Illinois Environmental Protection Agency
Bureau of Air, Permit Section
Springfield, Illinois

Project Summary for a Construction Permit Application from Nucor Steel Kankakee, Inc. for modifications to its electric arc furnace in Bourbonnais, Illinois

Site Identification No.: 091801AAA
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I. INTRODUCTION

Nucor Steel Kankakee, Inc. (Nucor) has requested a construction permit to modify its electric arc furnace (EAF) by upgrading the oxygen delivery system, which will provided improved operational control of the melting and refining process. This change will increase furnace yield compared to the existing lance technology by more evenly injecting oxygen into the molten bath. This improvement in operational performance would increase the potential annual steel production and emissions of the plant.

The Illinois EPA has reviewed Nucor's application and made a preliminary determination that the application for the proposed project meets applicable requirements. Accordingly, the Illinois EPA has prepared a draft of the construction permit that it would propose to issue for the proposed construction and modifications. However, before issuing the permit, the Illinois EPA is holding a public comment period and a public hearing to receive comments on the proposed issuance of the permit and the terms and conditions of the draft permit.

II. PROJECT DESCRIPTION

Nucor's Bourbonnais plant has a single electric arc furnace to supply the raw steel for the concrete reinforcing bar and other steel bar products manufactured at the plant. Steel scrap is melted and refined in the arc furnace using electricity as the main source of heat. The furnace was installed in 1988 by Birmingham Steel, the owner of the plant at that time, replacing the prior furnace at the plant (Construction Permit 88110038).

Nucor's proposed operational modifications, by upgrading the equipment used to introduce oxygen into the furnace, will increase furnace yield compared to the existing lance technology by more evenly injecting oxygen into the molten bath, which, will reduce loss of iron to the layer of slag formed on top of the molten metal. The resultant increase in EAF performance and operational efficiency is anticipated to increase potential annual steel production to 1,100,000 tons from 876,000 tons, as allowed by Nucor's current permit. These modifications will result in increased emissions from the furnace.

The principal air pollutants emitted from the furnace are particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NOx), volatile organic material (VOM), and sulfur dioxide (SO2). In addition to having PM emissions due to the physical loss of material during operation, the arc furnace is also a source of gaseous pollutants from the chemical reactions that occur during the refining of the scrap, the presence of contaminants in the scrap, and the high temperature in the furnace.

Emissions of PM from the furnace are controlled by enclosure of the furnace shop with collected exhaust directed to two fabric filters or baghouses, including a supplementary baghouse that Nucor recently installed. Because the furnace was constructed after 1983, the furnace is considered a new furnace and is subject to the federal New Source Performance Standards, NSPS for Steel Plants, 40 CFR 60 Subpart AAa, which addresses PM emissions from arc furnace operations at steel mills.

Emissions of gaseous pollutants from the furnace are controlled by work practices and equipment. In particular, SO2 and VOM are minimized by management of raw materials, CO is minimized by an air gap, so that CO in the exhaust from the furnace is destroyed by combustion in a refractory lined section of ducted work and for emissions of CO, NOx, SO2 and VOM the furnace is also subject to requirements established under the federal rules for Prevention of Significant Deterioration of Air Quality (PSD), 40 CFR 52.21. These requirements were established for a modification of the plant in the early 1990's that was subject to permitting under the PSD rules. (Refer to Construction Permits 93010095 and 04100024)

III. PROJECT EMISSIONS

The potential annual emissions of the modified furnace, as would be allowed by the construction permit, are summarized below. Actual emissions would be less than the permitted emissions as the facility would typically operate at less than its maximum capacity and control equipment normally operates to achieve emission rates that are lower than the applicable standards and limitations.

Downstream emissions are based on the amount of metal processed and natural gas consumption at the reheat furnaces and rolling mills. Nucor already produces more metal billets than they can process at the downstream operations. Additional production from the furnace modifications will not increase emissions of downstream processes but only increase the number of billets that Nucor sells for offsite processing. In addition the reheat furnaces and rolling mills are currently limited by natural gas consumption which is not modified by this permitting action.

Permitted Annual Emissions of the Furnace (Tons/Year)

PM	VOM	SO_2	NO_x	CO
89.5	154.8	275.8	145.8	1100.0

IV. APPLICABLE EMISSION STANDARDS

The application shows that the modified furnace will readily comply with applicable emission standards, including applicable state emission standards (35 Ill. Adm. Code: Subtitle B, Subchapter c) and applicable federal emission standards adopted by the United States EPA (40 CFR Part 60). The federal emission standards include the New Source Performance Standards (NSPS) for electric arc furnaces, 40 CFR 60 Subpart AAa.

The modified furnace would also be subject to the federal National Emission Standards for Hazardous Air Pollutants (NESHAP), Standards of Performance for Steel Plants: electric Arc Furnaces and Argon-Oxygen Decarburization Vessels, 40 CFR 60 Subpart AAa. This is because the plant is not a major source for emissions of hazardous air pollutants (HAPs).

V. PREVENTION OF SIGNIFICANT DETERIORATION (PSD)

The project is subject to PSD review for emissions of sulfur dioxide (SO2) and carbon monoxide (CO). This is because Nucor has requested limits that would allow significant increases in emissions of SO2 and CO, i.e., more than 40 and 100 tons/year respectively.

The substantive requirements of the PSD rules for a major project for a pollutant are: 1) A case-by-case determination of Best Available Control Technology (BACT), 2) An ambient air quality impact analysis to confirm that the project would not cause or contribute to a violation of the National Ambient Air Quality Standard(s) (NAAQS) or applicable PSD increment(s); and 3) An assessment of the impacts on soils, vegetation and visibility. These requirements are addressed later in this document.

VI. CASE-BY-CASE CONTROL TECHNOLOGY DETERMINATION FOR BACT

Nucor submitted a "top-down" BACT demonstration in its application reflecting its judgment as to the control technologies for emissions of SO_2, and CO and associated emission limits that should be considered BACT under the PSD rules for the various units at the proposed facility.

The Illinois EPA has reviewed the material submitted by Nucor and made its independent determinations of BACT. In addition to the material submitted by Nucor, the Illinois EPA's determination of BACT relies upon its general knowledge of the types of operations at the proposed plant and specific information about existing facilities with similar operations that are located in Illinois. As explained below, the Illinois EPA concurred with Nucor's selection of control technologies as it reflected technologies that are in common use at similar facilities and effectively control emissions.

A. BACT Discussion for Modified EAF

CO

There are several types of control measures that are theoretically possible to reduce CO include direct-shell evacuation with a air gap in the collecting duct, thermal oxidation, catalytic oxidation, and oxygen injection.

The two types of oxidation devices that can generally be used to control CO emissions are thermal oxidation and catalytic oxidation. In a thermal oxidizer a combustion chamber is maintained, without the aid of heat recovery, at an elevated temperature through the combustion of an auxiliary fuel in order to combust or thermally break down contaminants. The contaminant to be controlled dictates the reactor temperature. However, the air gap in the collection duct already provides control of CO in the same manner as thermal oxidation. Catalytic oxidizers operate similarly to thermal oxidizers, except that a catalyst bed is used to increase the oxidation rate to enable destruction at a lower temperature. The difficulty with a catalytic oxidizer is 'blinding' of the catalyst bed. Blinding occurs when particulate from the exhaust stream plugs or coats the catalyst surface making it ineffective. Due to the deleterious affects of particulate loading on the catalyst, it would have to be applied after a baghouse.

Thermal and catalytic oxidation are both technically infeasible when applied at an EAF for CO control. Due to the variable and low concentration (100 to 500 ppmv) of CO in the exhaust stream after combustion from the air gap, a large amount of natural gas would be required to heat the stream to a sufficient temperature to further reduce the residual CO. The emissions of NOx from combustion of gas would outweigh the benefit from the CO emissions reductions that would be gained. In addition estimated annual fuel cost based on natural gas consumption would be approximately 100 million dollars.

Oxygen injection is a control method by which additional oxygen is injected into the furnace, which then reacts with CO to increase oxidation in the furnace converting the CO to CO_2. Two difficulties with oxygen injection are unreliable operation and process variability making timely gas analysis and system adjustment impractical. Also, at temperatures about 3500 ^oF, oxygen injection can lead to increased CO production.

Oxygen injection has proven unreliable on previous EAF applications. One of the primary limiting factors in CO combustion is inconsistent exhaust gas temperature; due to the variable nature of the EAF exhaust gas cycle temperature concentrations vary greatly. In addition, the primary purpose of oxygen injection is to supply additional oxygen to allow combustion of CO, the DEC already supplies sufficient oxygen to enable this reaction.

Similar to oxygen injection, duct burners suffer from the variability in exhaust gas concentrations and large flow volume inherent to an EAF operated with DEC. Duct burners also generate a large amount of additional emissions including CO through the combustion of natural gas required for their operation. This CO generation offsets a significant portion of what would otherwise be gained through their use.

Direct shell evacuation control (DEC) maintains a negative pressure above the metal or slag at the top of an EAF and captures emissions for direct ducting to the particulate control device. Dampers are used to maintain sufficient negative pressure to adequately control emissions, without drawing in so much air that emission are increased due to the presence of additional oxygen. The separate air gap provides sufficient air for combustion of CO without having excessive air (oxygen) in the furnace itself, which would act to lower the amount of sulfur retained in the steel or absorbed in the slag, with increased loss of sulfur from the furnace as SO_2 emissions.

Of the remaining control options discussed above, DEC with in-duct combustion are applicable and are proposed as BACT. The proposed BACT limit for CO is 2.0 lbs/ton of steel.

SO_2

SO_2 emissions originate from the combustion of sulfur containing materials used in the steel making process. Potential control technologies include low-sulfur charge carbon, scrap procurement, segregation, storage, and utilization, DEC, process modifications, and wet, semi-dry, and dry flue gas desulfurization (FGD). The addition of

charge carbon to the melt is an essential component of steel. Currently, Nucor is using low-sulfur charge carbon that has less than 0.5% sulfur by weight. This minimizes the contribution of charge carbon additions to SO2 emissions.

Scrap management programs reduce or eliminate scrap with high levels of contaminants. This acts to minimize steel scrap that could contribute to SO2 emissions from being accepted at the plant and being used.

Other work practices for the furnace minimize the variation in the furnace pressure encountered during the melt cycle. Large negative pressure inside the furnace may contribute to increased SO_2 formation. Large positive pressure would cause excessive shop opacity and the decreased combustion of CO and VOM. Balancing the furnace pressure minimizes the emissions of NOx and PM with the emissions of SO2 and CO from the EAF.

Flue gas desulfurization (FGD) also known as SO2 scrubbing is a process which typically employs the use of a calcium or sodium based alkaline reagent that in injected in the flue gas through a spray tower or directly in to the duct. The SO2 is absorbed, neutralized and/or oxidized by the alkaline reagent into a solid compound, either calcium or sodium sulfate. Flue gas desulfurization is considered technically infeasible for the following reasons. Relatively low SO2 concentrations and very large air flow volumes results in little opportunity for the droplets/sorbent to react with the SO2. The controlled outlet concentration typically found with these systems is higher than the proposed inlet concentration that would be present from the melt shop in this application. In addition, the SO2 concentration varies throughout the furnace cycle, making operation of any scrubber difficult. Finally, the exhaust gas flow rate and temperature also varies greatly throughout the furnace cycle, presenting conditions that are not amenable to effective operation of a scrubber.

The technically feasible options are low-sulfur charge carbon, scrap management, and work practices, which are all proposed as BACT for SO_2. The proposed SO_2 emission rate is 0.5 lb/ton of steel, 24-hour average.

X. PSD IMPACT ANALYSES

A. AIR QUALITY ANALYSIS

An ambient air quality analysis was conducted to assess the impact of the emissions of the proposed project. Under the PSD rules, this analysis must determine whether the proposed project will cause or contribute to a violation of any applicable air quality standard.

The air quality analyses for SO_2, and CO were performed using computerized dispersion modeling. The analyses conformed to the current guidance and requirements of the USEPA and the Illinois EPA. The Results are as follows:

Results of Significant Impact Analysis ($\mu g/m^3$)

Pollutant	Averaging Period	Maximum Predicted Impact	Significant Impact Level(ug/m^3)
CO	1-hour	111.5	2000
CO	8-hour	64.1	500
SO_2	3-hour	17.9	25
SO_2	24-hour	9.7	5
SO_2	Annual	0.8	1

Only the results of the 24-hour SO_2 modeling exceeded the significant impact level. As a result, ERM conducted a full impact analysis to determine compliance with the applicable National Ambient Air Quality Standards (NAAQS) and PSD increments for SO_2. The results of the NAAQS and PSD increment analyses are presented below.

Results of NAAQS Analysis for SO_2 (µg/m^3)

Pollutant	Averaging Period	Modeled Concentration	Background Concentration	Model Design Concentration	NAAQS
SO_2	Annual	6.1	10.5	16.6	80
SO_2	3-hour	92.2	144.1	236.3	1300
SO_2	24-hour	37.7	49.8	87.5	365

Results of Increment Analysis for SO_2 (µg/m^3)

Pollutant	Averaging Period	Modeled Concentration	PSD Increment	Percent of Increment Consumed
SO_2	Annual	3.6	20	18.0
	3-hour	83.8	512	16.4
	24-hour	33.4	91	36.7

As both tables show, none of the applicable NAAQS or PSD increments will be violated by the proposed changes. Based on the modeling results from ERM, the air quality analysis is considered to satisfy the PSD requirements for the proposed modification.

VI. PERMIT CONDITIONS

The conditions of the permit set forth the air pollution control requirements that the facility must meet. These requirements include the applicable emission standards that apply to the units at the facility. They also include the measures that must be used and the emission limits that must be met by emission units as BACT for emissions of SO_2, and CO.

The permit also establishes enforceable limitations on the amount of emissions for which the project is permitted. In addition to annual limitations on emissions, the permit includes short-term emission limitations and operational limitations, as needed to provide practical enforceability of the annual emission limitations. As previously noted,

actual emissions associated with the project would be less than the permitted emissions to the extent that the facility operates at less than capacity and control equipment normally operates to achieve emission rates that are lower than the applicable standards and limitations.

The permit also establishes appropriate compliance procedures for the ongoing operation of the facility, including requirements for emission testing, required work practices, operational monitoring, recordkeeping, and reporting. These measures are imposed to assure that the operation and emissions of the facility are appropriately tracked to confirm compliance with the various limitations and requirements established for individual emission units.

VII. REQUEST FOR COMMENTS

It is the Illinois EPA's preliminary determination that the application for the proposed modifications meets applicable state and federal air pollution control requirements. The Illinois EPA is therefore proposing to issue a construction permit for the modifications to the plant.

Comments are requested on this proposed action by the Illinois EPA and the conditions of the draft permit.