BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
NITROGEN OXIDES EMISSIONS FROM	)	R08-19
VARIOUS SOURCE CATEGORIES:	)	(Rulemaking – Air)
AMENDMENTS TO 35 ILL. ADM. CODE	)	
PARTS 211 AND 217	)	

NOTICE

ORIGINAL

TO: John Therriault
Assistant Clerk
Illinois Pollution Control Board
James R. Thompson Center
100 West Randolph St., Suite 11-500
Chicago, IL 60601

SEE ATTACHED SERVICE LIST

PLEASE TAKE NOTICE that I have today filed with the Office of the Clerk of the Illinois Pollution Control Board the TESTIMONY OF ROBERT KALEEL, VIR GUPTA, AND JAMES E. STAUDT, Ph.D., a copy of which is herewith served upon you.

ILLINOIS ENVIRONMENTAL
PROTECTION AGENCY

By: _____
Gina Roccaforte
Assistant Counsel
Division of Legal Counsel

DATED: August 29, 2008

1021 North Grand Avenue East
P. O. Box 19276
Springfield, IL 62794-9276
217/782-5544

THIS FILING IS SUBMITTED ON RECYCLED PAPER

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ORIGINAL

TESTIMONY OF ROBERT KALEEL

My name is Robert Kaleel. I am the Manager of the Air Quality Planning Section in the Bureau of Air at the Illinois Environmental Protection Agency ("Illinois EPA"). I have a Bachelor of Science degree in meteorology from Northern Illinois University. I have worked at the Illinois EPA for more than twenty-six years, and have been in my present position since 2004. Prior to that, I was the Manager of the Air Quality Modeling Unit in the Air Quality Planning Section, a position that I held for more than fifteen years. I have also worked as a private consultant as a specialist in air quality modeling.

As Manager of the Air Quality Planning Section, my responsibilities include oversight of staff that provides technical support for regulatory initiatives needed to address air quality issues in Illinois, including the regulatory proposal before the Illinois Pollution Control Board ("Board") at this hearing. The Air Quality Planning Section also provides technical support to the Bureau of Air's permitting and enforcement functions, and is responsible for maintaining the Bureau's emission inventory system, including Annual Emission Reports. I have been closely involved with the development of Illinois' State Implementation Plans to address the $PM_{2.5}$ and ozone nonattainment areas in Illinois.

My testimony will explain the purpose of this proposal, and highlight some of the components of the proposed rule. I would like to note that the Illinois EPA performed substantial outreach to stakeholders on the proposed rule. The Illinois EPA has participated in meetings with interested stakeholders, and has posted a draft of the proposed rule on its website for public comment. Illinois EPA received extensive comments on the draft rule, and this proposal incorporates many of the concerns and suggestions put forth in these comments.

The Illinois EPA's proposal is intended to control nitrogen oxides ("NO_x") emissions from various emission units located within the Chicago and Metro-East nonattainment areas

to meet certain obligations of the State of Illinois under the federal Clean Air Act ("CAA"). Specifically, the proposal is intended to satisfy Illinois' obligation to submit a State Implementation Plan ("SIP") to address the requirements under Sections 172 and 182 of the CAA for major stationary sources of NO_x in areas designated as nonattainment with respect to National Ambient Air Quality Standards ("NAAQS"). In addition, Section 110 of the CAA requires that states submit for the United States Environmental Protection Agency's ("USEPA") approval state plans that provide for the attainment and maintenance of standards established by USEPA through control programs directed to sources of the pollutants involved through such requirements as reasonably available control measures ("RACM") and reasonably available control technology ("RACT"). RACT is defined as the lowest emission limitation that a particular source can meet by applying a control technique that is reasonably available considering technological and economic feasibility. The Illinois EPA has concluded that affected sources can meet the requirements of the proposed rule through a number of control techniques such that compliance is both technically feasible and economically reasonable.

In Illinois, there are two areas designated as nonattainment (moderate) for the 8-hour ozone standard. The first is the Chicago-Gary-Lake County nonattainment area, which includes Cook, DuPage, Kane, Lake, McHenry, and Will Counties, and portions of Grundy and Kendall Counties in Illinois, as well as certain counties in northwest Indiana. The second area is the St. Louis nonattainment area, which includes the Metro-East counties of Jersey, Madison, Monroe, and St. Clair, as well as several counties in Missouri. NO_x is considered to be one of the primary precursors for the formation of ozone, so the CAA requires that Illinois' SIP provide for the implementation of RACT controls for NO_x for ozone nonattainment areas classified as moderate and above.

In Illinois, there are two areas designated as nonattainment for the $PM_{2.5}$ standard, the first being the Chicago-Gary-Lake County nonattainment area, which includes the same northern Illinois counties as the 8-hour ozone nonattainment area. The second nonattainment area is the St. Louis nonattainment area, which again has similar, though not identical, area boundaries as for ozone. For $PM_{2.5}$, Jersey County is not part of the nonattainment area, but Baldwin Township in Randolph County is included. NO_x is considered a primary precursor to the formation of $PM_{2.5}$, so the promulgation of RACT controls for NO_x is appropriate.

It should be noted that USEPA has in recent years completed reviews of the NAAQS for both particulate matter and ozone. In October 2006, USEPA strengthened the 24-hour $PM_{2.5}$ standard, and in March 2008, USEPA strengthened the 8-hour ozone standard. It is likely that the same areas in Illinois that are currently designated as nonattainment for the present standards will soon be designated as nonattainment for one or both of these revised standards. Reducing NO_x emissions in these areas will likely help Illinois to achieve the newly revised NAAQS as well satisfying current CAA obligations.

Illinois EPA's regulatory proposal aims to achieve NO_x reductions in Illinois from a number of source categories while providing reasonable flexibility for the affected sources. The regulatory proposal requires major stationary sources located in the nonattainment areas in Illinois to comply with the emissions limitations set by the proposed rule beginning May 1, 2010. Major stationary sources include those that emit or have the potential to emit NO_x in an amount equal to or greater than 100 tons per year. The emissions limitations apply on an ozone season basis and on an annual basis to industrial boilers, process heaters, glass melting furnaces, cement kilns, lime kilns, iron and steel reheat, annealing, and galvanizing furnaces, aluminum reverberatory or crucible furnaces, and fossil fuel-fired boilers that emit at least 15 tons of NO_x per year or at least five tons per ozone season and are located at major stationary sources.

Flexibility is built into the regulations as they allow compliance to be demonstrated through an emissions averaging plan. Sources may aggregate and then average the NO_x emissions from units at the same location in Illinois to comply with the emissions limitations provided that each unit is covered by only one emissions averaging plan. The emissions averaging option allows the owners or operators of affected sources more flexibility in complying with the requirements of this proposal while achieving the same amount of emission reductions at that location.

In addition, the proposed regulations provide for certain exemptions. Such regulations do not apply to an emission unit operating under a federally enforceable limit of NO_x emissions from such units to less than 15 tons per year and less than five tons per ozone season. In addition, the regulations do not apply to coal-fired boilers that are complying with the multi-pollutant standards under Section 225.233 of Part 225, or the combined pollutant

standards under Subpart F of Part 225 (i.e., control requirements and standards for emissions of mercury, NO_x and SO_2).

G:/rob/NOx RACT Testimony Kaleel (Aug 08)

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ORIGINAL

TESTIMONY OF VIR GUPTA

My name is Vir Gupta. My educational background includes a Master of Engineering Degree in Chemical Engineering from Punjab University, Chandigarh, India, in May 1973. From August 1971 to May 1979, I worked as a scientific officer at Bhabha Atomic Research Center in Mumbai, India, where my job duties included research and development work for the production of thorium compounds from thorium concentrates.

I joined the Illinois Environmental Protection Agency ("Agency") on November 1, 1979, and started my work in the Permit Section of the Bureau of Air. I reviewed permits for electric utility boilers, industrial boilers, chemical process industries, bulk gasoline plants and terminals, and sources emitting toxic and hazardous pollutants, among others. I also attended several training courses and seminars on the control of sulfur dioxide ("SO_2"), nitrogen oxides ("NOx"), particulate matter, volatile organic compounds and hazardous air pollutants.

I began working in the Air Quality Planning Section of the Bureau of Air in June 1992 and since that time I have been involved in various projects including preparation of the 1990 ozone season weekday emissions inventories, draft NOx Reasonably Available Control Technology ("RACT") regulations for Chicago and Metro-East non-attainment areas, clean up of existing air pollution control regulations, NOx SIP Call regulations, general conformity regulations as applicable to federal facilities, conducting a feasibility

study for multi-pollutant controls for electric utility boilers, and preparing summary reports on new electric utility turbines and boilers permitted by the Agency. I also attended several seminars and workshops for the control of NOx, SO_2, particulate matter, and mercury emissions.

My involvement in the development of this regulatory proposal includes identification of potentially affected sources located in the Chicago and Metro-East non-attainment areas and estimation of emissions reductions expected from the proposed emission limits.

For this purpose, I reviewed the Agency NOx inventory for the year 2005 for major sources of NOx emissions. I also reviewed several federal Alternative Control Techniques Documents for NOx emissions from industrial/commercial/institutional boilers, utility boilers, process heaters, cement kilns, iron and steel plants, and glass melting furnaces, a STAPPA/ALAPCO document on controlling nitrogen oxides under the Clean Air Act, and the federal AirControlNet's Documentation Report. These and other documents are referenced in the Technical Support Document ("TSD") that is filed with this rulemaking.

Based on my review of the literature, other state regulations, and the Agency's inventory, I recommended the following source categories for NOx controls: Industrial and electric utility boilers, process heaters, cement and lime kilns, reheat, annealing and galvanizing furnaces at iron and steel plants, glass melting furnaces, and aluminum melting furnaces. These source categories are discussed in further detail in the TSD.

Based on the proposed NOx emissions limits, I prepared a summary of anticipated NOx reductions in Chicago and Metro-East non-attainment areas which is listed in

Section 10, Table 10-1 in the TSD. This table shows the number of units in each source category affected by the proposed rule, year 2005 NOx emissions, controlled NOx emissions, and NOx reductions from the application of the proposed limits. In summary, this table shows a total of 196 units emitting 44,625 tons of NOx emissions in 2005, and NOx reductions of 20,666 tons, or a 46.3% reduction, by the application of the proposed limits.

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TESTIMONY OF JAMES E. STAUDT, Ph.D.

I, James E. Staudt, have been retained by the Illinois Environmental Protection Agency ("Illinois EPA") as an expert in this nitrogen oxides ("NOx") rulemaking addressing various source categories and Reasonably Available Control Technology ("RACT").

The purpose of my testimony is to describe how NOx emissions from industrial facilities impacted by the proposed NOx RACT rule can be controlled and what those controls are expected to cost for affected facilities. These source types include Industrial Boilers and Electrical Generating Unit Boilers, Process Heaters, Cement Kilns, Lime Kilns, Reheat, Annealing, and Galvanizing Furnaces used at Iron and Steel Plants, Glass Melting Furnaces, and Aluminum Melting Furnaces that meet the size and other criteria to be subject to the proposed rule.

I. BACKGROUND AND QUALIFICATIONS

I am currently the president of Andover Technology Partners ("ATP"). As president of ATP, I have advised power plants, industrial facilities, equipment suppliers and government agencies on different means of complying with emissions regulations in cost-effective ways. For over twenty years, I have focused on pollutant control technologies, including NOx, sulfur dioxides ("SO_2") and mercury emissions control. For the past eleven years (since 1997), I have been a consultant with my own business – Andover Technology Partners. My primary area of business as a consultant is associated with my expertise relating to the performance and cost of

air pollution control on power plants and industrial facilities. Clients have included the United States Environmental Protection Agency ("USEPA"), power plant owners, industrial plant owners, technology suppliers, and others. I have published several papers and reports, including papers in peer-reviewed journals and reports issued by the USEPA, on NOx control and control of other pollutants. Several of these papers have been coauthored with staff of the USEPA. For most of the period from 1988 to 1997, I was employed by companies that provided air pollution control technology (Research Cottrell and Fuel Tech) or power plant and refinery gas analyzers (Spectrum Diagnostix, a subsidiary of Physical Sciences that was acquired by Western Research). Over this period, as an employee of these companies, I sold, designed, and commissioned air pollution control technology at numerous power plants and industrial facilities.

I received my B.S. in Mechanical Engineering from the U.S. Naval Academy in 1979. I received my M.S. (1986) and Ph.D. (1987) in Mechanical Engineering from the Massachusetts Institute of Technology. In 2001, I was awarded the Chartered Financial Analyst designation from the CFA Institute. From 1979 to 1984, I served as a commissioned officer in the U.S. Navy in the Engineering Department of a nuclear-powered aircraft carrier.

II. SUMMARY OF TESTIMONY

The purpose of my testimony is to describe how NOx emissions from industrial facilities impacted by the proposed NOx RACT rule can be controlled and what those controls are expected to cost for affected facilities. By reference, my testimony includes the TECHNICAL SUPPORT DOCUMENT ("TSD") for CONTROL OF NITROGEN OXIDE EMISSIONS from Industrial Boilers and Electrical Generating Unit Boilers, Process Heaters, Cement Kilns, Lime Kilns, Reheat, Annealing, and Galvanizing Furnaces used at Iron and, Steel Plants, Glass Melting Furnaces, Aluminum Melting Furnaces (AQPSTR 07-02). I cooperated with the Illinois EPA in the preparation of that document, which supports the proposed rule, as well as the

preparation of the proposed rule itself. My cooperation includes contributions to the document and proposed rule. My contribution to the TSD was to provide updated information on the available technologies for control of emissions from these sources, their capabilities in terms of reduction of NOx emissions, and the costs associated with employing these technologies.

NOx Emissions from Combustion Sources

Many industrial processes rely on high temperatures and combustion of fuels to produce those temperatures. Oxides of nitrogen, called NOx, are produced during combustion of fuel with air. NO and NO_2, the components of NOx, are formed as a result of oxidation of nitrogen. The nitrogen may be available in the fuel, is available from the nitrogen present in the combustion air, or may be present in feed materials. NOx is formed at high temperatures when there is excess oxygen available for the oxidation reactions, which are also typical conditions during combustion or during some high temperature manufacturing processes. Depending upon the source of nitrogen and the chemical pathway to form the NOx, NOx is generally called "Fuel NOx," "Thermal NOx" or "Prompt NOx." For industrial processes that treat materials at high temperatures, such as glass furnaces, there can also be NOx formed from oxidation of nitrogen in feed materials, and this may be called "Feed NOx."

Because NOx emissions are undesirable, methods have been developed to minimize the amount of NOx that is produced during combustion of the fuel. These methods are called combustion controls, and combustion controls are often, but not always, the least expensive approach to control NOx. However, because complete combustion of the fuel relies upon having adequate temperature and availability of oxygen, good combustion is normally at odds with low NOx emissions. Therefore, combustion controls can be limited in their ability to reduce NOx while also maintaining good combustion performance. For this reason, post-combustion controls have been developed. Post-combustion controls reduce the NOx emissions that remain after combustion, most often by reacting a chemical reagent with the NOx to convert the NOx and reagent into benign products – typically nitrogen and water. It is also possible to reduce NOx emissions through Process Modifications. Process Modifications reduce NOx by changing the process in a way to reduce combustion requirements. The TSD provides detailed descriptions of the various technologies available for each source category as well as the performance and cost of these technologies. What follows is a very general description of the technologies.

Combustion Controls

Combustion controls reduce the amount of NOx that is formed, and they are available for each source category that is affected by this proposed rule. Because combustion controls are usually (but not always) less expensive than post-combustion controls, extensive research has been performed to advance low NOx combustion controls for industrial facilities. Since combustion controls are available for each source type affected by this proposed rule, for most affected facilities combustion controls are expected to be adequate for meeting the requirements of the proposed rule. Each type of industrial source has its own unique characteristics. Nevertheless, all combustion controls rely on at least one, if not several, of the following principles:

- *Low excess air* – Reducing the available air to the burner will generally reduce the NOx level by reducing available oxygen to react with the nitrogen and form NOx. However, alone this approach is very limited because combustion will become poor if combustion air is reduced too far.
- *Staging of air* – Air staging achieves low NOx emissions by slowly admitting the air to the flame and delaying the mixing of fuel and air such that most of the fuel is consumed in an oxygen deficient environment where NOx does not form. Staging of air is performed in nearly all low NOx burners that have turbulent, diffusion flames, which is the most common sort of flame for the sources affected by this proposed rule. Air staging is also performed with overfire air and tertiary air, where burnout air is admitted downstream of the primary combustion zone in a boiler. Oscillating combustion, described in the TSD, is also a form of air staging, with alternating fuel-rich and fuel-lean zones.
- *Staging of fuel* – Fuel staging is when fuel is admitted in more than one zone, typically in a primary zone and in a secondary, downstream zone. This allows for less intense combustion in the primary zone and can also enable there to be an oxygen-deficient secondary combustion zone where NOx from the primary combustion zone is reduced. Technologies such as reburning use fuel staging. Some low NOx burners – particularly for gaseous fuels - employ fuel staging. Mid-kiln firing for cement kilns is also a form of fuel staging.

- *Lean premixed combustion* – This is an option only for low nitrogen, volatile fuels, such as natural gas. Such burners are capable of extremely low NOx levels because they address all forms of combustion NOx – Fuel NOx, Thermal NOx and Prompt NOx. Such burners are most often employed in mechanical draft boilers and heaters.
- *Flue gas recirculation* – Flue gas recirculation enables reduction of flame oxygen level and reduction of peak flame temperature by recirculation of a portion of flue gas back to the combustion zone. Many low NOx burners for gas-fired applications (both diffusion flame and premixed flame burners) utilize this principle. External flue gas recirculation relies on ductwork from the exhaust back to the burner, which is effective but increases cost. Internal flue gas recirculation, available on some burners for heaters and furnaces, permits use of flue gas recirculation without the need for additional ductwork.
- *Nitrogen depletion* – Reducing the available nitrogen for oxidation can be performed by reducing nitrogen in the fuel (or feed materials) through fuel substitution with lower nitrogen fuel (or feed materials) or by reducing nitrogen in the combustion air by using oxygen enriched combustion. For high temperature manufacturing processes that can produce NOx from oxidation of nitrogen in feed materials, NOx may be reduced through substitution of low-nitrogen feed materials for high-nitrogen feed materials. Nitrogen in the combustion air can also be reduced. Oxy-combustion is one method that uses this approach by using oxygen rich-combustion air. Besides lower NOx emissions, another benefit of oxy-combustion is that it can also improve efficiency and will reduce the necessary gas flow-rate by reducing the largest component of combustion air and flue gas – nitrogen.

The costs of combustion controls are typically under $2,500 per ton of NOx removed. Therefore, for the majority of units affected by this proposed rule, combustion controls will provide adequate reduction for compliance at a reasonable cost.

Post-Combustion Controls

Because combustion controls may not reduce NOx to adequately low levels, there are post-combustion controls that reduce the NOx formed in the combustion process. The most widely used post-combustion controls are Selective Catalytic Reduction ("SCR") and Selective Non-Catalytic Reduction ("SNCR"). Both processes reduce NOx by reacting it with ammonia or

urea to form harmless nitrogen and water. Both processes may be used alone or in combination with combustion controls for even higher reduction of NOx. There are other approaches available that are less widely used.

- *SCR* – SCR is a very well established technology that can provide very high reduction of NOx – in the range of 90%. It has been widely used on utility boilers, turbines, diesel engines as well as industrial facilities. SCR is usually more expensive to install than other controls that provide less effective control of NOx because it is necessary to install a catalyst reactor in the ductwork. SCR also entails an ongoing cost of ammonia or urea and also periodic replacement of catalyst. Therefore, most facility owners will prefer to install other controls that provide adequate NOx reduction to comply with the rule at a lower cost. I do not expect SCR to be used to a great extent to comply with this rule, except perhaps in an averaging approach with other, uncontrolled units, because SCR is more expensive than other approaches. However, SCR can and has been installed to provide NOx reductions at costs below $2,500/ton, and such costs are typical for facilities that are not otherwise controlled to low NOx levels.
- *SNCR* – SNCR is also a well established technology that can provide significant reduction of NOx – the exact amount depending upon the application. SNCR has been used on a wide range of industrial source types, including boilers, kilns, process heaters, and furnaces. The only requirement is to have access to inject ammonia or urea reagent into the gas at the proper temperature range. SNCR has the advantage of being less expensive to install than SCR and frequently less expensive to install than combustion controls. SNCR does entail an ongoing cost of ammonia or urea. Therefore, many facility owners will prefer to install other controls that provide adequate NOx reduction to comply with the rule at a lower cost. However, in general, SNCR is capable of providing NOx reductions for a wide range of sources at costs – measured in $/ton of NOx removed – well below the cost of SCR and sometimes less than the cost of combustion controls. As a result, SNCR can be applied to many sources affected by the proposed rule to provide NOx reductions at reasonable costs that are typically below $2500/ton, and in some cases well below $2500/ton.

Process Modifications

Process modifications reduce NOx by changing the process in a way to reduce combustion requirements. These could be energy-efficiency measures, such as modifying a long kiln to a preheater or precalciner kiln. Or, they could be other approaches, such as electric boost that reduce the need for heat generation by combustion. Electric boost would not be used in boilers or cement kilns, but could be used in some manufacturing processes to heat materials. The costs of process modifications will be specific to the process and would typically be employed if determined to be less expensive than other approaches that are available.

III. SUMMARY

This proposed NOx RACT rule affects several source categories. Fortunately, for each of the source categories affected there are available controls that can be used to provide the NOx reductions required by the rule at costs envisioned to be within the expectations for RACT. The TSD that is included in my testimony by reference describes in detail each of the technologies and expected costs for each source type.

STATE OF ILLINOIS)
) **SS**
COUNTY OF SANGAMON)
)

CERTIFICATE OF SERVICE

I, the undersigned, an attorney, state that I have served via approved facsimile the attached TESTIMONY OF ROBERT KALEEL, VIR GUPTA, AND JAMES E. STAUDT, Ph.D., upon the following person:

John Therriault
Assistant Clerk
Illinois Pollution Control Board
James R. Thompson Center
100 West Randolph St., Suite 11-500
Chicago, IL 60601

and mailing it by first-class mail from Springfield, Illinois, with sufficient postage affixed to the following persons:

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ILLINOIS ENVIRONMENTAL
PROTECTION AGENCY,

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Assistant Counsel
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Dated: August 29, 2008

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