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Via E-Mail & Certified Mail

Mr. J. Wick Havens, Chief  
Division of Air Resource Management  
Bureau of Air Quality  
P.O. Box 8468  
Harrisburg, PA 17105-8468

Re: Ozone Transport Commission's Regional  
Attainment Strategies Control Measures  
Comments Regarding Cement Manufacturing  
Sector – NO<sub>x</sub> Control Reduction Strategy

Dear Mr. Havens:

Lehigh Cement Company (Lehigh) appreciates the opportunity to comment on the OTC's NO<sub>x</sub> Control Strategies for the cement sector. Lehigh operates cement manufacturing facilities in York and Evansville, PA

Lehigh has several concerns with OTC's control measure summary for cement kilns which are stated briefly below and elaborated upon herein.

1. The recommended control measure of 2.0 lbs. NO<sub>x</sub>/ton of clinker is not an achievable rate at each Pennsylvania cement manufacturing plant and may not even be achievable on average across the Pennsylvania cement industry.
2. The expectation that installing SNCR on all cement process types will be sufficient to reduce NO<sub>x</sub> emissions at each plant to the 2.0 lbs./ton limit is unrealistic.
3. SCR is not sufficiently developed to make it commercially available in the U.S. and; therefore, should not be considered a control technology.
4. OTC's cost estimates are flawed.

5. PaDEP should not support or impose costly and burdensome regulations on any industry sector without first demonstrating that such regulations will provide measurable, cost-effective progress toward attaining the 8 hour ozone NAAQS.
6. PaDEP should consider allowing the cement industry to opt into a system where emission reduction credits could be generated and traded.
1. The recommended control measure of 2.0 lbs. NO<sub>x</sub>/ton of clinker is not an achievable rate at each Pennsylvania cement manufacturing plant and may not even be achievable on average across the Pennsylvania cement industry.

It is well documented that NO<sub>x</sub> emissions from cement kilns can be highly variable from kiln-to-kiln and plant-to-plant. In fact cement kiln NO<sub>x</sub> emissions are driven by so many different operating parameters (e.g. fuel-type and firing configuration, raw material mix, and product type), that emissions for a given kiln at a single plant will experience significant variability within the normal range of operations.

NO<sub>x</sub> formation in a cement kiln occurs by several mechanisms. Nitrogen in the fuel will oxidize to form NO<sub>x</sub>, as will nitrogen in the feed stock. These mechanisms are called Fuel NO<sub>x</sub> and Feed NO<sub>x</sub>, respectively. While these reactions do occur and contribute slightly to the over all NO<sub>x</sub> formation, the dominant NO<sub>x</sub>-forming mechanism is from heating the nitrogen rich ambient air that is pulled through the kiln. The NO<sub>x</sub> that is formed by this mechanism is called Thermal NO<sub>x</sub>.

The raw materials in a cement pyroprocessing system undergo four steps to produce clinker, i.e., drying, preheating, calcining and incipient fusion (“burning”). All cement pyroprocessing systems utilize a rotary kiln in which the raw feed components are fused into a calcium-silicate mineral, referred to as “clinker”. This sintering process takes place in the high-temperature “burning zone” of a kiln system. The material temperature in the burning zone must be sufficient to complete the chemical reactions between calcium oxide and the siliceous, argillaceous and ferriferous components of the raw material mix. Although this temperature is similar in all plants, i.e., approximately 1,480°C (2,700°F), it is dependent on the chemistry of the raw material mix and other factors, and is not constant even in the same kiln system.

The four pyroprocessing systems achieve the first three steps of the pyroprocess differently.

- In a wet kiln system, the raw materials are introduced into the rotary kilns as aqueous slurry. The evaporation of the water in the slurry requires a significant amount of energy. In the early part of the last century, the wet process replaced the original dry process during a time of low energy costs to provide a means for improved product quality through better blending of raw materials as slurry.
- When equipment was developed to adequately blend dry raw materials, an alternative to the high-energy wet process was once again available. In a long-dry kiln system, the raw materials are introduced into the rotary kiln as a dry powder. Absent the need to evaporate many tons of water each day, the dry process is more thermally efficient than the wet process.
- When it became necessary to remove particulate matter from the flue gas stream of a cement kiln, the preheater kiln system was developed to cool the flue gas so that a baghouse could be used for pollution control. In the preheater system, dry raw material mix is fed to a series of vessels arranged vertically in a tower in which the drying and preheating of the raw mix is accomplished in just a few seconds as opposed to the hour or more required in wet and long-dry kiln systems. Upon exiting the preheater tower, the raw materials are sufficiently heated so that calcination can commence immediately in the rotary kiln. The more-efficient preheater kiln system became available during a time of escalating energy prices and, for this reason, became popular for new installations and retrofits independent of the need for pollution control.
- The most energy intensive step in the manufacture of cement clinker is the calcination of the calcareous component of the raw mix. In the precalciner kiln system, a vessel is inserted between the preheater tower and the rotary kiln in which as much as 60% of the fuel is efficiently burned in direct contact with raw material from the preheater tower that is ready for calcination. After a very few seconds in the calciner vessel, the raw materials enter the rotary kiln almost completely calcined. Thermal energy efficiency is the greatest in the precalciner kiln system.

Consequently, the process temperature profiles are different in ways that can affect the generation and emission of NO<sub>x</sub>. Therefore, to impose one emission standard on all four kiln types is not realistic, regardless of control technologies. The main reason for this is that not all kilns are the same. The raw materials and fuel inputs are site specific. Both of these components, along with the kiln type, have a direct impact on NO<sub>x</sub> emissions. Burnability of the raw materials that makes up the kiln feed will differ from plant to plant and can even vary within a given plant; therefore, so will the NO<sub>x</sub> emissions.

Technologies are not often physically possible or fully effective if applied as a retrofit technology to an existing kiln, even if they are technically feasible. By contrast, control technologies can be optimized during the design and construction of a new kiln line. In these cases, engineering evaluations can determine the operation of given technology and design the new line to minimize aspects of operation and physical equipment configuration that could reduce the efficiency of the intended control. Retro-fitting controls to existing equipment does not provide this opportunity and, more often than not, adversely affects the ability of the control to perform. Furthermore, these effects are not always predictable, so the level of control demonstrated on one kiln system cannot automatically be assumed applicable to other existing kilns, particularly if they are of different process-types. Therefore, assuming that all kilns in Pennsylvania will be able to perform at NO<sub>x</sub> emission rates established at kilns in other states and/or countries is an unreasonable expectation, particularly since almost all of these are newly constructed kilns.

2. The expectation that installing SNCR on all cement process types will be sufficient to reduce NO<sub>x</sub> emissions at each plant to the 2.0 lbs. /ton limit is unrealistic.

With an SNCR control NO<sub>x</sub> is reacted with ammonia or urea in an environment with a specific temperature range and for a sufficient residence time. The effective temperature range for a SNCR system is approximately 1600°-2000°F. For a preheater/precalciner system, this would occur in a zone near the lowest stage of the preheater tower. Below the effective temperature, ammonia present in the gas stream does not react and "ammonia slip" occurs. Likewise, if excessive quantities of ammonia/urea are injected, some pass through un-reacted and cause ammonia slip. Either case will result in a release of ammonia from the stack and could result in producing a detached plume, causing an opacity compliance issue

If injection occurs at temperatures above the effective range, ammonia present in the gas stream will react to form additional NO<sub>x</sub> and NO<sub>x</sub> emissions may increase.

SNCR has been shown to be a viable NO<sub>x</sub> control technology on cement kilns that utilize the preheater (PH) or preheater/precalciner (PH/PC) process. However, SNCR is very dependent on temperature and residence time and, even with optimization, will only provide a certain degree of reduction prior to experiencing an ammonia slip. As explained above, NO<sub>x</sub> emissions can be highly variable between cement kilns with relatively high baseline NO<sub>x</sub> emissions may be able to demonstrate relatively high reduction percentages. Kilns with relatively low baseline emissions, however, will be challenged by the "diminishing returns" effect. Simply put, the greater concentration of NO<sub>x</sub> in a given volume, the more opportunity there will be for ammonia to react. As the concentration decreases, reaction

opportunities are reduced and interferences prohibiting reactions are increased. Therefore, the implementation of SNCR on existing PH and PH/PC kilns will be very site specific. As such, the assumption that all PH and PH/PC kilns can achieve a 2.0 lb/ton emission rate is unrealistic.

For the rest of the kiln process types, SNCR is not a proven technology in the U.S. This would be an innovative control technology for these types of kilns and; therefore, reduction rates can not be reliably predicted at this time.

3. SCR is not sufficiently developed to make it commercially available in the U.S. and; therefore, should not be considered a control technology.

SCR for NO<sub>x</sub> control is not a proven technology in the cement industry. Theoretically, SCR will reduce NO<sub>x</sub> emissions by reacting NO<sub>x</sub> with ammonia (NH<sub>3</sub>) to form nitrogen and water. The exhaust gas stream is passed through a catalyst bed, typically a vanadium pentoxide catalyst where the reaction occurs. There are several considerations that must be taken into account when designing an SCR control system and estimating the capital and operating costs. Items to be considered include the following:

- Gas volumetric flow
- Amount of NO<sub>x</sub> in the exhaust gas
- Required NO<sub>x</sub> control
- Exhaust gas temperature
- Quantity of and composition of particulate in the exhaust gas (there may be catalyst poisons in the flue gas)
- Amount of SO<sub>2</sub> and SO<sub>3</sub> in the exhaust gas
- Allowable SO<sub>2</sub> and SO<sub>3</sub> oxidation rate
- Required catalyst life
- Allowable NH<sub>3</sub> slip
- Space available for equipment and tie-ins

The operating temperature within the SCR must be controlled to optimize efficiency, to control the SO<sub>2</sub> to SO<sub>3</sub> oxidation and to protect the catalyst. Operating temperatures in the SCR will range from approximately 600°-800°F. Lower temperatures may result in increased formation of ammonium bisulfate (NH<sub>4</sub>HSO<sub>4</sub>) as SO<sub>3</sub> reacts with NH<sub>3</sub> and water. Higher temperatures may sinter the catalyst (the catalytic components react with the ceramic substrate) thereby reducing the catalyst activation.

The current state of SCR is best summed up in the attached document that was sponsored by the Portland Cement Association. This document addresses the concerns of SCR on cement kilns.

4. OTC's cost estimates are flawed.

OTC suggests that installing SNCR, along with annualized costs would be less than \$2,500 per ton. (Company)believes that this cost estimation is based upon the following flawed assumptions. First, OTC suggests that all kiln types can achieve a 60% NO<sub>x</sub> reduction. As stated in item #2 above, SNCR reductions will vary greatly from plant to plant and process type. Second, no where in the control measure summary does OTC mention installation of SNCR costs. Rather, it references two EPA scenarios using SNCR. One is biosolid, dewatered sewage sludge and the other using the NOXOUT technology. The biosolids may not be readily available or pertinent for all Pennsylvania cement plants. Furthermore, permanent use of bio-solids may not be accepted by the communities local to cement plant operations. This opposition could prohibit permitting such systems for use. The NOXOUT example uses urea as the agent as opposed to ammonia. Urea may not be readily available as is ammonia and the costs and reduction efficiencies will vary. Too many assumptions are taken into account for this cost analysis to be reliable.

For long wet process kilns, in order to meet the temperature requirements for the SNCR system, there are limited options:

- End of pipe technology, similar to SCR. This would be cost prohibitive due to the high fuel cost to heat the gas stream to the appropriate range.
- Injecting packets of urea into the burning zone of the kiln
- Mid kiln injection

Injecting urea into the burning zone or at mid kiln would be considered innovative technology and would require pilot testing to prove out. It would be necessary to determine the feed rate for the urea or ammonia. Injecting packets of urea will result in inconsistent conditions within the kiln, thereby reducing the overall effectiveness of the system. It will be important to quantify the actual NO<sub>x</sub> reductions achieved.

5. PA DEP should not support or impose costly and burdensome regulations on any industry sector without first demonstrating that such regulations will provide measurable, cost-effective progress toward attaining the 8 hour ozone NAAQS.

The economic well-being of the Commonwealth will not be advanced if the Department chooses to move forward with costly control measures that do not result in a significant contribution to attainment of the ozone standard. Unless there are assurances that significant progress will be made and that progress justifies the cost burden that will be placed on industry, the Department should not support the proposed control measures.

6. PADEP should consider allowing the cement industry to opt into a system where emission reduction credits could be generated and traded.

Further, Lehigh suggests that a facility be allowed to generate emission reductions by financing emission reductions at any other facility in Pennsylvania at which cost-effective reductions can be achieved. Reductions generated in this way could be used by the financing facility to meet its emission targets or could be sold to other facilities needing emission credits. Under these circumstances, all emission reductions would be the property of the entity providing the financing rather than the facility at which emission reductions were accomplished. Secondary, cement plant should be allowed to enter into a bona fide trading market with other industrial sectors.

Lehigh appreciates the opportunity to comment on this significant issue. Lehigh wants to be part of the solution not part of the problem, and we look forward to working with the PaDEP to develop an equitable and workable program, which will contribute to meeting PADEP's objectives.

Sincerely,

Timothy L. Matz  
Corporate Environmental Manager

TLM/lmt

encl:-

c: T. Powers – York  
C. Bortz - Evansville