary limitation of FGR is that it alters the distribution of heat (resulting in cold spots) and lowers the efficiency of the furnace. Since it may be necessary to add additional burners (hence, increasing emissions of other pollutants) to the EAF to reduce the formation of cold spots, FGR technology to reduce EAF NO_x emissions is not considered feasible. Since the EAF does not operate on burner combustion, but relies upon the electric arc and chemical energy for oxidation, neither pathway is amenable to FGR application. Thus, this option is considered technically infeasible for this application and will not be considered any further in this BACT analysis.

(2)   Selective Catalytic Reduction (SCR) -- In this process, ammonia (NH_3), usually diluted with air or steam, is injected through a grid system into the exhaust gas stream upstream of a catalyst bed. On the catalyst surface the NH_3 reacts with NO_x to form molecular nitrogen and water. The basic reactions are as follows:

$$4NH_3 + 4NO + O_2 \rightarrow 4N_2 + 6H_2O \qquad (i)$$

$$8NH_3 + 6NO_2 \rightarrow 7N_2 + 12H_2O \qquad \text{(ii)}$$
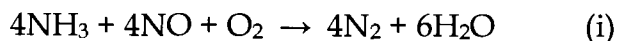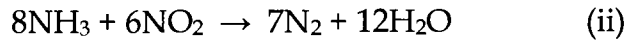
The reactions take place on the surface of the catalyst. Usually, a fixed bed catalytic reactor is used for SCR systems. The function of the catalyst is to effectively lower the activation energy of the NO_x decomposition reactions. Technical factors related to this technology include the catalyst reactor design, optimum operating temperature, sulfur content of the charge, catalyst deactivation due to aging, ammonia slip emissions and design of the ammonia injection system.

Three types of catalyst bed configurations have been successfully applied to commercial sources: the moving bed reactor, the parallel flow reactor and the fixed bed reactor. The fixed bed reactor is applicable to sources with little or no particulate present in the flue gas. In this reactor design, the catalyst bed is oriented perpendicular to the flue gas flow and transport of the reactants to the active catalyst sites occurs through a combination of diffusion and convection.

Depending on system design, NO_x removal of 80 - 90 percent may be achievable under optimum conditions (refer, USEPA "ACT Document - NO_x Emissions from Iron and Steel Mills", Sept., 1994). The reaction of NH_3 and NO_x is favored by the presence of excess oxygen. Another variable affecting NO_x reduction is exhaust gas temperature. The greatest NO_x reduction occurs within a reaction window at catalyst bed temperatures between 600 °F - 750 °F for conventional (vanadium or titanium-based) catalyst types, and 470 °F - 510 °F for platinum-based catalysts. Performance for a given catalyst depends largely on the temperature of the exhaust gas stream being treated. A given catalyst exhibits optimum performance when the temperature of the exhaust gas stream is at the midpoint of the reaction temperature window for applications where exhaust gas oxygen concentrations are greater than 1 percent. Below the optimum temperature range, the catalyst activity is greatly reduced, potentially allowing unreacted ammonia (referred to as "ammonia slip") to be emitted directly to the atmosphere.

The SCR system may also be subject to catalyst deactivation over time. Catalyst deactivation occurs through two primary mechanisms – physical deactivation and chemical poisoning. Physical deactivation is generally the result of either continual exposure to thermal cycling or masking of the catalyst due to entrainment of particulates or internal contaminants. Catalytic poisoning is caused by the irreversible reaction of the catalyst with a contaminant in the gas stream. Catalyst suppliers typically guarantee a 3-year catalyst lifetime for a sustainable emission limit.

In order for an SCR system to effectively reduce NO_x emissions, the exhaust gas stream should have relatively stable gas flow rates, NO_x concentrations, and temperature. In addition, certain elements such as iron, nickel, chrome, and zinc can react with platinum catalysts to form compounds or alloys which are not catalytically active.

These reactions are termed "catalytic poisoning", and can result in premature replacement of the catalyst. An EAF flue gas may contain a number of these catalytic poisons. In addition, any solid material in the gas stream can form deposits and result in fouling or masking of the catalytic surface. Fouling occurs when solids obstruct the cell openings within the catalyst. Masking occurs when a film forms on the surface of catalyst over time. The film prevents contact between the catalytic surface and the flue gas. Both of these conditions can result in frequent cleaning and/or replacement requirements. Due to the above effective technical applicability constraints, SCR technology has never been applied to EAF operations.

In addition to the above reservations regarding effective applicability of potential SCR application to EAFs, the technology is also associated with the following environmental impacts:

1. Unreacted ammonia (around 5-10 ppmv) would be emitted to the environment as ammonia slip. Based on conservative estimates of a 7 ppmv ammonia slip, approximately 97.0 tons/yr of ammonia could be potentially emitted from the existing EAF. Ammonia is also a pollutant of concern when addressing PM2.5. Any ammonia emissions would represent a negative impact on the desired results when addressing PM2.5;

2. Formation of ammonium salts can readily foul the catalyst section, resulting in reduced efficiency and increase back pressure;

3. Small amounts of ammonium salts would be emitted as PM_{10} and PM2.5.

4. Safety issues associated with the transportation, handling and storage of aqueous ammonia; and

5. Potentially hazardous waste handling and disposal of spent catalyst.

Successful applications of SCR technology to control NO_x emissions from EAFs are not known. The analysis presented above discusses a number of effective technical applicability concerns regarding SCR. In order for the SCR system to effectively reduce NO_x emissions, the exhaust gas stream should have relatively stable gas flow rates, NO_x concentrations, and temperature. The temperature of the EAF exhaust gas will vary widely over the melt cycle, and the gas flow rates and NO_x concentrations will exhibit a wide amplitude. Moreover, the presence of particulates in the exhaust gas prior to the EAF baghouse may result in fouling of the catalyst, rendering it ineffective. Also, the SCR system cannot be installed after particulate removal in the EAF baghouse due to unacceptably low temperatures outside the effective operating range. Note that SCR technology has not been utilized to control NO_x emissions from EAFs. Any projected application of SCR to EAFs would be considered a "technology transfer." In view of the

above limitations, the SCR option is considered technically infeasible with unresolved technical issues and significant environmental impacts. Thus, this option is considered technically infeasible for this application and will not be considered any further in this BACT analysis.

(3) **Non-Selective Catalytic Reduction (NSCR)** -- The NSCR system is a post-combustion add-on exhaust gas treatment system. It is often referred to as a "three-way conversion" catalyst since it reduces NO_x, unburned hydrocarbons (UBH), and CO simultaneously. In order to operate properly, the combustion process must be stoichiometric or near-stoichiometric which is not maintained in an EAF and varies widely under regular operation. Under stoichiometric conditions, in the presence of the catalyst, NO_x is reduced by CO, resulting in nitrogen and carbon dioxide. Currently, NSCR systems are limited to rich-burn IC engines with fuel rich ignition system applications. Moreover, potential problems with NSCR systems include catalyst poisoning by oil additives such as phosphorus and zinc (present in galvanized scrap steel charged in the EAF). In view of the above limitations, the NSCR option is considered technically infeasible for this application and will not be considered any further in this BACT analysis.

(4) **$SCONO_x$-Catalytic Oxidation/Absorption** -- This is a catalytic oxidation/absorption technology that has been applied for reductions of NO_x, CO and VOC from an assortment of combustion applications that mostly include – small turbines, boilers and lean-burn engines. However, this technology has never been applied for steel mill EAFs. $SCONO_x$ employs a single catalyst for converting NO_x, CO and VOC. The flue gas temperature should be preferably in the 300-700 °F range for optimal performance without deleterious effects on the catalyst assembly. The technology was developed as an alternative to traditional SCR applications which utilize ammonia resulting in additional operational safeguards, unfavorable environmental impacts and excessive costs. In the initial oxidation cycle, the CO is oxidized to CO_2, the NO gets converted to NO_2 and the VOC gets oxidized to carbon dioxide and water. The NO_2 is then absorbed on the potassium carbonate coated (K_2CO_3) catalyst surface forming potassium nitrites and nitrates (KNO_2, KNO_3). Prior to saturation of the catalyst surface, the catalyst enters the regeneration cycle.

In the regeneration phase, the saturated catalyst section is isolated with the expedient of moving hinged louvers and then exposed to a dilute reducing gas (methane in natural gas) in the presence of a carrier gas (steam) in the absence of oxygen. The reductant in the regeneration gas reacts with the nitrites and nitrates to form water and elemental nitrogen. Carbon dioxide in the regeneration gas reacts with potassium nitrites and nitrates to recover the potassium carbonate, which is the absorber coating that was on the surface of the catalyst before the oxidation/absorption cycle began. Water (as steam) and elemental nitrogen are exhausted up the stack and the re-deposited K_2CO_3 allows for another absorption cycle to begin.

SCONO$_x$ technology is a variation of traditional SCR technology and for optimal performance it makes similar demands such as - stable gas flows, lack of thermal cycling, invariant pollutant concentrations and residence times on the order of 1-1.5 seconds. However, the initial attractive feature of not using ammonia has been replaced by other potential operational problems that impair the effectiveness of the technology.

In summary, an effective SCONO$_x$ application to a steel mill EAF application has the following reservations:

1. The technology is not readily adaptable to high-temperature applications outside the 300-700 °F range and is susceptible to thermal cycling that will be experienced in the Nucor application;

2. Scale-up is still an issue. The technology has not been demonstrated for larger applications and the vendor's contention in this context is still being debated upon;

3. Optimum SCONO$_x$ operation is predicated by stable gas flow rates, NO$_x$ concentrations and temperature. As discussed earlier, the nature of EAF operations do not afford any of these conditions which will significantly impair the effective control efficiency of the SCONO$_x$ system;

4. The catalyst is susceptible to moisture interference and the vendor indicates negation of its warranties and performance guarantees if the catalyst is exposed to any quantity of liquid water. However, during certain atmospheric conditions, the catalyst could be potentially exposed to moisture following a unit shutdown or leakage from water cooled ducts;

5. The prospect of moving louvers that effect the isolation of the saturated catalyst readily lends itself to the possibility of thermal warp and in-duct malfunctions in general. The process is dependent on numerous hot-side dampers that must cycle every 10-15 minutes. Directional flow solutions are not yet known to have been implemented for this technology;

6. The K$_2$CO$_3$ coating on the catalyst surface is an active chemical reaction and reformulation site which makes it particularly vulnerable to fouling. On some field installations, the coating has been found to be friable and tends to foul in the harsh in-duct environment;

7. During the regeneration step, the addition of the flammable reducing gas (natural gas which contains 85% methane) into the hot flue gas generates the possibility of LEL exceedances and subsequently catastrophic failure in the event

the catalyst isolation is not hermetic or there is a failure in the carrier steam flow; and

8. There is a possibility of some additional SO_2 emissions if the dry scrubber with the tandem "guard-bed" $SCOSO_x$ unit experiences a malfunction.

Thus, there are significant reservations regarding effective technical applicability of this control alternative for a steel mill EAF application. Moreover $SCONO_x$ technology has never been proposed nor successfully implemented for similar industry applications. In view of the above limitations, $SCONO_x$ is considered technically infeasible for the present application and will not be considered any further in this BACT analysis.

(5) Shell DeNO$_x$ System (modified SCR) -- The Shell DeNO$_x$ system is a variant of traditional SCR technology which utilizes a high activity dedicated ammonia oxidation catalyst based on a combination of metal oxides. The system is comprised of a catalyst contained in a modular reactor housing where in the presence of ammonia NO_x in the exhaust gas is converted to nitrogen and water. The catalyst is contained in a low pressure drop lateral flow reactor (LFR) which makes best use of the plot space available. Due to the intrinsically high activity of the catalyst, the technology is suited for NO_x conversions at lower temperatures with a typical operating range of 250-660 °F. In addition, the vendor contends that conventional SCR systems that use honeycomb catalysts generally operate in the temperature range of 610-720 °F with attendant pressure drops of between 2.8-4.0 inches WG. The Shell DeNO$_x$ technology can not only operate at a lower temperature but also have a lower pressure drop penalty of around 2 inches WG.

The low temperature operation is the only aspect of the Shell DeNO$_x$ technology that marks its variance from traditional SCR technology. From an EAF application standpoint, there are no additional differences between this technology and SCR technology.

In summary, an effective Shell DeNO$_x$ application to the EAF application has the following reservations:

1. The Shell DeNO$_x$ system does not suffer from similar placement limitation considerations discussed earlier for SCRs. However, even a downstream of EAF baghouse placement of the system does not render it completely safe from the prospect of particulate fouling. The catalyst will still be exposed to particulates which can inflict a masking effect impairing the effective control efficiency of the system;

2. Optimum Shell DeNO$_x$ operation is predicated by stable gas flow rates, NO_x concentrations and temperature. The nature of EAF operations do not afford any

of these conditions which will significantly impair the effective control efficiency of the Shell DeNO$_x$ system;

3. Since steel is produced from scrap, there is the possibility of the presence of catalytic poisons which can adversely affect the Shell DeNO$_x$ catalyst resulting in impaired control efficiencies and frequent replacement of the catalyst;

4. The catalyst is particularly susceptible to thermal fluctuations. The vendor indicated a threshold temperature of around 680 °F for catalyst degradation;

5. The use of relatively large amounts of ammonia - a regulated toxic chemical - will have accidental release and hazardous impact implications; and

6. As discussed earlier, even a 7 ppmv ammonia slip from a 1,050,000 dscfm exhaust gas flow can result in the emission of approximately 97.0 tons/yr of ammonia which is a regulated hazardous air pollutant with well documented health impacts.

Thus, there are significant reservations regarding effective technical applicability of this control alternative for an EAF application. Moreover Shell DeNO$_x$ has never been proposed nor successfully implemented for similar steel mill applications. Any projected application of Shell DeNO$_x$ to EAFs would be considered a "technology transfer." In view of the above limitations, the Shell DeNO$_x$ option is considered technically infeasible with unresolved technical issues and significant environmental impacts for this application. Thus, it will not be considered any further in this BACT analysis.

(6) Selective Non-Catalytic Reduction (SNCR) -- The three commercially available SNCR systems are Exxon's Thermal DeNO$_x$® system, Nalco Fuel Tech's NO$_x$OUT® system and Low Temperature Oxidation (LTO). These technologies are reviewed below for technical feasibility in controlling EAF NO$_x$ emissions.

Exxon's Thermal DeNO$_x$® - Exxon's Thermal DeNO$_x$® system is a non-catalytic process for NO$_x$ reduction. The process involves the injection of gas-phase ammonia (NH$_3$) into the exhaust gas stream to react with NO$_x$. The ammonia and NO$_x$ react according to the following competing reactions:

$$2NO + 4NH_3 + 2O_2 \rightarrow 3N_2 + 6H_2O \qquad (i)$$

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O \qquad (ii)$$
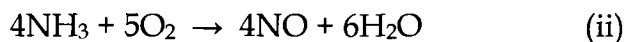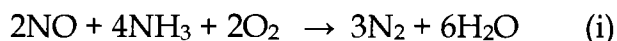
The temperature of the exhaust gas stream is the primary criterion controlling the above selective reaction. Reaction (i) dominates in the temperature window of 1,600 °F - 2,200

°F resulting in a reduction of NO_x. However above 2,200 °F, reaction (ii) begins to dominate, resulting in enhanced NO_x production. Below 1,600 °F, neither reaction has sufficient activity to produce or destroy NO_x. Thus, the optimum temperature window for the Thermal DeNO$_x$® process is approximately 1,600 oF - 1,900 °F. The above reaction temperature window can be shifted down to approximately 1,300 °F - 1,500 °F with the introduction of readily oxidizable hydrogen gas. In addition, the process also requires a minimum of 1.0 second residence time in the desired temperature window for any significant NO_x reduction.

In order for the Thermal DeNO$_x$® system to effectively reduce NO_x emissions, the exhaust gas stream should have relatively stable gas flow rates; ensuring the required residence time and be within the prescribed temperature range. Based on discussions with Exxon and vendors knowledgeable about steel mill operations, application of Thermal DeNO$_x$® technology to control NO_x emissions from EAF operations are not known. Therefore, any projected application of the process to EAF operations would be considered a "technology transfer".

In summary, an effective Thermal DeNO$_x$® application to the EAF application has the following reservations:

1. The placement of the Thermal DeNO$_x$® system in an adequate temperature regime. In order to achieve optimum operational efficiency the system should be located in a temperature region of at least 1,300 °F and preferably between 1,600 °F - 1,900 °F which would put it upstream of the EAF baghouse. Such a placement configuration would not afford the desired temperature range which would be typically in the region of 300 °F - 400 °F with an entry temperature of 210 °F at the inlet to the EAF baghouse. The system cannot be placed further upstream for operational hazard reasons. Also any injection mechanism upstream of the baghouse will be susceptible to prompt particulate fouling;

2. Optimum Thermal DeNO$_x$® operation is predicated by stable gas flow rates, NO_x concentrations and temperature. The nature of EAF operations do not afford any of these conditions which will significantly impair the effective control efficiency of the Thermal DeNO$_x$® system;

3. The use of relatively large amounts of ammonia - a regulated toxic chemical - will have accidental release and hazardous impact implications; and

4. Even a 7 ppmv ammonia slip from a 1,050,000 dscfm exhaust gas flow can result in the emission of approximately 97.0 tons/yr of ammonia which is a regulated hazardous air pollutant with well documented health impacts.

Depending on system design, NO_x removal of 40-70 percent may be achievable under optimum conditions (refer, USEPA "ACT Document - NO_x Emissions From Iron and Steel Mills" Sept., 1994). In view of the concerns with the availability of steady gas flows and prescribed residence times, thermal cycling and the ability of the control option to load-follow varying pollutant concentrations and the fact that the source will be required to continually comply with an hourly emission rate, an effective NO_x control efficiency will be hard to maintain for an EAF application. It should be noted that if the required residence time or other optimum operation parameters are not available, unreacted ammonia will be released directly to the atmosphere.

There are significant reservations regarding effective technical applicability of this control alternative for an EAF application. In order for the Thermal DeNO$_x$® system to effectively reduce NO_x emissions, the exhaust gas stream should have relatively stable gas flow rates, ensuring the requisite residence time requirements and temperature. The temperature of the EAF exhaust gas will vary widely over the melt cycle, and will not remain in the desired temperature window during all phases of operation. Similarly, the gas flow rates will not remain stable during furnace operation, precluding the possibility of adequate residence time. Moreover, Thermal DeNO$_x$® technology has never been proposed nor successfully implemented to control NO_x emissions from EAFs. Any projected application of the process to the EAF would be considered a "technology transfer". In view of the above limitations, the Thermal DeNO$_x$® option is considered technically infeasible with significant environmental impacts for this application and will not be considered any further in this BACT analysis.

Nalco Fuel Tech's NO$_x$OUT® - The NO$_x$OUT® process is very similar in principle to the Thermal DeNO$_x$® process, except that it involves the injection of a liquid urea (NH_2CONH_2) compound (as opposed to NH_3) into the high temperature combustion zone to promote NO_x reduction. The chemical reaction proceeds as follows:

$$NH_2 + NO \rightarrow N_2 + H_2O \text{ (i)}$$
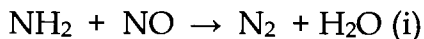
The reaction involves the decomposition of urea at temperatures of approximately 1,700 °F - 3,000 °F. Certain proprietary additive developments have allowed the operational temperature window to shift to approximately 1,400 °F - 2,000 °F. However, the process still has similar constraints as the Thermal DeNO$_x$® system. The limitations are dictated by the reaction-controlling variables such as stable gas flow rates for a minimum residence time of 1.0 second in the desired temperature window to ensure proper mixing.

As with the Thermal DeNO$_x$® system, the NO$_x$OUT® system suffers from essentially similar limitations to effectively reduce NO_x emissions from EAF operations. Moreover, applications of the NO$_x$OUT® technology to control NO_x emissions from steel mill EAF

operations are not known. Therefore, any projected application of the process to the Nucor application would be considered a "technology transfer".

Similar to the Thermal DeNO$_x$® application, an effective NO$_x$OUT® application to the EAF application has the following reservations:

1. The placement of the NO$_x$OUT® system in an adequate temperature regime. In order to achieve optimum operational efficiency the system should be located in a temperature region preferably between 1,400 °F - 2,000 °F which would put it upstream of the EAF baghouse. Firstly, such a placement configuration would not afford the desired temperature range which would be typically in the region of 300 °F -400 °F with an entry temperature of 210 °F at the inlet to the EAF baghouse. Also any injection mechanism upstream of the baghouse will be susceptible to prompt particulate fouling;

2. Optimum NO$_x$OUT® operation is predicated by stable gas flow rates, NO$_x$ concentrations and temperature. The nature of EAF operations do not afford any of these conditions which will significantly impair the effective control efficiency of the NO$_x$OUT® system; and

3. Although the NO$_x$OUT® technology does not utilize ammonia directly, secondary chemical reactions under certain conditions (such as unreacted urea combining to form ammonia) can generate ammonia from the process. In fact the vendor indicates a 25 ppmv ammonia at the exhaust stack which is higher than direct ammonia applications discussed earlier. Even a 7 ppmv ammonia slip from a 1,050,000 dscfm exhaust gas flow can result in the emission of approximately 97.0 tons/yr of ammonia which is a regulated hazardous air pollutant with well documented health impacts.

Depending on system design, NO$_x$ removal of 40-70 percent may be achievable under optimum conditions (refer, USEPA "ACT Document - NO$_x$ Emissions From Iron and Steel Mills" Sept., 1994). In view of the concerns with the availability of steady gas flows and prescribed residence times, thermal cycling and the ability of the control option to load-follow varying pollutant concentrations and the fact that the source will be required to continually comply with an hourly emission rate, an effective NO$_x$ control efficiency will be hard to maintain for an EAF application. It should be noted that if the required residence time or other optimum operation parameters are not available, secondary production ammonia will be released directly to the atmosphere. In some instances, it may even be higher than direct ammonia applications discussed earlier.

There are significant reservations regarding effective technical applicability of this control alternative for an EAF application. In order for the NO$_x$OUT® system to

effectively reduce NO$_x$ emissions, the exhaust gas stream should have relatively stable gas flow rates, ensuring the requisite residence time requirements and temperature. The temperature of the EAF exhaust gas will vary widely over the melt cycle, and will not remain in the desired temperature window during all phases of operation. Similarly, the gas flow rates will not remain stable during furnace operation, precluding the possibility of adequate residence time. Moreover, NO$_x$OUT® technology has never been proposed nor successfully implemented to control NO$_x$ emissions from EAFs. Any projected application of the process to the EAF would be considered a "technology transfer". In view of the above limitations, the NO$_x$OUT® option is considered technically infeasible with significant environmental impacts for this application and will not be considered any further in this BACT analysis.

<u>Low Temperature Oxidation (LTO)</u> -- LTO technology has never been utilized for any steel mill EAF application. The vendor has listed applications for mostly industrial boilers and cogeneration gas turbines which have a more favorable energy balance. The technology is a variant of SNCR technology using ozone. The ozone is injected into the gas stream and the NO$_x$ in the gas stream is oxidized to nitrogen pentoxide (N$_2$O$_5$) vapor which is absorbed in the scrubber as dilute nitric acid (HNO$_3$). The nitric acid is then neutralized with caustic (NaOH) in the scrubber water forming sodium nitrate (NaNO$_3$). The overall chemical reaction can be summarized as follows:

$$NO_2 + NO + 2O_3 + NaOH \rightarrow HNO_3 + NaNO_3 + 2O_2 \text{ (i)}$$
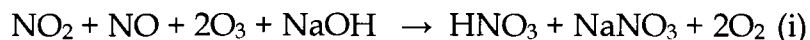
For optimal performance, the technology requires stable gas flows, lack of thermal cycling, invariant pollutant concentrations and residence times on the order of 1 - 1.5 seconds. In addition, LTO technology requires frequent calibration of analytical instruments which sense the NO$_x$ concentrations for proper adjustment of ozone injection. Since LTO uses ozone injection, it has a potential for ozone slip which can vary between 5 - 10 ppmv. Also, the technology requires a cooler flue gas of less than 300 °F at the point of ozone injection, otherwise the reactive gas is rendered redundant. The technology also suffers from low NO$_x$ conversion rates (40% - 60%), potential for nitric acid vapor release (in the event of a scrubber malfunction) with subsequent regional haze impacts and the handling, treatment and disposal issues for the spent scrubber effluent.

In conclusion, the technology is still nascent and evolving out of the earlier bench scale solution to effect a reliable SNCR application utilizing reactive gas-phase ozone to control NO$_x$ emissions from combustion applications. The technology is neither applicable nor proven for steel mill EAF applications and attendant limitations render it technically infeasible in its current manifestation. In view of the above, the LTO control option is considered technically infeasible for this application and will not be considered any further in this BACT analysis.

In order to implement an effective technical applicability for the control options discussed above, a stable temperature regime (along with non-varying gas flows and pollutant concentrations) for specific target windows is imperative which cannot be afforded by Nucor's EAF operation for the following reasons:

1. As discussed earlier, the add-on control options cannot be located upstream of the baghouse in order to acquire the requisite temperature window due to particulate interference which can severely degrade the effective technical applicability of the respective control alternative;

2. In order to avoid particulate interference, the add-on control options will have to be located downstream of the EAF baghouse. The exhaust gas temperatures exiting the baghouse vary according to the following:

    a. Overall seasonal variation due to changes in the temperature of the ambient air;

    b. Changes in ambient air relative humidity;

    c. Operational cycle of the EAF - tapping, charging, bucket charge, etc.; and

    d. Type of materials being added to the furnace depending on the grade of steel being produced.

3. The add-on control systems are not very adept at load-follow with varying process conditions resulting in significant erosion of their effective technical applicability; and

4. The catalytic systems are susceptible to poisoning by certain interferents and heavy metals.

Evaluation of Most Effective NO_x Controls for EAF

Various control alternatives were reviewed for technical feasibility in controlling NO_x emissions from the EAF. With the exception of combustion control utilizing existing natural gas-fired oxyfuel burners, the applicability of the remaining control options is questionable and is considered technically infeasible. Since, only a single control option was ascertained to be technically feasible, no ranking of control alternatives has been provided.

None of the steel mills reviewed for this analysis have proposed or successfully implemented any controls besides natural gas-fired oxyfuel burners. The other control options have been shown to be technically infeasible. Based on a review of similar

EAF/LMF melt shop applications, the proposed controls represent the best available control technology for the existing EAF/LMF melt shop application.

NOₓ BACT for EAF

As outlined above, for the existing EAF, the oxy-fuel fired burners are the only technically feasible control option. Review of the RBLC data shows limits established for EAFs ranging from 0.13 lb/ton to 1.0 lb/ton, with most facilities at 0.35 lb/ton or higher. One facility has a NO_x limit at 0.13 lb/ton, which is an older limit not followed in any subsequent BACT determination and is considered unrealistically low. Two facilities have NO_x limits just below 0.30 lb/ton.

BACT Control of Volatile Organic Compound Emissions

VOC emissions from the EAF will be intermittent and limited to the brief period during EAF charging when organic compounds such as oil or paint present in the scrap are volatilized. Potential VOC control alternatives include the following:

(1) Catalytic or Thermal Oxidation;

(2) Degreasing of scrap metal prior to charging in the EAF; and

(3) Scrap management program.

CO Oxidation Catalysts -- Based upon a review of the previously listed information resources, there is no known application of oxidation catalysts to control VOC emissions from an EAF. The optimal working temperature range for VOC oxidation catalysts is approximately 850 °F - 1,100 °F with a minimum exhaust gas stream temperature of 500 °F for minimally acceptable control. Exhaust gases from the EAF will undergo rapid cooling as they are ducted from the furnace. Thus, the temperature will be far below the minimum 500 °F threshold for effective operation of CO oxidation catalysts. Additionally, the particulate loading in the exhaust gas stream is anticipated to be too high for efficient operation of a oxidation catalyst. Masking effects such as plugging and coating of the catalyst surface would almost certainly result in impractical maintenance requirements, and would significantly degrade the performance of the catalyst. Consequently, this control alternative is considered technically infeasible for this application and will not be considered any further in this BACT analysis.

Degreasing of scrap metal prior to charging in the EAF is impractical. The amount of pollution generated by degreasing scrap would be greater than the amount of pollution generated by melting the scrap. There would be thousands of gallons required to degrease the large amount of scrap used annually in the EAFs. Thus, both of these control alternatives are considered technically infeasible and will be precluded from further consideration in this BACT analysis.

The mill utilizes a scrap management program to eliminate the purchase of scrap steel that is heavily oiled. A broker or a Nucor representative is responsible for inspecting shipments of scrap received. The scrap inspector visually inspects the shipments and determine the category of the scrap. An EPA regulation NESHAP YYYYY applicable to mini mills requires that the receipt of free oils in scrap steel charged to furnaces be prohibited. This regulation applies to Nucor, including inspection and recordkeeping requirements.

Evaluation of Most Effective VOC Controls for EAF

Various control alternatives were reviewed for technical feasibility in controlling VOC emissions from the EAF. With the exception of a scrap management program, the applicability of the remaining control options were determined to be technically infeasible. Based on a review of the information resources referenced earlier, it is revealed that these control alternatives have not been successfully implemented to reduce VOC emissions from EAFs. Thus, the projected use of any of these technologies would be considered a "technology transfer." Since, only a single control option was ascertained to be technically feasible, no ranking of control alternatives has been provided.

None of the steel mills reviewed in this analysis have proposed or successfully implemented any controls besides scrap management. The other control options have been shown to be technically infeasible.

Based on a review of similar EAF melt shop applications, the existing controls and the emission limit represent the best available control technology for the EAF melt shop application.

Proposal for VOC BACT for EAF

BACT for controlling VOC emissions from the EAF is proposed as the utilization of the scrap steel management program which includes prohibiting utilizing scrap steel with free oils.

Particulate emissions from the EAF will be captured by the DEC and a roof exhaust system and ultimately exhausted through a baghouse. The New Source Performance Standard (NSPS) and NESHAP for particulate matter emissions from an EAF are both 0.0052 grains/dscf. This limit has recently been interpreted to include the combination of condensable and filterable components of PM. Fabric filtration in baghouses is the predominant control device for EAFs. Other particulate control options are not considered as effective or technically feasible. A review of the RBLC database revealed that generally EAFs have been permitted at 0.0018 gr/dscf (filterable) for PM10.

Evaluation of Most Effective PM/PM$_{10}$/PM$_{2.5}$ Controls for EAF

Fabric filtration is the predominant control option for abatement of particulate emissions (PM, PM$_{10}$, PM$_{2.5}$) from an EAF application. Other particulate control options are not considered as effective or technically feasible for an EAF application. Based on a review of the information resources referenced earlier, it was revealed that these control alternatives have not been successfully implemented to reduce particulate emissions from EAFs. Thus, the projected use of any of these technologies would be considered a "technology transfer." Since, only a single control option was ascertained to be technically feasible, no ranking of control alternatives has been provided.

PM$_{2.5}$ emissions from the electric arc furnaces are generally identical to PM$_{10}$ emissions. As indicated in AP-42 (Iron and Steel Production, Table 12.5-2), the particle size distribution for particulate matter emission from an EAF controlled by a baghouse shows that 76 percent of the emissions are PM$_{10}$ and less and 74 percent of the emissions are PM$_{2.5}$ and less. Thus, the PM$_{2.5}$ emissions from the baghouse are estimated to be 97.4 percent (74/76) of the PM$_{10}$ emissions.

A review of the RBLC database revealed that other steel mills have a similar emission limit. None of the steel mills reviewed in this analysis have proposed or successfully implemented any controls besides fabric filtration. The other control options have been shown to be technically infeasible.

Based on a review of similar EAF melt shop applications, the proposed controls and the emission limit represent the best available control technology for the EAF melt shop application.

Proposal for PM/PM$_{10}$ BACT and PM$_{2.5}$ LAER for EAF

BACT for controlling PM$_{2.5}$ emissions from the EAF is proposed as the use of fabric filtration to meet a filterable PM$_{2.5}$ limit of 17.4 lbs/hr and 0.00176 gr/dscf

BACT Control of Sulfur Dioxide (SO$_2$) Emissions

The source of SO$_2$ emissions from the EAF is attributable to the sulfur content of the raw materials charged in the EAF, materials which will be blown into the foaming slag process, and to a much lesser extent, the sulfur content of oil on the scrap steel.

Potential EAF SO$_2$ Control Alternatives

The alternatives which are potentially available to control SO$_2$ emissions from the EAF include the following:

1. Lower-Sulfur Charge Substitution; and

2. Flue Gas Desulfurization (FGD) options -

    a.   Wet Scrubbing

    b.   Spray Dryer Absorption (SDA)

    c.   Dry Sorbent Injection (DSI)

Technical Feasibility of SO$_2$ Control Alternatives

The test for technical feasibility of any control option is whether it is both available and applicable to reducing SO$_2$ emissions from the EAF. The previously listed information resources were consulted to determine the extent of applicability of each identified control alternative.

(1) Lower-Sulfur Charge Substitution -- Based on discussions with plant personnel, charge substitution with lower sulfur-bearing raw materials is not practical due to inconsistent availability. Nucor has used low sulfur injection carbon and charge carbon in the steel making process, however, Nucor has found that these materials have uncertain future availability. For example, Nucor's low sulfur injection carbon may not always be available because the source does not offer long term contracts.

CARBON TYPES

Carbon basically has 3 different uses at the EAF: scrap and scrap substitutes, charge carbon (bucket fed and top fed), and injection carbon. Each of these carbon types act differently on the operation. While there is some minor substitutability, none of these types can truly be a substitute for any of the others.

Scrap/Scrap Substitutes

This is carbon inherent in the scrap/scrap substitute charge fed to the furnace. This carbon is consumed in the liquid phase of the steel. As such, it has a very high heating efficiency and the majority of the sulfur remains dissolved in the steel.

Charge Carbon (Bucket Fed)

This carbon is used to increase the amount of carbon in the liquid steel bath. While not as efficient as carbon already in the scrap/scrap substitutes, approximately 35 – 50% of the fixed carbon can be picked up in the bath depending on many variables. The balance of the fixed carbon acts on the slag (reducing FeO similar to injection carbon, but without the foaming effect) or burns in the top space.

Charge Carbon (Top Fed)

This carbon is used to reduce the FeO in the slag. It has a relatively high efficiency, with approximately 75% of the fixed carbon reducing FeO. Reaction in the top of the slag layer means that approximately 2/3 of the sulfur leaves as SO_x, while the remainder stays in the steel and slag.

Injection Carbon

This is a carbon media that is injected into the slag layer where it reduces FeO and generates CO gas. This foams the slag and improves electrical efficiency. It has a relatively high efficiency, with approximately 65 – 85% of the fixed carbon reducing FeO. Reaction in the middle of the slag layer means that approximately one-half of the sulfur leaves as SO_x, while the remainder stays in the steel and slag.

CARBON SOURCES

The sources of this carbon can take many forms. Nucor is dealing with the chemically active "fixed" carbon and not the total carbon or BTU value. Volatiles in the carbon are flash distilled in the top space and play very little part in the furnace. Typical carbon sources are coal, metallurgical coke and petroleum coke.

Petroleum Coke

For many years petroleum coke was the preferred injection carbon source. This material was very high in fixed carbon, relatively low in sulfur, less abrasive, low in ash, and inexpensive. Since it was only available in small sizes (<1/4") it was not usable as charge carbon. In recent years low sulfur petroleum coke has been in high demand, costs have increased and availability is limited. Most places have tried substituting some blend of low and high sulfur petroleum cokes. As the supply tightened, more anthracite coal (eastern availability) and metallurgical coke were blended to compensate for reduced availability of petroleum coke. The coal has a different density and does not transport well with petroleum coke in pneumatic systems.

Metallurgical Coke

Metallurgical coke has been used both as charge and injection carbon. As charge carbon, the material works well. The high fixed carbon content and large piece size makes a good combination. The only drawback is that the coke tends to retain water. Excess water can be an explosion hazard, and precautions to drain water and avoid ice are vital. As mentioned above, the abrasive nature of metallurgical coke with the 10 – 20% ash content causes many problems as an injection carbon. The higher ash content also causes inefficiencies in the furnace, raising power consumption, and creating greater slag amounts as the ash is moved to the slag.

Coal

Anthracite coal is the primary coal used in EAF steelmaking where it is available. Bituminous coal can be used. Due to higher volatile content, bituminous coal has lower ignition and flash points. This means that it can ignite and even explode under certain storage conditions. Some bituminous coal is used as charge carbon in Utah because of the local availability. Other than brief experiments, bituminous coal is not used as an injection carbon because of the hazards.

SUPPLY TRENDS

Petroleum coke has been rising in sulfur content for the past several years. As more of the world's available crude is heavier and higher in sulfur content, the sulfur levels in petroleum coke will continue to increase. Most domestic petroleum coke supplies are projected to be around 3-3.5% sulfur. Lower sulfur petroleum cokes are difficult to obtain.

Metallurgical coke is currently both manufactured in the U.S. and imported from overseas. Many of the U.S. producers are at least partially dependent on foreign coal. In the early part of this decade over supply from China severely damaged domestic production capability and, when the Chinese government restricted the export of coke,

a severe shortage developed. Metallurgical coke producers in the U.S. are also heavily dependent on a very few coking coal deposits in the Northeast.

Bituminous coal, while plentiful, is not suited to many steelmaking situations. The supply of low volatile low sulfur bituminous coal is not much better than that of the low sulfur anthracite discussed below. The low fixed carbon levels mean that much larger quantities are required to meet the carbon requirements of the EAF. These coals also pose a safety hazard in many existing storage and handling systems.

Anthracite coal could be an option for lower SO2 emissions but it presents its own operational problems and availability problems for use in a mill located in the west. U.S. production is confined almost exclusively to central Pennsylvania. The main alternative use of this material is home and industrial heating. This means that price and availability varies seasonally, and even within the seasons, weather conditions can drastically affect market conditions. Of greatest impact is the cost prohibitive rail rates of moving material across the US. China, Russia, and Vietnam can be foreign suppliers of this material. High ocean freights and market disruptions caused by expansion in China have made this imported material prohibitively expensive. Occasionally spot cargos have been offered when Far East demand temporarily drops, but these cargos disappear as soon as the Oriental demand returns. Traders that do extensive business with China have been informed that the Chinese government plans to continue increasing tariffs and export restrictions to make China a net importer of coal and conserve both future reserves and limited infrastructure, which is tied up moving coal to the coast, instead of expanding their domestic economy.

Assessment

Petroleum coke sulfur concentrations are increasing and low sulfur petroleum cokes are essentially unavailable. Metallurgical coke is limited in supply, not useable as an injection carbon, and is used for other critical industrial operations besides steelmaking, making it difficult to consistently obtain and subject to periodic price spikes. Bituminous coals are largely unsuited to steelmaking, leaving anthracite as the remaining major source. Anthracite sulfur concentrations are also increasing and the supply of the lower sulfur coals is diminishing both domestically and in the world market. Therefore, continued availability of low sulfur sources of carbon cannot be assured.

The fixed carbon is another important variable. As the percent of fixed carbon diminishes, correspondingly more of the carbon source must be used to achieve the same result. Not only are the lower sulfur coals and cokes decreasing in availability, but they are not cost effective. Because of the combined problems caused by decreasing availability, increased cost, and the consequent difficulty in relying upon the lower

sulfur feedstocks, lower sulfur feedstocks, including carbon sources, are not technically and economically feasible.

(2) **Flue Gas Desulfurization** -- FGD systems currently in use for SO_2 abatement can be classified as wet and dry systems. Note that based on a review of the RBLC database and discussions with various individuals knowledgeable about steel mill operations, it was revealed that control technologies for SO_2 abatement have not been successfully implemented for EAFs. However, FGD options which have been traditionally applied to utility boilers may be available to control SO_2 from the EAF. Therefore, the application of these technologies to the EAF will be examined further.

For FGD controls in general, the expected variability and low SO_2 concentrations in the gas stream are not amenable to responsive FGD treatment which is typically geared for high sulfur fuel combustion systems. In addition, the relatively large gas flow and the large amplitude temperature variations would cause insurmountable operational difficulties. The effective SO_2 control efficiencies would be significantly impaired.

(2a) Wet Scrubbing -- Wet scrubbers are regenerative processes which are designed to maximize contact between the exhaust gas and an absorbing liquid. The exhaust gas is scrubbed with a 5 - 15 percent slurry, comprised of lime (CaO) or limestone ($CaCO_3$) in suspension. The SO_2 in the exhaust gas reacts with the CaO or $CaCO_3$ to form calcium sulfite ($CaSO_3.2H_2O$) and calcium sulfate ($CaSO_4$). The scrubbing liquor is continuously recycled to the scrubbing tower after fresh lime or limestone has been added.

The types of scrubbers which can adequately disperse the scrubbing liquid include packed towers, plate or tray towers, spray chambers, and venturi scrubbers. In addition to calcium sulfite/sulfate, numerous other absorbents are available including sodium solutions and ammonia-based solutions.

There are various potential operating problems associated with the use of wet scrubbers. First, particulates are not acceptable in the operation of wet scrubbers because they would plug spray nozzles, packing, plates and trays. Thus, the scrubber would have to be located downstream of the EAF baghouse. This would substantially increase the capital cost of the wet scrubber, which is typically two to three times more expensive than the capital cost for a dry scrubber. Wet scrubbers also require handling, treatment, and disposal of a sludge by-product. In this case, air emissions would be exchanged for a large-scale water pollution problem. Treatment of wet scrubber wastes requires reverse osmosis (RO) units which are unreliable; requiring frequent maintenance by an experienced operator. Finally, the volumetric exhaust gas flow rate from through the baghouse system is high. When coupled with the relatively low SO_2 emission rates, a relatively small SO_2 concentration of around 1-20 ppmv will result in the exhaust. The SO_2 concentration will also vary widely over the EAF cycle which operate as a batch process. This will preclude efficient application of wet scrubbing.

Based on discussions with major wet scrubber vendors (i.e., Wheelabrator Air Pollution Control Inc., Bionomic Industries Inc., Beco Engineering Company, Ducon Technologies Inc.), it was clearly evident that there was a dearth of experience in applying wet scrubbing technology for an EAF application. This fact corroborated the findings from the review of the RBLC database and discussions with various individuals knowledgeable about steel mill operations that control technologies for SO_2 abatement have not been successfully implemented for EAFs. The possibility of water in the baghouse is a major operating problem, which would allow the dust to form into hard cement in the baghouse hoppers and cause the bags to blind with the caked dust. This would then lead to opacity problems and broken dust augers in the baghouse.

In general, the consensus of the major vendors was against applying wet scrubbing technology for the following reasons:

- Intrinsic nature of EAF operations on a batch basis;

- Inability to efficiently control SO_2 due to cyclic nature of process, timing of SO_2 evolution from the furnace, and duration of SO_2 emissions;

- Variability of SO_2 emissions and low SO_2 concentrations;

- Variability of gas flow and temperature with unpredictable thermal cycling; and

- Unable to provide credible and sustained SO_2 removal guarantees due to above reasons.

Thus, there are significant reservations regarding effective technical applicability of this control alternative for the EAF application. Due to the large gas flows, the equipment would have to be over-sized with care for corrosion resistance. Besides the issues pertaining to pollutant concentration cycling and lack of compensatory system response, there are concerns about handling, treatment and disposal of sludge-phase and liquid-phase wastes which have the potential of being classified as hazardous wastes. Moreover wet scrubbing has never been proposed nor successfully implemented for similar steel mill applications. In view of the above limitations, the wet scrubber option is considered technically infeasible for this application and will not be considered any further in this BACT analysis.

(2b) Spray Dryer Absorption (SDA) -- An alternative to wet scrubbing is a process known as dry scrubbing, or spray-dryer absorption (SDA). As in wet scrubbing, the gas-phase SO_2 is removed by intimate contact with a suitable absorbing solution. Typically, this may be a solution of sodium carbonate (Na_2CO_3) or slaked lime [$Ca(OH)_2$]. In SDA systems the solution is pumped to rotary atomizers, which create a spray of very fine droplets. The droplets mix with the incoming SO_2-laden exhaust gas

in a very large chamber and subsequent absorption leads to the formation of sulfites and sulfates within the droplets. Almost simultaneously, the sensible heat of the exhaust gas which enters the chamber evaporates the water in the droplets, forming a dry powder before the gas leaves the spray dryer. The temperature of the desulfurized gas stream leaving the spray dryer is now approximately 30 - 50 °F above its dew point.

The exhaust gas from the SDA system contains a particulate mixture which includes reacted products. Typically, baghouses employing Teflon-coated fiberglass bags (to minimize bag corrosion) are utilized to collect the precipitated particulates.

The SDA process would not have many of the potential operating problems associated with the wet scrubbing systems. However, the volumetric exhaust gas flow rate from the melt shop(s) will be approximately 1,050,000 dscfm. When coupled with the relatively low SO_2 emission rates, a relatively small SO_2 concentration of around 1-20 ppmv in the exhaust will result. The SO_2 concentration will also vary widely over the EAF cycle. Based on discussions with a major SDA vendor (Wheelabrator Air Pollution Control Inc.), this control alternative has significant limitations for effective technical applicability for an EAF application:

a. The very low SO_2 concentration of around 1 - 20 ppmv in the influent coupled with a relatively large gas flow of 1,050,000 dscfm would retard the adequate contact interface with the reagent. The vendor noted that the inlet SO_2 concentrations would be lower than the outlet concentrations that most SDAs are designed for;

b. The variations in the SO_2 concentration during and between heats would severely impair the control system's capability to respond adequately. SDA systems are not designed for adept load-follow flexibility;

c. The low temperature of the exhaust gas of around 210 °F and the low gas moisture would not allow sufficient thermal gradient for an appropriate approach to saturation which typically specifies that the temperature of the desulfurized gas stream leaving the spray dryer be around 30 – 50 °F above its dew point;

d. Thermal cycling during the regular batch operation of the EAF in concert with the melting and refining heats could potentially result in less than desirable temperature approaches to saturation, thereby, raising the prospect of wet fouling. The system would be hard to control with attendant near-loss of SO_2 control efficiencies; and

e. Unable to provide credible and sustained SO_2 removal guarantees due to above reasons.

Thus, there are significant reservations regarding effective technical applicability of this control alternative for the EAF application. In addition to the above issues, there are

significant concerns about handling, treatment and disposal of large amounts of dry solid wastes which have the potential of being classified as hazardous wastes. Moreover SDA has never been proposed nor successfully implemented for similar steel mill applications. In view of the above limitations, the SDA dry scrubbing option is considered technically infeasible for this application and will not be considered any further in this BACT analysis.

(2c) _Dry Sorbent Injection (DSI)_ -- This control option typically involves the injection of dry powders into either the furnace or post-furnace region of utility-sized boilers. This process was developed as a lower cost option to conventional FGD technology. Since the sorbent is injected directly into the exhaust gas stream, the mixing offered by the dry scrubber tower is not realized. The maximum efficiency realized for this SO_2 control technology is estimated to be fairly nominal. It is felt that if sufficient amounts of reactants are introduced into the flue gas, there is a possibility of some degree of mixing and reaction. The science is inexact and the coupling of reactant dosage and in-flue mixing which impacts the SO_2 control efficiency is susceptible to variability in SO_2 concentrations.

The dry sorbent injection process would not have many of the potential operating problems associated with the wet scrubbing systems. However, the volumetric exhaust gas flow rate from the EAF will be approximately 1,050,000 dscfm. When coupled with the relatively low SO_2 emission rates, a relatively small SO_2 concentration of 1 - 20 ppmv will result in the exhaust. The SO_2 concentration will also vary widely over the EAF cycle. The injection dose of sorbent materials would be hard to control in order to match variability in SO_2 concentrations. Similar control systems are fraught with chronic operational problems with the sensors requiring frequent maintenance and calibration.

Based on discussions with a major scrubbing vendor (Wheelabrator Air Pollution Control Inc.), this control alternative has significant limitations for effective technical applicability for an EAF application which were discussed earlier in the context of a dry scrubbing (SDA) system:

a. The very low SO_2 concentration of around 1 - 20 ppmv in the influent coupled with a relatively large gas flow of 1,050,000 dscfm would retard the adequate contact interface with the reagent. The vendor noted that the inlet SO_2 concentrations would be lower than the outlet concentrations that most DSIs are designed for:

b. The variations in the SO_2 concentration during and between heats would severely impair the control system's capability to respond adequately. DSI systems are not designed for adept load-follow flexibility and variable reactant dose control with fast response times comparable to anticipated process conditions;

c. Due to the anomalies of mixing afforded by the process, the reaction kinetics are not very flexible and rather time-dependent. Unlike the SDA system, the mixing uncertainty can potentially reduce DSI technology to a sheer brute-force proposition resulting in unstable and unpredictable performance;

d. In a DSI-fabric filter coupled system configuration, whereby most of the reaction takes place on the filter cake on the bags, the vendor felt that adequate residence time simply would not be available since the attendant higher particulate load would necessitate a higher cleaning frequency of the fabric filter; and

e. Unable to provide credible and sustained SO_2 removal guarantees due to above reasons.

Thus, there are significant reservations regarding effective technical applicability of this control alternative for the EAF application. In addition to the above issues, similar to the SDA, there are significant concerns about handling, treatment and disposal of large amounts of dry solid wastes which have the potential of being classified as hazardous wastes. Moreover DSI has never been proposed nor successfully implemented for similar steel mill applications. In view of the above limitations, the DSI dry scrubbing option is considered technically infeasible for this application and will not be considered any further in this BACT analysis.

Evaluation of Most Effective SO_2 Controls for EAF

Various control alternatives were reviewed for technical feasibility in controlling SO_2 emissions from the EAF. All potential control options were determined to be technically infeasible. Based on a review of the information resources referenced earlier, it is revealed that these control alternatives have not been successfully implemented to reduce SO_2 emissions from EAFs. Thus, the projected use of any of these technologies would be considered a "technology transfer."

A review of the RBLC database revealed only that other steel mills have a similar emission limit. None of the steel mills reviewed in this analysis have proposed or successfully implemented any controls. The other control options have been shown to be technically infeasible.

Based on a review of similar EAF melt shop applications, the existing controls and the emission limit represent the best available control technology for the EAF melt shop application.

Proposal for SO_2 BACT for EAF

BACT for controlling SO_2 emissions from the EAF is the use of a scrap management program and variable charge and injection carbon materials to meet the maximum SO_2 emission rates.

BACT Analysis for Caster and Caster Steam Vent

The caster forms a solid continuous slab as molten steel passes through a water-cooled mold. Fugitive PM emissions may be generated during the casting of hot metal; however, the emissions are evacuated to the melt shop baghouse, which is BACT for PM emissions. A small amount of fugitive PM emissions is included with the emissions from the melt shop building. The steel billets are water-sprayed to cool the steel. The steam generated from this process is vented through a vent to the atmosphere. A small amount of PM emissions are associated with the steam. PM emissions tested at the caster steam vent at the Nucor Crawfordsville, Indiana steel mill were used to represent PM emissions for the Utah caster steam vent. There are no feasible controls for these PM emissions.

BACT Analysis for Caster Area Roof Emissions

The caster emissions include emissions from the tundish and ladle preheating, skull lancing, ladle stirring, and other caster operations. The preheating of the ladle and tundish is done with natural gas fired burners. The use of natural gas is BACT as use of other fuels represent higher emission rates. The skull lancing is an operation that removes excess steel from the tundish and ladles through the use of cutting torches. This process takes place inside the caster building and the some of the emissions are assumed to escape the building. This source is not in continuous operation, thus, no further controls are justified. Ladle stirring and caster operations can occur at the caster and involve the additions of alloy and stirring the molten steel with a nitrogen lance. The molten steel is then poured and cast into billets. Emissions are fugitive in nature and a portion of the emissions are assumed to escape the building. There are no feasible control methods for the small emissions associated with this operation.

BACT Analysis for Billet Reheat Furnaces

Nucor has two reheat furnaces. Reheat furnace No. 1 is rated at a maximum of 160 MMBtu/hr; limited to 1,320,000,000 ft^3 natural gas/year and has a NO_x emission rate of 0.09375 lb/MMBtu. Reheat furnace No. 2 is rated at a maximum of 134 MMBtu/hr; limited to 980,000,000 ft^3 natural gas /year and has a NO_x emission rate of 0.0597 lb/MMBtu. Both reheat furnace can use propane but this is during emergency conditions. The table below provides a list of reheat, tunnel, roller hearth and reheat furnaces at other steel mills with their NO_x emission limit.

STEEL MILL	HEAT INPUT RATE (MMBtu/hr)	NOx EMISSION RATE (lb/MMBtu)
Nucor Steel – Tuscaloosa, AL	400	0.075
Nucor Steel – Auburn, NY	179	0.075
Nucor Steel – Hickman, AR	250.5	0.18
Nucor-Yamato Steel- Blytheville, AR	300	0.171
Nucor Gallatin – Ghent, Kentucky	124 (No.1)	0.09
	80.7 (No.2)	
MacSteel – Fort Smith, AR	45	0.14
Nucor Steel – Darlington, SC	140 (No.1)	0.104
	125 (No.2)	0.104
	185 (proposed)	0.092
Nucor Steel – Huger, SC	125 (No. 1)	0.19
	85 (No. 2)	0.17
	185 (reheat furnace)	0.15
Nucor Steel – Cofield, NC	309	0.128
Nucor Steel – Crawfordsville, IN	174	0.19
	26 (shuttle furnaces)	0.10
Nucor Steel – Birmingham, AL	203	0.174
Nucor Steel – Kankakee, IL	160	0.07
Charter Steel – Saukville, WI	115	0.09
Chaparral Steel	276	0.21
IPSCO Steel	--	0.23
Republic Technologies – Canton, OH	196.2	0.112
Ameristeel - Baldwin	--	0.19

As indicated in the above table, the NO_x emissions rates range from 0.07 to 0.23 lb/MMBtu. The lowest NO_x emission rates are for the Nucor Kankakee, IL ; Nucor Tuscaloosa, AL; and Nucor Auburn, NY are 0.07 0.075, and 0.075 lb/MMBtu, respectively. Nucor's present NOx emissions are 0.09375 and 0.0597 lb/MMBtu, for reheat furnace no. 1 and reheat furnace No.2, respectively.

2.5.1   *BACT Control of Oxides of Nitrogen (NO$_x$) Emissions*

NO_x emissions from the reheat furnace primarily result from combustion by-product of the fuel. The reheat furnaces have ultra-Low NO_x burners to minimize NO_x emissions. The use of ultra-Low NO_x burners (NO_x emissions of 0.075 lb/MMBtu) was accepted as BACT technology. As a result, since this represents BACT, it is not necessary to address lesser control technologies. As part of Nucor's Consent Decree, a detailed investigation was undertaken for NO_x emission controls from the reheat furnace. The conclusions were that ultra low NO_x burners to meet a limit of 0.075 lb NO_x/MMBtu can be applied

to new reheat furnaces. Existing reheat furnaces retrofitted with new burners should meet an emission limit of 0.09 lb NO_x/MMBtu. This investigation looked at other add-on controls such as SCR.

BACT Control of Volatile Organic Compound Emissions

The reheat furnaces have ultra-low NO_x burners. The VOC emissions for the reheat furnace were calculated using the latest AP-42 emissions factors (Table 1.4-2, July 1998). The emission factor was 5.5 lbs/million cubic foot and represents low NO_x burners. The natural gas combustion factors were derived based on tests for various boilers. These factors have generally been applied to other industrial emission sources that combust natural gas (e.g. reheat furnace, dryers and burners).

VOC emissions from the reheat furnace primarily result from combustion by-product of the fuel. Due to the relatively small emissions from natural gas combustion, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT analysis. A review of the RBLC database did not indicate the application of add-on control alternatives for VOC control from similar sized natural gas-fired reheat furnaces. In conclusion, for the existing reheat furnaces, BACT for controlling VOC emissions is proposed as the use of natural gas-fired burners employing good combustion practices per manufacturer's guidance to meet a VOC emission rate of 0.0055 lbs/MMBtu.

BACT Control for $PM_{2.5}$ Emissions

$PM_{2.5}$ emissions from the reheat furnace primarily result from combustion by-product of the fuel. Due to the relatively small emissions from natural gas combustion, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT/LAER analysis. A review of the RBLC database did not indicate the application of add-on control alternatives for $PM_{2.5}$ from similar sized natural gas-fired reheat furnaces. BACT for controlling $PM_{2.5}$ emissions is proposed as the use of natural gas-fired burners employing good combustion practices per manufacturer's guidance to meet a $PM_{2.5}$ emission rate of 0.0076 lb/MMBtu.

BACT Control of Sulfur Dioxide (SO_2) Emissions

SO_2 emissions from the reheat furnace primarily result from combustion by-product of the fuel. Due to the relatively small emissions from natural gas combustion, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT analysis. A review of the RBLC database did not indicate the application of add-on control alternatives for SO_2 control from similar sized natural gas-fired reheat furnaces. BACT for controlling SO_2 emissions is the use of

natural gas-fired burners employing good combustion practices per manufacturer's guidance to meet a SO$_2$ emission rate of 0.0006 lb/MMBtu.

BACT Analysis for Natural Gas-Fired Preheaters and Dryers

Nucor's natural gas fired preheaters and dryers are located and exhaust in the melt shop building.

BACT Control of Oxides of Nitrogen (NO$_x$) Emissions

NO$_x$ emissions from these small preheaters and dryers primarily result from combustion by-product of the fuel. Due to the relatively small emissions from natural gas combustion, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT analysis. A review of the RBLC database did not indicate the application of add-on control alternatives for NO$_x$ control from similar sized natural gas-fired combustion equipment in other industries. Based on a review of similar natural gas-fired applications, the proposed emission limit represents the best available control technology for the burners and dryers.

In conclusion, for the preheaters and dryers, BACT for controlling NO$_x$ emissions is proposed as the use of natural gas-fired burners employing good combustion practices per manufacturer's guidance to meet a NO$_x$ emission rate of 0.1 lb/MMBtu.

BACT Control of PM$_{2.5}$ Emissions

Particulate matter emissions from the small preheaters and dryers primarily result from carryover of non-combustible trace constituents in the fuel. Typically, particulates are hard to detect with natural gas firing due to the low ash content. The USEPA reference AP-42 recommends that all particulate emissions from natural gas combustion are less than 1 micron in aerodynamic diameter.

Based on a review of the previously listed information resources including the RBLC database, it was revealed that with the exception of natural gas as fuel and good combustion practices, no other control technologies for particulate abatement have been successfully implemented for small preheaters and dryers emissions. In addition, the RBLC database did not reveal any add-on control technologies for similar sized natural gas-fired combustion equipment in other industries.

Based on a review of similar natural gas-fired applications, the proposed emission limit represents the best available control technology for the small preheaters and dryers.

BACT for controlling PM$_{2.5}$ emissions from the small preheaters and dryers is proposed as the use of natural gas combustion with good combustion practices per manufacturer's guidance to meet a TSP/PM$_{10}$ emission rate of 0.0076 lb/MMBtu.

BACT Control of Sulfur Dioxide (SO$_2$) Emissions

SO$_2$ emissions from these small preheaters and dryers primarily result from combustion by-product of the fuel. Due to the relatively small emissions from natural gas combustion, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT analysis. A review of the RBLC database did not indicate the application of add-on control alternatives for SO$_2$ control from similar sized natural gas-fired combustion equipment in other industries. Based on a review of similar natural gas-fired applications, the current emission limit represents the best available control technology for the proposed burners and dryers.

BACT for controlling SO$_2$ emissions from preheaters and dryers the use of natural gas-fired burners employing good combustion practices per manufacturer's guidance to meet an SO$_2$ emission rate of 0.0006 lb/MMBtu.

BACT Control of Volatile Organic Compound Emissions

VOC emissions from these small preheaters and dryers primarily result from combustion by-product of the fuel. Due to the relatively small emissions from natural gas combustion, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT analysis. A review of the RBLC database did not indicate the application of add-on control alternatives for VOC control from similar sized natural gas-fired combustion equipment in other industries. Based on a review of similar natural gas-fired applications, the proposed emission limit represents the best available control technology for the burners and dryers.

BACT for controlling VOC emissions from preheaters and dryers is the use of natural gas-fired burners employing good combustion practices per manufacturer's guidance to meet a VOC emission rate of 0.0055 lb/MMBtu.

BACT/LAER Analysis for Proposed Heat Retention Boxes

While not installed, Nucor has permits to add natural gas combustion equipment that will include a two heat retention boxes (each rated at 5 MMBtu/hr). These would be located in the rolling mill building.

BACT Control of Oxides of Nitrogen (NO$_x$) Emissions

NO$_x$ emissions from these small burners primarily result from combustion by-product of the fuel. Due to the relatively small emissions from natural gas combustion, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT analysis. A review of the RBLC database did not indicate the application of add-on control alternatives for NO$_x$ control from similar sized natural gas-fired combustion equipment in other industries. Based on a review of similar natural gas-fired applications, the proposed emission limit represents the best available control technology for the burners.

BACT for controlling NO$_x$ emissions is the use of natural gas-fired burners employing good combustion practices per manufacturer's guidance to meet a NO$_x$ emission rate of 0.05 lb/MMBtu.

BACT Control PM$_{2.5}$ Emissions

Particulate matter emissions from the small burners primarily result from carryover of non-combustible trace constituents in the fuel. Typically, particulates are hard to detect with natural gas firing due to the low ash content. The USEPA reference AP-42 recommends that all particulate emissions from natural gas combustion are less than 1 micron in aerodynamic diameter.

Based on a review of the previously listed information resources including the RBLC database, it was revealed that with the exception of natural gas as fuel and good combustion practices, no other control technologies for particulate abatement have been successfully implemented for natural gas fired burners.. In addition, the RBLC database did not reveal any add-on control technologies for similar sized natural gas-fired combustion equipment in other industries.

BACT for controlling PM$_{2.5}$ emissions from the small preheaters and dryers is the use of natural gas combustion with good combustion practices per manufacturer's guidance to meet a PM$_{2.5}$ emission rate of 0.0076 lbs/MMBtu.

BACT Control of Sulfur Dioxide (SO$_2$) Emissions

SO$_2$ emissions from these small preheaters and dryers primarily result from combustion by-product of the fuel. Due to the relatively small emissions from natural gas combustion, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT analysis. A review of the RBLC database did not indicate the application of add-on control alternatives for SO$_2$ control from similar sized natural gas-fired combustion equipment in other industries. Based on a review of similar natural gas-fired applications

BACT for controlling SO₂ emissions is the use of natural gas-fired burners employing good combustion practices per manufacturer's guidance to meet an SO_2 emission rate of 0.0006 lb/MMBtu.

BACT Control of Volatile Organic Compound Emissions

VOC emissions from these small burners primarily result from combustion by-product of the fuel. Due to the relatively small emissions from natural gas combustion, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT analysis. A review of the RBLC database did not indicate the application of add-on control alternatives for VOC control from similar sized natural gas-fired combustion equipment in other industries. Based on a review of similar natural gas-fired applications, the use of natural gas burners represents the best available control technology for the burners.

BACT Analysis for Plant Wide Torches and Lancing

Nucor conducts various torching and lancing throughout the mill utilizing either acetylene or natural gas as a fuel.

BACT Control of Oxides of Nitrogen (NO_x) Emissions

NO_x emissions from these torches primarily result from combustion by-product of the fuels. Due to the relatively small emissions from combustion, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT analysis. .

BACT Control of $PM_{2.5}$ Emissions

Particulate matter emissions from these torches primarily result from carryover of non-combustible trace constituents in the fuel and particulate from the burning of steel.

Based on a review of the previously listed information resources including the RBLC database, no other control technologies for particulate abatement have been successfully implemented for small torches. In addition, the RBLC database did not reveal any add-on control technologies tor similar torching operations.

Torching operations are conducted plant wide both within large buildings and outdoors. Mostly the torching operations are intermittent at various locations where capturing these emissions are not practical, and even if they were at specific locatons only, the amounts are very small where add on capture devices are not warranted for BACT. Torches utilized at the caster at a permanent location and located below a

ventilation system where much of the emissions are captured and passed through the EAF baghouse which controls particulate emissions.

BACT Control of Sulfur Dioxide (SO₂) Emissions

SO_2 emissions from these torches primarily result from combustion by-product of the fuel. Due to the relatively small emissions from combustion, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT analysis. A review of the RBLC database did not indicate the application of add-on control alternatives for SO_2 control for torches.

BACT Control of Volatile Organic Compound Emissions

VOC emissions from these torches primarily result from combustion by-product of the fuel. Due to the relatively small emissions from combustion, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT analysis.

BACT Analysis for Rolling Mill

Fumes in roll mill are associated with the hot steel rolling process. The steel is spray with water to reduce its temperature and minimize $PM_{2.5}$ emissions. A high level of control is assumed (99.9%) due to continuous water spray and because the operation is contained within a building. Because oils are lost to the water and the water contacts hot steel, some VOC emissions result from the vaporization of the heavy oils. These VOC emissions are addressed through a mass balance quantification methods by studies conducted by Nucor Corporation.

Because of the large area of the emission source within the building and the large volume of air to be evacuated, it is not practical to capture particulate and VOC emissions from the rolling operations to meet BACT.

BACT Analysis for Roll Mill 1 Saw Shack Baghouse

Fumes in the mill associated with abrasive saw cutting are exhausted by a fan having a flow rate of 15,000 cfm and an outlet grain loading of 0.01 grain/dscf. Based on a review of the RBLC database, fabric filtration is the only add-on control of choice for similar process applications. As a consequence, the baghouse is BACT for $PM_{2.5}$ emissions from the abrasive saw.

BACT Analysis for Roll Mill 1 Jump Mill Baghouse

Nucor has obtained a permit, but does not currently operate, a baghouse to capture fumes from a hot rolling mill stand which makes several passes. These fumes currently are emitted within the building, but if installed, could be exhausted by a fan having a flow rate of 8,000 cfm and an baghouse having an outlet grain loading of 0.01 grain/dscf. The baghouse would have a stack to vent outdoors. Based on a review of the RBLC database, fabric filtration is the only add-on control of choice for similar process applications. As a consequence, the baghouse is BACT for for $PM_{2.5}$ emissions from the roll mill building.

BACT Analysis for Scrap Steel Handling

Scrap Steel handling can cause emissions of PM2.5 resulting from dirt and rust on the steel. Existing BACT controls are in place that consists of the following with estimated control: direct from railcar (70 percent control); handled from covered truck dump (50 percent control); handled to and from stockpiles, watered as necessary (50 percent control); and handled from uncovered truck dump, watered as necessary (50 percent control). BACT controls in place and opacity restrictions are contained in permits.

BACT Analysis for Storage Silos

Nucor has 4 carbon silos with three baghouses, one of which exhausts inside the melt shop, and the meltshop is evacuated to the EAF baghouse. There are two lime silos which are served with one baghouse. The silos have a small baghouse to prevent the material from escaping during filling operations. Each baghouse has an estimated flow rate of 1,020 cfm and an outlet grain loading of 0.01 grain/dscf. Based on a review of the RBLC database, fabric filtration is the only add-on control of choice for similar process applications. As a consequence, baghouse control is considered as BACT for $PM_{2.5}$ emissions from the storage silos.

BACT Analysis for Paved/Unpaved Roads

The mill has paved and unpaved roads for the transportation of raw materials and slag, in addition to other miscellaneous vehicle travel. Nucor dramatically reduces $PM_{2.5}$ emissions associated with vehicular traffic on paved roadways by periodically sweeping or water flushing (as conditions warrant). Nucor dramatically reduces $PM_{2.5}$ emissions associated with vehicular traffic on unpaved roadways by water spray and/or chemical treatment in sufficient frequency to minimize emissions. The present controls applied to paved and unpaved roads are BACT for $PM_{2.5}$.

BACT Analysis for Material Handling and Stockpiles

Material handling consists of the following with estimated control: alloy/lime stockpiles (3-sided roofed bin, 90 percent control); alloy handling railcar unloading NE (Water sprays); alloy handling railcar unloading melt shop belly dump (90 percent control within building); small slag storage pile for truck bed lining (controlled by size); slag transfer to truck transfer below grade (90 percent control); and belly dump lime unloading at melt shop (90 percent control). The resulting small emissions with the controls in place are BACT.

BACT Analysis for Cooling Towers

Nucor has the following cooling towers set installations: roll mill contact (8,000 gpm); roll mill and melt shop non contact (4,600 gpm); DEC (10,000 gpm); and the caster system (4,000 gpm). The cooling towers are equipped with drift mist eliminators have a drift rate of 0.0006 percent, except for the DEC system which has a drift rate of 0.001 percent. The maximum PM emissions associated with the towers are 1.57 tpy and assumed all PM2.5. PM emissions were calculated using the factor of 0.16 presented in the technical paper "Calculating Realistic PM_{10} Emissions from Cooling Towers" (Reisman and Frisbie). The use of drift eliminators for cooling towers is BACT.

BACT Analysis for Emergency Generators

Nucor is permitted diesel-fueled, gasoline powered, and natural gas fired generators. As emergency generators, they are seldom used with periodic maintenance firing and occasional use with loss of power. The majority are hand carry sized used backup UPS systems for computers in the event of extended loss of power. Some larger generators are installed in stationary locations to handle critical operations such as emergency equipment or molten steel. All stationary generators meet the applicable requirements for generators contained in EPA's NESHAP or NSPS, which is BACT for generators. These federal regulations address NOX, organic emissions, and particulates.

BACT Analysis for Miscellaneous Painting and Solvent Cleaning

Nucor has miscellaneous painting and solvent use. Painting is conducted plant wide on buildings, equipment, for safety markings, and to identify products. Present VOC emissions are included in plantwide permit limitations for the amounts that can be purchased or used. Typically, a BACT analysis for painting operations identifies that a paint booth with particulate filters is necessary to meet BACT. VOC emissions control are not considered feasible, due to the small emissions levels from the miscellaneous painting. Because painting is conducted plant wide a specific paint booth with add-on control is not possible for miscellaneous painting operations. However, spray most painting is performed inside a building which greatly limits the PM emissions to the

atmosphere. Similarly, miscellaneous solvent use is utilized plant wide. Miscellaneous solvent use is distinguished from the utilization of parts washers in that solvents are used at the location of the repair. The majority of these solvents used are in aerosol cans which are sprayed on the equipment part at the operating location where it may be repaired on-line or at a designated repair location. The equipment is typically too large to be placed in a parts washer with a closing lid.

Nucor does have a painting process at the operation for providing painted product to customers. As part of the process, this painting operation is limited to the types of paint that can be used to limit VOC emissions. The rule is applicable in nonattainment areas and is 2.3 lbs/VOC per gallon of paint. Nucor utilizes a water based paint to comply with this rule. Compliance with this rule meets VOC BACT for painting used in a process. The painting operation used at Nucor is a dip process. Therefore does not cause any particulate emissions where a BACT analysis is necessary.

BACT Analysis for Sandblasting

Sandblasting can represent significant emissions of PM if substantial sandblasting is completed and the operations are uncontrolled. Nucor conducts sandblasting within a 3-sided building with a roof. Sand blasting is not part of Nucor's manufacturing process. Rather it is used for our own equipment maintenance or functionality. The amount of $PM_{2.5}$ is very limited due to the small utilization and containment within buildings. Control is achieved by limiting air movement around the operations so that PM settles in the immediate area. Nucor's controls meet the sandblasting requirements contained in R307-206, UAC and BACT.

BACT Analysis for Volatile Organic Storage Tanks

There are 2 diesel storage tanks and one gasoline storage tank. Emissions associated with these tanks are calculated with the USEPA TANKS program. These tanks are equipped with pressure relief devices to reduce breathing losses. VOC emissions are very small. Due to the small emissions associated with the filling and evaporative losses due to these tanks, no further control is necessary to meet BACT.

BACT Analysis for Vacuum Ladle Degasser

Nucor has permitted, but not yet installed, a vacuum ladle degasser that will process the molten steel in the melt shop. The vacuum degasser will be limited to 100,000 tons/year and approximately 1,500 hours/year. The exhaust gas will be ducted to a flare.

BACT Control of Oxides of Nitrogen (NO$_x$) Emissions

NO$_x$ emissions from the vacuum degasser result from the degassing of the liquid steel and due to combustion by-product of the fuel in the flare (used for CO emissions control). Due to the relatively small emissions from natural gas combustion and the vacuum degassing process, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT analysis. A review of the RBLC database did not indicate the application of add-on control alternatives for NO$_x$ control from vacuum degassers. Based on a review of similar applications, the proposed emission limit of 0.005 lb/ton represents the best available control technology for the vacuum degasser.

BACT Control of Particulate Matter (PM/PM$_{10}$) and LAER for PM$_{2.5}$ Emissions

Particulate matter emissions from the vacuum degasser result from the degassing of the liquid steel and due to combustion by-product of the fuel in the flare (used for CO emissions control). Due to the relatively small emissions from natural gas combustion and the vacuum degassing process, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT analysis. A review of the RBLC database did not indicate the application of add-on control alternatives for PM from vacuum degassers.

Based on a review of similar natural gas-fired applications, the proposed emission limit represents the best available control technology for the vacuum degasser.

In conclusion, BACT for PM/PM$_{10}$ and LAER for PM$_{2.5}$ emissions from the vacuum degasser is proposed as the use of natural gas combustion with good combustion practices per manufacturer's guidance to meet a PM/PM$_{10}$/PM$_{2.5}$ emission rate of 0.008 grain/dscf.

BACT Control of Sulfur Dioxide (SO$_2$) Emissions

Sulfur dioxide emissions from the vacuum degasser result from the degassing of the liquid steel and due to the combustion by-product of the fuel in the flare (used for CO emissions control). Due to the relatively small emissions estimated from natural gas combustion and the vacuum degassing process, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT analysis. A review of the RBLC database did not indicate the application of add-on control alternatives for SO$_2$ control from the vacuum degasser.

BACT Control of Volatile Organic Compounds (VOC) Emissions

Volatile organic compound emissions from the vacuum degasser result from the degassing of the liquid steel and due to the combustion by-product of the fuel in the flare (used for CO emissions control). Due to the relatively small emissions estimated from natural gas combustion and the vacuum degassing process, the application of add-on controls is considered impractical and will be precluded from further consideration in this BACT analysis. A review of the RBLC database did not indicate the application of add-on control alternatives for VOC control from the vacuum degasser.