STATE OF M[illegible]

DEPARTMENT OF ENVIRONMENTAL PROTECTION

ANGUS S. KING, JR.
GOVERNOR

EDWARD O. SULLIVAN
COMMISSIONER

Dragon Products Company, Inc.	)	**Departmental**
Knox County	)	**Findings of Fact and Order**
Thomaston, Maine	)	**Air Emission License**
A-326-72-N-A	)	Amendment #5

After review of the air emission license amendment application, staff investigation reports, and other documents in the applicant's file in the Bureau of Air Quality, pursuant to 38 M.R.S.A., Section 344 and Section 590, the Department finds the following facts:

I. REGISTRATION

A. Introduction

1. Dragon Products Company (Dragon) of Thomaston, Maine was issued Air Emission License (A-326-72-D-A/R) on June 15, 1989, permitting the operation of their portland cement manufacturing facility.

2. The Air Emission License (A-326-72-D-A/R) was subsequently amended on 28 August 1992 (A-326-72-I-A), on 14 January 1994 (A-326-72-J-M), 8 November 1994 (A-326-72-L-M), 20 January 1995 (A-326-72-M-M), and 19 October 1995 (A-326-72-O-M).

3. Dragon has requested an air emission license amendment to address Reasonable Available Control Technology (RACT) for Nitrogen Oxides (NOx), as required by Chapter 138 of the Maine Air Regulations.

B. Application Classification

The application for Dragon is considered to be an amendment to incorporate the NOx RACT requirements as required by Chapter 138, of the Maine Air Regulations.

II. <u>BEST PRACTICAL TREATMENT</u>

A. Introduction

Dragon is in an attainment area for all US EPA designated criteria air pollutants, except for ozone which Knox county is designated as moderate nonattainment, and thus, is subject to the nonattainment requirements for ozone. Chapter 138 of the Maine Air Regulations requires that every major source of NOx apply RACT to their applicable NOx emissions.

Dragon operates a wet-process, portland cement kiln capable of producing approximately 1850 tons of product per day with a fuel use of 4,500,000 Btu per ton of clinker. Clinker is the hard fused nodules formed from a proportioned mixture of raw materials burned at a suitable temperature. Dragon produces Type I and II clinker.

At the time of RACT analysis, kiln fuel contained a blend of 72% coal and 28% petroleum coke, with small amounts (less than 0.5%) of #2 fuel and recycled waste oil used to preheat the kiln during start-up and as back-up fuel. The coal/coke blend is dried and pulverized in a vertical roller mill.

Raw materials are ground in a wet, raw mill to produce a kiln feed slurry containing 30-31% moisture. Kiln feed blending is achieved in a series of slurry tanks, where sulfates and alkalis in the raw materials are controlled by material selection and/or burning techniques.

The kiln is equipped with a chain system as a means of heat transfer from the hot kiln gases to the wet slurry. A reciprocating grate roller cools the clinker discharged from the kiln from 2,500°F to less than 200°F. A portion of the air used to cool the clinker serves as hot combustion (secondary) air for the kiln. Primary air, amounting to about 10-15% of the total air required for fuel combustion, comes from the coal mill and enters the kiln through the burner pipe with the pulverized coal/coke mixture.

Bag type dust collectors are used to remove dust from the kiln exit gases and excess air from the cooler. The kiln also has a wet scrubber which can use cement kiln dust to remove SO_2 from the kiln gases and alkalis from the cement kiln dust. The cement kiln dust can then be returned to the kiln as raw material.

B. RACT for NOx Emissions

Chapter 138 prescribes that owners or operators of miscellaneous stationary NOx sources meeting the applicable criteria of Chapter 138 conduct an alternative RACT determination which details various options for the reduction of NOx emissions to the atmosphere.

The major NOx source at Dragon is the pyroprocess manufacturing of portland cement. NOx is emitted in the counter-current exit gases of the rotary kiln to the atmosphere. Dragon has several other minor combustion devices that produce and emit NOx; however, their NOx emissions are exempt from Chapter 138 since their maximum potential to emit is less than 10 tons per year. The evaluation of NOx control will focus only on emissions from the kiln.

Control Analysis

Three major factors affect the quantity of NOx produced in the portland cement manufacturing process; they are type of fuel, amount of fuel, and conditions of energy release from the fuel. NOx formation is fuel, temperature, and also operator dependent.

Dragon evaluated the technical and economic feasibility of various NOx control options for their kiln. There are two approaches to the reduction of NOx emissions from Dragon's rotary kiln, first by reducing the amount of NOx that is generated and secondly by removing NOx from the exit gases.

NOx Inventory

Total Maximum Potential and Actual Potential NOx Mass Emissions of Affected Equipment at the Dragon Plant

Combustion Devices	Maximum Mass Emission Tons/ Year NO_2	Actual Potential Mass Emissions Tons/ Year NO_2
Portland Cement Kiln	3206	1905
Minor Devices	12	5
Total	3218	1910

The above maximum-potential-uncontrolled mass emissions from Dragon's plant were determined from firing 100% #6 oil. The mass emission inventory was developed from measurements of NOx emitted from the kiln. Dragon has measured compounds in the exit gases of the kiln with a specification CEM system since December 1990.

During the period in which the CEM NOx data was analyzed, Dragon's kiln averaged 55 tons per hour (1320 tons per day) of clinker production. Dragon emitted a mean mass emission rate of 435 pounds of NOx per hour which is equivalent to 7.9 pounds of NOx per ton of clinker. On an annual average basis (8760 hours), Dragon's kiln has the potential to emit 1905 tons of NOx.

Dragon has the capacity of 1850 tons of clinker per day. The maximum potential uncontrolled NOx emissions from the plant is the amount that would be emitted during operation at full capacity while burning oil at a fuel efficiency comparable to an average kiln. For the kiln the maximum potential emissions are 732 lb NOx /hr as a 90-day rolling average (8.784 ton/day and 3206.16 ton/yr).

Process and Combustion Modifications

1. Alternate Fuels
   According to the EPA's *Alternative Control Techniques Document -- NOx Emissions from Cement Manufacturing*, thermal NOx formation is assumed to be the dominant mechanism for NOx formation in cement kilns. Oil-fired kilns produce more thermal NOx than coal-fired kilns, since oil burners produce a more intense and hot flame compared to the less intense flame produced by coal burners, therefore, a coal-fired kiln is expected to produce less NOx than an oil-fired kiln. While Dragon utilized a blend of 72% coal and 28% coke at the time of the RACT analysis, the ratio has since then been adjusted to approximately 60% coal and 40% coke. The higher heating value and lower nitrogen content of coke help reduce NOx emissions.

2. Reduction of fuel demand
   The reduction of fuel demand results in a reduction of NOx generation. Dragon has reduced their fuel usage rate (BTUs per ton of clinker made) by reducing the slurry moisture in the wet process. Reducing slurry moisture results in the need for less fuel to boil off the water.

3. Installation of a Continuous Emission Monitor (CEM)
   Dragon has had a NOx analyzer since 1986 which has improved the operational control of the kiln, allowing energy consuming excursions to be corrected earlier.

4. More Uniform Kiln Feed
   Dragon has installed a new x-ray spectrometer to control the chemistry of the kiln feed. Dragon also installed classifying liners in the raw mill to provide a more favorable particle size distribution of the feed to the kiln. More accurate control of chemistry and finer raw material feed can result in more stable kiln operation and less fuel consumption.

5. Additional fuel efficiency improvements
   Dragon has implemented plans for a more efficient chain hanging pattern in their kiln. This change should result in more efficient transfer of heat in the kiln to dry the slurry. Dragon has also made revisions to the clinker cooler. In addition, Dragon has revised the hot section of the clinker cooler to improve heat recovery thus reducing the amount of fuel burned in the kiln. The fuel efficiency improvements were completed in early 1995.

6. Operator Training
   Dragon has implemented improvements in its existing program of on-the-job training as well as formal classroom seminars. This should result in a team of kiln operators all similarly trained with the latest techniques and knowledge to achieve the most consistent, efficient kiln operation as possible at the Dragon plant.

7. Convert to Indirect-Coal Firing/ Low NOx Burners
   Dragon has implemented a conversion from a semi-direct combustion system to an indirect system in order to reduce the amount of primary air from 22% to 8-10% of total combustion air, and Dragon has installed a Pillard Rotaflam low-NOx burner. The higher-temperature combustion air which results, typically reduces fuel consumption. Also the indirect-firing system utilizes a surge bin that provides faster response to changes in fuel quantities, thereby providing better flame control. The low NOx burners allow for staged combustion thus reducing NOx emissions.

NOx Reduction by the Use of Burning Tires

Dragon has investigated burning tires in the kiln as a potential NOx reduction technique. Dragon has submitted a mass-balance mathematical model which has predicted a 4% NOx reduction in Dragon's kiln and a statistical analysis of actual emission data collected at a long dry process cement kiln employing mid-kiln tire derived fuel (TDF) usage, which netted a 13.9 % NOx reduction. Dragon operates a long wet process kiln, consequently it is only reasonable to predict a potential 10% reduction in NOx emissions at Dragon's plant with the implementation of mid-kiln TDF. Based on only a potential 10% NOx reduction, it is economically unreasonable to require Dragon to fire TDF in their kiln at this time in the State of Maine.

NOx Reduction by the Treatment of the Exhaust Gases

The basis for the reduction of NOx from exhaust gases is the reversal of the NOx generation to the ultimate reformation of N_2 gas. This reversal can be accomplished in selective non catalytic reduction (SNCR), in selective catalytic reduction (SCR), and in the Tri-NOx system.

SNCR, SCR, and the Tri-NOx will be addressed briefly in this order due to their unfeasibility as a control for NOx emissions at Dragon's wet process portland cement plant.

1. Selective Catalytic Reduction (SCR)
   The SCR process uses ammonia in the presence of a catalyst to reduce NOx to N_2. The controlling factors for the conversion efficiency of the SCR process are reaction temperature, gas residence time, mole ratio of NOx and NH_3, and effectiveness of the catalyst. The first three factors can be controlled by system design. However, the catalyst can be poisoned by solid particles, potassium salts, sulfur salts, or sulfur dioxide and sulfur trioxide, all of which occur in kiln gases.

   A SCR system has never been used on a cement kiln beyond an unsuccessful pilot study in Japan in the late 1970s. The initial conversion efficiencies were approximately 98% for the pilot study, however the catalyst quickly became less effective and the efficiency was reduced to less than 70%.

   The capital and operating cost for the SCR treatment of NOx in the exhaust gases from Dragon's portland cement kiln are estimated to be approximately $180 million. Because of its high cost and lack of proven effectiveness for any kilns, SCR is not a feasible alternative for RACT at Dragon Products.

2. Selective Non Catalytic Reduction (SNCR)
   SNCR involves the injection of ammonia or urea, without a catalyst, into a gas stream at a temperature of 1,600-2,000°F. The reactive temperature for

SNCR occurs about mid kiln in the wet process. There is no access to inject ammonia or urea into a wet kiln. For this reason SNCR is not applicable for long wet kilns.

Other materials and certain waste fuels are introduced at the mid point of some kilns. However this introduction can only occur a couple of times for each kiln revolution. Ammonia injection is effective only when introduced, stoichiometrically, on a continuous basis, thus it is highly unlikely that any significant reduction of NOx would result from the periodic introduction of ammonia. Therefore, it is concluded that SNCR is not currently technically feasible for the Dragon wet process kiln.

3. Tri-NOx Process
   The Tri-NOx process developed by the Tri-Mer Corporation uses a series of oxidation and reduction reactions in aqueous solution to reduce NOx to N_2. Six stages of vessels would be required to treat the exhaust gas from a portland cement kiln system. The magnitude of chemical consumption and products produced as a result of this process makes the Tri-NOx process unfeasible for the control of NOx emissions.

RACT Conclusion

All post combustion control technologies are unfeasible as RACT given the lack of proven applications on a wet cement kiln. Furthermore, the application of any of these technologies would be economically unreasonable. Only the SCR is technically feasible; however, it is economically unreasonable.

Mid-kiln firing of tire derived fuel (TDF) will only result in a 4% reduction of NOx emissions based on mass balance calculations performed for Dragon's plant or will only result in a 13% reduction as shown by data obtained from a dry kiln firing TDF. Dragon operates a wet kiln; therefore, it is reasonable to predict a 10% reduction of NOx emissions at Dragon's plant following the installation of equipment for mid-kiln burning of TDF fuel. Based on only a potential 10% NOx reduction and the excessive capital and labor costs associated with TDF fuel, it is economically unreasonable to require Dragon to fire TDF in their kiln at this time in the State of Maine.

The only reasonably available control technologies for the reduction of NOx are process and combustion modifications. Dragon had instituted many of these control technologies in advance of the RACT analysis performed at the plant in 1994 which have resulted in NOx emissions 20% below the average for wet process kilns and in emissions reduced to 60% of the facility's maximum potential-uncontrolled NOx emissions.

Dragon has reduced the slurry moisture in the wet process from 35-45% to 30-31% which has resulted in a reduction of fuel demand and has installed a x-ray spectrometer to control the chemistry of the kiln feed.

Dragon has implemented the following modifications: improvements to the kiln's chain hanging pattern, revisions to the clinker cooler, adjustments of the fuel blend ratio to approximately 60% coal and 40% petroleum coke, converting from a semi-direct fired system to an indirect fired system, and installing low NOx burners for staged combustion. These process and combustion changes were implemented at Dragon in the spring of 1995 due to their advantageous impact on process stability and efficiency, as well as their resultant emissions reduction. In addition to the NOx emission reductions achieved from converting from oil to coal/coke firing, Dragon has implemented changes in 1995 which have resulted in a 14% reduction in NOx emission from the 1990 baseline and in a 17% reduction from 1992 NOx emissions. The average mean value NOx emission reductions have been demonstrated through NOx emission monitoring data and analysis.

Year	Mean 24-hr average NO concentration (lb/hr)	Mean 1-hr average NO concentration (lb/hr)
1990	277	-
1991	287	-
1992	287	288
1993	269	269
1994	273	275
1995 (after conversion)	238	239

Based on the above, the Bureau of Air Quality Control finds that Dragon Products, Inc. meets the requirements of NOx RACT as specified in Chapter 138.

III. EMISSION STANDARDS

A. NOx RACT Limits

NOx emissions at Dragon are measured using a CEM. At Dragon instantaneous CEM values are read several times per second and rolling one minute averages are calculated from these. These one minute averages are then used to calculate hourly average values. NOx emissions are not stable in Dragon's exhaust since NOx emissions vary with coal/coke ratios, raw feed rates, Type I vs. Type II clinker production, and other operational factors all of which affect the statistical averages calculated from CEM data. Stable conditions do not occur over a continuous period of time for a kiln which accounts for the tremendous variations observed in the exit gases.

Therefore, NOx emissions from the kiln shall not exceed a maximum of 800 lbs/hr for any one hour period, 335 lbs/hr expressed as a 90 day rolling average, and 1467 TPY, based on existing monitoring data. The existing monitoring data and existing NOx emission limits are expressed in NO equivalents; however, all future NOx emission monitoring data and emission limits shall be expressed in NO_2 equivalents. NOx emission limits expressed in NO_2 equivalents are 1227 lbs/hr for any one hour period, 514 lbs/hr expressed as a 90 day rolling average, and 2249 TPY.

These emission values shall be re-evaluated by July 31, 1997.

ORDER

The Department hereby grants Air Emission License A-326-72-N-A, subject to the conditions found in Air Emission License A-326-72-D-A/R, in the amendments A-326-72-I-A, A-326-72-J-M, A-326-72-L-M, A-326-72-M-M, and A-326-72-O-M, and in the following conditions:

The following are new conditions:

(22) By July 31, 1997, Dragon shall submit a written report which shall include a statistical analysis of the CEM 24-hour block NOx emissions (lb/hr), and in addition submit and propose a NOx emission limit that satisfies BPT. In addition by July 31, 1997, Dragon shall propose a lb NOx per ton clinker emission limit on a 30-day rolling average that satisfies the NOx RACT requirements of this license. The statistical analysis shall be calculated for at least 18 months of NOx emission data. Following the Department's review and

evaluation of the report, the license shall be amended to incorporate a NOx emission limit established by the Department.

(23) In accordance with Chapter 117 of the DEP regulations, Dragon shall continue to calibrate, operate, maintain and audit their CEM for continuously monitoring NOx emissions from their kiln stack.

(24) Dragon shall report NOx emissions in NO_2 equivalents to the Department.

(25) This amendment shall expire concurrently with Air Emission License #A-326-72-D-A/R.

DONE AND DATED IN AUGUSTA, MAINE THIS 5th DAY OF June 1996.

DEPARTMENT OF ENVIRONMENTAL PROTECTION

BY: James P. Brooks for
EDWARD O. SULLIVAN, COMMISSIONER

PLEASE NOTE THE ATTACHED SHEET FOR GUIDANCE ON APPEAL PROCEDURES

Date of initial receipt of application 31 January, 1995
Date of application acceptance 1 February, 1995

Date filed with the Board of Environmental Protection

FILED
JUN 6 1996
BOARD OF ENVIRONMENTAL PROT.
STATE OF MAINE

This Order prepared by Sarah R. Anderson, Bureau of Air Quality