OTC Draft White Paper
NOx Controls for Natural Gas Pipeline Compressor Prime Movers

Introduction

The Ozone Transport Commission (OTC) identified natural gas pipeline compressor prime movers as a potential category for emission control strategies at its November, 2010 meeting. The OTC tasked the Stationary and Area Source (SAS) Committee to explore the issue, and a workgroup formed by the committee drafted this white paper to describe the issue and suggest potential Commission action—e.g., a model rule to achieve NOx emissions reductions from this emission source and assist the OTC states in achieving national ambient air quality standards for ozone.

Within the Ozone Transport Region (OTR), natural gas pipeline compressor prime movers fueled by natural gas are used in several phases of natural gas supply: 1) gathering the natural gas from the well field and transporting it to the main transportation pipeline system; 2) moving natural gas through the main pipeline system to distribution points and end users; and 3) injecting and extracting natural gas from gas storage facilities. These natural gas pipeline compressor prime movers, mostly driven by internal combustion (IC) reciprocating engines and combustion turbines, are a significant source of nitrogen oxide (NOx) emissions year-round. Data sources indicate that nine OTR states have large natural gas compressor facilities (CT, MA, MD, ME, NJ, NY, PA, RI, VA); three OTR states contain a number of natural gas well field compressors (MD, NY, PA); and two OTR states have natural gas underground storage facilities (PA, NY).

This white paper specifically addresses natural gas pipeline compressor prime movers. The SAS Committee will continue to examine other areas of natural gas production for potential control strategies to obtain emissions reductions. However, the Committee has no recommendations for other sectors of natural gas production at this time.

Source Description

Only limited data are available regarding the population of natural gas pipeline compressor prime movers fueled by natural gas in the OTR. The most comprehensive data are available for 2007 (including a MARAMA point source emissions inventory for that year); therefore, 2007 is currently being regarded as the base year. The 2007 data indicate that there are a multitude of natural gas compressor facilities in the OTR (including 150 classified as “major emissions sources”). These include 2-stroke lean-burn internal combustion (IC) reciprocating engines, 4-stroke lean-burn IC reciprocating engines, 4-stroke rich-burn IC reciprocating engines, and combustion turbines. The 2007 data show:

- At least 409 reciprocating engine prime movers with ratings of 200 HP to 4300 HP, which includes a large number of makes and models
- At least 125 combustion turbine prime movers with ratings of 1000 HP to 20,000 HP, which includes a moderate number of makes and models.

Many of these prime movers may be in excess of 40 years old. The MARAMA point source emissions inventory data indicates that in 2007 this population of natural gas prime movers emitted approximately 11,000 tons of NOx in the OTR annually (about 30 tons/day on average).

Regulatory History

Many of the OTR natural gas pipeline compressor prime movers were subject to review and potential regulation under applicable state NOx Reasonably Available Control Technology (RACT) provisions. The stringency of these regulations varies from state to state. Subsequent to the initiation of NOx RACT regulatory activities in the 1990's, the operating characteristics of these compressors may have changed, and there has been progress in the effectiveness of retrofit NOx controls for many of the types of natural gas pipeline compressor prime movers in the OTR. Some states may also have addressed NOx emissions from these prime movers as part of pollution transport regulations. Two examples are as follows:

State	Rule/Regulation	NOx Limits	Comments
New York	New York State Department of Environmental Conservation, Subpart 227-2, Reasonably Available Control Technology (RACT) For Major Facilities of Oxides Of Nitrogen (NOx)	Stationary Gas Fired RICE ≥ 200 HP in severe ozone non-attainment, ≥ 400 HP outside severe ozone non-attainment: 1.5 g/bhp-hr Stationary Gas Fired Combustion Turbine ≥ 10 MMBTU/hr: 50 ppm @ 15% O2	Rule provides for alternate RACT
Pennsylvania	Chapter 145. Interstate Pollution Transport Reduction, Subchapter B. Emissiosn of NOx From Stationary Internal Combustion Engines	Stationary Rich Burn RICE > 2400 HP: 1.5 g/bhp-hr Stationary Lean Burn > 2400 HP: 3.0 g/bhp-hr	Rule part of allowance trading program

EPA has established NOx emissions requirements in 40 CFR Part 60, Subpart JJJJ (NSPS) (1/18/08 73 FR 3567) applicable to natural gas-fueled, spark ignition (SI) engines, including specific requirements for lean-burn (LB) engines, as follows:

Engine Type	Output Rating	Manufacture Date	NOx Emissions Limit
SI Nat. Gas	100≤HP<500	mfg after 7/1/2008	2.0 g/HP-hr
SI Nat. Gas	100≤HP<500	mfg after 1/1/2011	1.0 g/HP-hr
SI Nat. Gas	HP≥500	mfg after 7/1/2007	2.0 g/HP-hr
SI Nat. Gas	HP>500	mfg after 7/1/2010	1.0 g/HP-hr
SI Nat. Gas LB	500≥HP<1350	mfg after 7/1/2008	2.0 g/HP-hr
SI Nat. Gas LB	500≥HP<1350	mfg after 7/1/2010	1.0 g/HP-hr

EPA has also established NOx emissions requirements in 40 CFR Part 60, Subpart KKKK (NSPS) (7/6/06 71 FR 38482) applicable to natural gas-fueled combustion turbines, as follows:

Turbine	Heat Input Rating	NOx Emissions Limit
New Nat. Gas Fired	≤ 50MMBTU/hr	100 ppm @ 15% O2
New Nat. Gas Fired	50<MMBTU/hr≤850	25 ppm @ 15% O2
New, Modified, or Reconstructed Nat. Gas Fired	>850MMBTU/hr	15 ppm @15% O2
Modified or Reconstructed Nat. Gas Fired	≤50MMBTU/hr	150 ppm @15% O2
Modified or Reconstructed Nat. Gas Fired	50<MMBTU/hr≤850	96 ppm @15% O2

Candidate Control Measures Summary

Industry literature indicates that there are a large number of makes and models of each of the types of natural gas pipeline compressor prime movers represented in the OTR (2-stroke lean burn, 4-stroke lean burn, 4-stroke rich burn, and combustion turbine). This literature also indicates that the effectiveness of any given NOx reduction technology may differ among the various makes and models, and that sometimes a given technology may not be commercially available for a particular make or model. Generically, the following retrofit NOx reduction technologies are commercially available for natural gas fueled, spark ignition internal combustion reciprocating engines:

	Potential NOx Reduction		
NOx Control Retrofit	**2 Stroke Lean Burn**	**4 Stroke Lean Burn**	**4 Stroke Rich Burn**
High Energy Ignition System	10%	10%	10%
Intake Air Upgrade (turbocharger, etc)	75%	60% - 70%	N/A
Improved Mixing (high pressure fuel inject)	90%	90%	N/A
Pre-Combustion Chamber Ignition System	90%	90%	N/A
NSCR Catalyst (w/ air/fuel ratio controller)	N/A	N/A	90% - 99%
SCR Catalyst	50% - 95%	50% - 95%	N/A

For combustion turbine prime movers, the following NOx reduction technologies are commercially available:

NOx Control Technology	Potential NOx Reduction
Water Injection	40%
Dry Low NOx Burners	60%
SCR	95%

Estimated Potential NOx Reductions

Due to data limitations regarding the population of natural gas pipeline compressor prime movers in the OTR (as noted above), it is not possible to estimate the NOx reduction potential from this source sector with a high level of certainty. Utilizing the 2007 population data from MARAMA, it is estimated that the NOx emissions from this source sector can be reduced by a minimum of 6 tons/day during the ozone season, and 8 tons/day on an annual average basis (compared to about 30 tons/day average daily emissions). The annual average NOx emission reduction potential is greater than that for the ozone season because of variable natural gas demand throughout the year.

Rule Development Issues

The available data are insufficient to adequately define the entire population of natural gas pipeline compressor prime movers in the OTR. Data insufficiencies relate to the number of units, their current rate of NOx emissions, current level of NOx control, and technical data to determine potential for additional NOx reductions. The currently available data indicates that some units are already well controlled and others appear to have little control. However, for most units data are unavailable regarding their NOx control. In order to fully define the population, estimate current NOx emissions, and estimate the NOx reduction, the OTR states will need to provide additional data concerning their populations of natural gas pipeline compressor prime movers.

Natural gas supply and transport industry trade organizations have traditionally been very involved and interested in the development of additional NOx control requirements for natural gas pipeline compressor prime movers. Such organizations were very vocal during the development of EPA's NOx emissions regulations, such as the NOx State Implementation Plan (SIP) Call. The Committee anticipates that these trade organizations will take an active role in the development of any OTC effort to address NOx emissions from the natural gas pipeline compressor prime movers.

Recommendation

The estimated potential NOx emissions reductions from natural gas pipeline compressor prime movers seems to justify a continuation of data collection and analysis to calculate a more definitive value for the NOx reduction potential. The SAS Committee recommends that the Ozone Transport Commission formally request that OTR jurisdictions provide access to the necessary information, as available, to support this effort.

Publicly available information indicates that NOx controls are commercially available to achieve significant NOx emissions reductions from currently uncontrolled natural gas pipeline compressor prime movers. The Committee also recommends that in parallel with the data collection effort, that the SAS Committee should proceed with development of a model rule to address NOx emissions from this source category. It is recommended that such a model rule provide the regulated community an alternative between meeting a NOx emission percentage reduction, or specified NOx emission rates, on a unit-type specific basis, and also provide for alternative RACT recommendations on a technological or economic basis. The Committee should also be charged with considering whether units of a certain age should be required to be replaced.