

THE DEC POLICY SYSTEM



New York State
Department of Environmental Conservation

PROGRAM POLICY

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Title: Nitrogen in Fuel

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Abstract:

This document provides information required to develop emission factors for boilers.

Related References:

All applicable rules, regulations and federal requirements are listed in DAR-6.

I. PURPOSE

The policy was developed to provide emission factors for boilers with heat inputs ranging from 10mmBTU/hr. up to and including 100mmBTU/hr., for the purposes of capping out of NO_x RACT, Title V or to determine the baseline emissions for a cost effectiveness analysis.

II. BACKGROUND

This policy explains 6 NYCRR 227-2, NO_x RACT, which became effective on February 19, 1994.

III. POLICY

This policy defines the method which may be used to estimate NO_x emissions.

IV. RESPONSIBILITY

Emissions of NO_x may be estimated by the boiler owners.

This policy was developed to provide emission factors for boilers with heat inputs ranging from 10 mmBtu/hr up to and including 100 mmBtu/hr, for the purposes of capping out of NO_x RACT, Title V, or to determine the baseline emissions for a cost effectiveness analysis.

6 NYCRR 227-2, NO_x RACT, became effective on February 19, 1994. A facility is a major stationary NO_x source under this regulation if it has the potential to emit 25 tons or more per year of NO_x in the New York City Metropolitan area and the lower Orange County Metropolitan area. For the remainder of New York State, those facilities with the potential to emit 100 tons or more per year of NO_x are major stationary sources. Facilities which limit their potential to emit through enforceable permit conditions, so they do not exceed the above thresholds will no longer be major NO_x sources.

The nitrogen content of residual oil greatly affects the NO_x emissions from boilers with 10 to 100 mmBtu/hr maximum heat input. Because of the low Sulfur requirements in New York City (0.3% S) and Nassau, Rockland and Westchester Counties (0.37% S), NO_x emissions will be the controlling pollutant for residual oil fired boilers in New York City when determining Title V and NO_x RACT applicability. SO₂ emissions will determine the Title V applicability for the remainder of the residual oil fired boilers in the State. However, facilities may still cap out of the NO_x RACT requirements by limiting emissions to below the major facility threshold.

Before 1993, NO_x emission estimates from AP-42 were based upon the emission factor formula:

$$22 + 400 * N^2 = \text{lb NO}_x / 1000 \text{ gal. of oil burned}$$

(where N is the percent fuel nitrogen content)¹

The estimates could range from 38 to 122 lb/1000 gallons of fuel burned (0.25 to 0.81 lb/mmBtu) for fuels with nitrogen contents of 0.2% to 0.5%, respectively. In 1993, the EPA changed the formula to:

$$20.54 + 104.39 * N = \text{lb NO}_x / 1000 \text{ gal. of oil burned}$$

The new expected emissions were 41 to 73 lb/1000 gallons of fuel burned (0.28 and 0.48 lb/mmBtu) for nitrogen contents of 0.2% and 0.5%, respectively.²

The conversion rate of fuel bound nitrogen into NO_x emissions decreases as the nitrogen content increases. One of the reasons for this may be that with low excess air combustion, there may be pockets where there is insufficient oxygen to combine with the nitrogen in the fuel and the reactive pathway may be for the nitrogen molecules to combine to form elemental nitrogen.³

The old AP-42 formula estimated that the conversion rate increased significantly as the nitrogen content increased. The new AP-42 formula provides estimates based upon a linear conversion rate. While the new formula is not entirely accurate, it is more accurate than its predecessor.

Data Collection

The Department has compiled nitrogen in fuel data from Consolidated Edison, Long Island Lighting, Massachusetts DEP, and Maine DEP. The data was from 1990 to 1994. The nitrogen content ranged from 0.02% to 1.21%, and the sulfur content ranged from 0.25% to 2.0%. The nitrogen content averaged 0.381%

with a standard deviation of 0.117% for the 192 data points collected. The Department is continuing its data collection effort to monitor nitrogen in fuel trends.

Ability to control N in residual oil

Nitrogen is removed by the same process used to remove sulfur from fuel oils.⁴ Nitrogen appears to be more tightly bound in the oil molecules than sulfur, so the removal efficiencies are not equal. When distillate oil is desulfurized by 75-90%, about-25-30% of the fuel nitrogen is removed. Residual oil is not commonly desulfurized in the United States. .

Much higher pressures and temperatures are needed to remove nitrogen from fuel compared to those needed for sulfur removal. This adds to the cost of the residual oil. At these higher temperatures and pressures, the fuel hydrocarbons also begin to crack. These two factors make it more advantageous for refiners to continue cracking the fuel and turn it into more valuable distillate fuel than to keep it as residual oil.

Therefore, nitrogen removal from residual oil is not a practical option to control NO_x emissions, nor can a steady supply of low nitrogen oil be expected to be readily and reliably obtained.

Sulfur

According to a preliminary study on the denitrification of fuel oil, fuel nitrogen content appears to roughly correlate to the sulfur content.⁴ However, this is not firmly supported by the data collected by the Department. The percent nitrogen in fuel for low sulfur oil ($\leq 0.5\%$ S) ranged from 0.1% to 0.65% and the nitrogen content of 1% S fuel ranged from 0.02% to 1.21%. This may be caused by the oil coming from different fields of the world (Venezuela, East Texas, etc.). Each field has its own characteristics which could result in differing nitrogen-sulfur relationships. Therefore, sulfur content cannot serve as a surrogate for predicting the nitrogen content when looking at residual oil as a whole.

Northeast Oil Study

The Stationary Source Review Committee of the Northeast States for Coordinated Air Use Management (NESCAUM) commissioned a study of fuel oil nitrogen effects on NO_x emissions. The study developed high and low uncontrolled fuel bound NO_x emission estimates for utility and industrial boilers.³ To compare the study results with the new AP-42 emission estimates, the Department used a baseline of 0.15 lb/mmBtu of NO_x which is derived from thermal NO_x. This was based upon the estimate the new AP-42 formula would provide for a residual oil which has no fuel bound nitrogen.² The 0.15 was added to the estimated emissions from the Northeast oil study. The estimates were higher than the new AP-42 emission factor formula.

Emission Rate Plots

Attached to this policy are three figures. Figure 1 is a plot of the nitrogen content of residual oil versus the following NO_x emission estimates, expressed in lb/mmBtu:

1. The new AP-42 formula. (New)
2. The low NO_x emission estimates from the Northeast oil study. (Low)

3. The high NO_x emission estimates from the Northeast oil study. (High)
4. The overall average of the new AP-42 estimates, the High estimates from the oil study and the low estimates from the oil study. (Average)

The Department added 0.15 lb/mmBtu of NO_x derived from thermal NO_x to the estimated emissions from the Northeast oil study.

Figure 2 is a plot of the nitrogen content of residual oil versus the average of the three estimates expressed in lb/mmBtu. Figure 3 is Figure 2 converted from lb/mmBtu to lb/1000 gallons of fuel burned. This was converted by using a heat content of 0.15 mmBtu/gallon for residual oil.

EMISSION FACTOR

For the purposes of capping a facility, the emission estimate should be based upon a nitrogen content of one standard deviation above the average or 0.5%. This nitrogen content level will provide some certainty that the facility will not exceed the major facility threshold of 100 or 25 ton per year. The estimated emission rate for this nitrogen content is 0.5 lb/mmBtu or 75 lb/1000 gallons of fuel burned.

If a facility believes that the NO_x emissions from its units are below 0.5 lb/mmBtu when burning 0.5% nitrogen oil, the facility may perform stack tests to confirm the emission rate. The oil being fired must be sampled for nitrogen content. If the nitrogen content of the oil is not 0.5%, then Figure 2 should be consulted to determine the emissions expected at the particular nitrogen content (e.g. if 0.4% nitrogen oil is being fired, the expected NO_x emissions would be about 0.45 lb/mmBtu).

If the tested NO_x emissions are different than the line in Figure 2, then the 0.5 lb/mmBtu may be changed by the percentage that the tested emissions differ. For example, if the boiler actually emits 0.40 lb/mmBtu instead of 0.45 lb/mmBtu when firing 0.4% nitrogen oil, then the boiler could be expected to provide similar performance (12% below 0.5 lb/mmBtu or 0.44 lb/mmBtu) when firing 0.5% nitrogen oil.

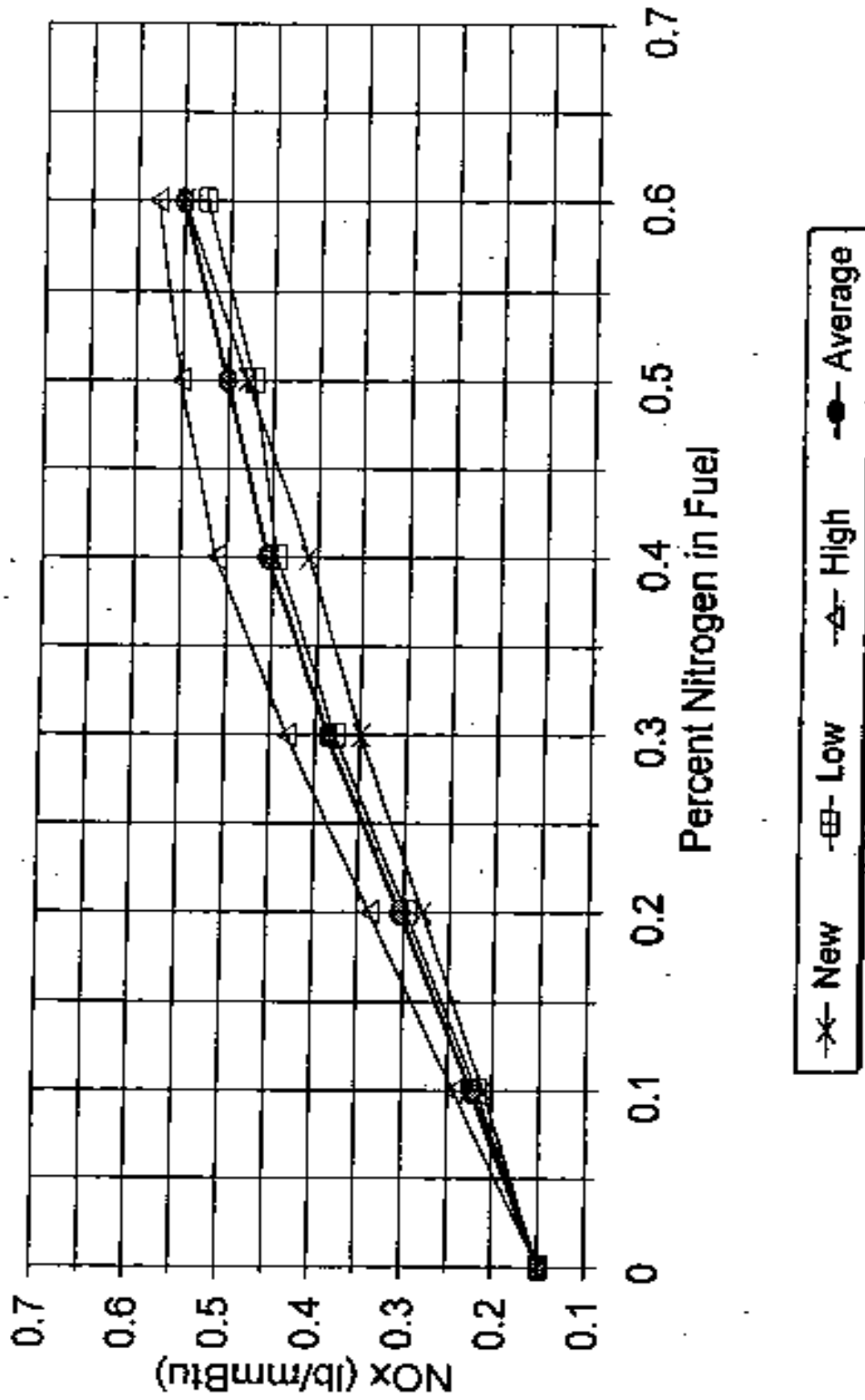
The Department shall continue to collect nitrogen in fuel data and will revise this policy as necessary.

References

1. Compilation of Air Pollution Factors (Fourth Edition), AP-42, U.S. EPA, Section 1.3 Fuel Oil Combustion, October, 1986.
2. Compilation of Air Pollution Factors (Fourth Edition), AP-42, U.S. EPA, Section 1.3 Fuel Oil Combustion, 1993.
3. Fuel Oil Nitrogen Effect on NO_x Emissions and Controlled Levels, prepared for Northeast States for Coordinated Air Use Management by Acurex Environmental Corporation, 1994.
4. Denitrification of Fuel Oil (Preliminary Study), Bill Johnson Ozone/CO Programs Branch, January 1993.

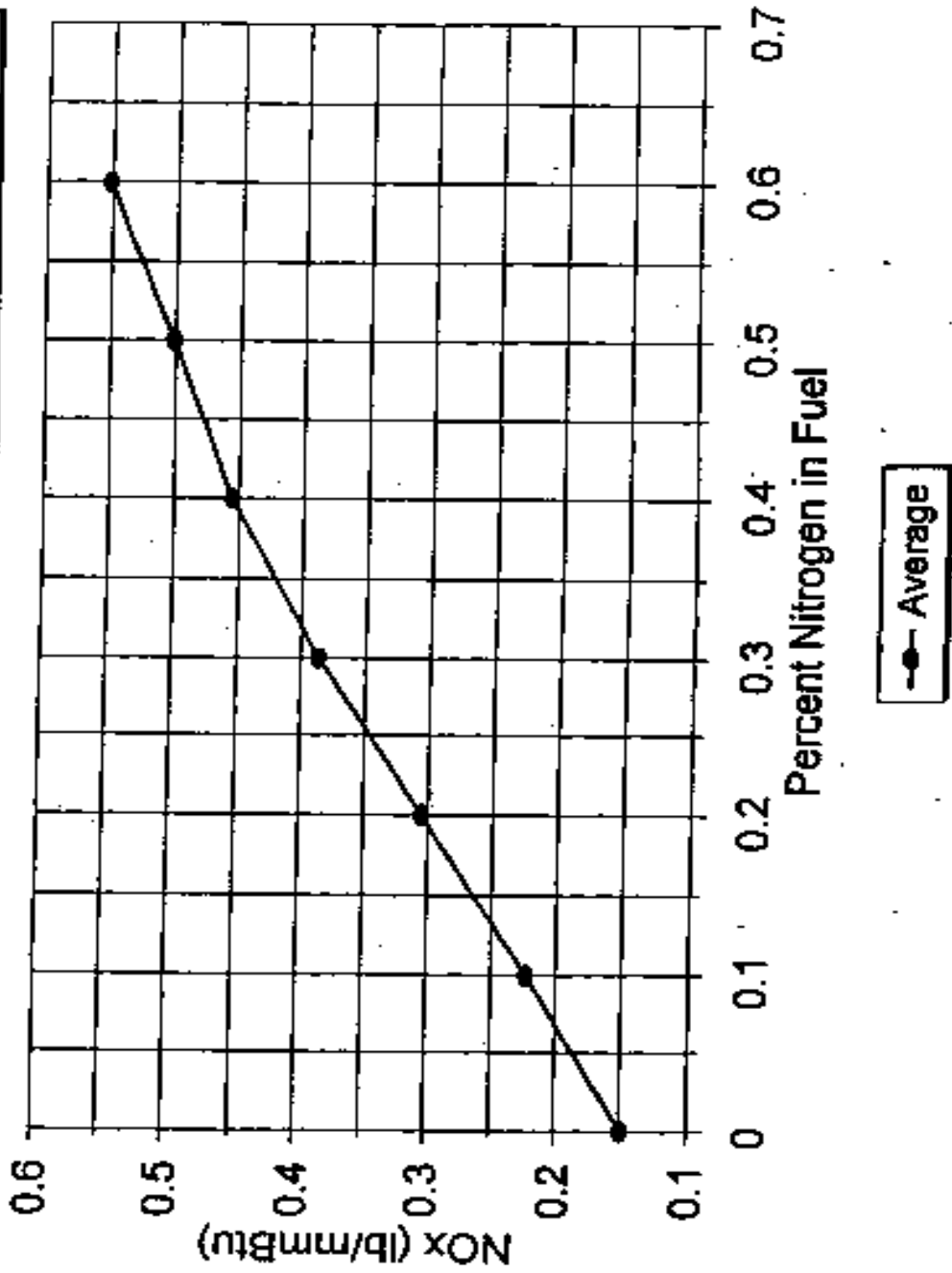
Uncontrolled NOx Emissions

Figure 1



Uncontrolled NOx Emissions

Figure 2



Uncontrolled NOx Emissions

Figure 3

