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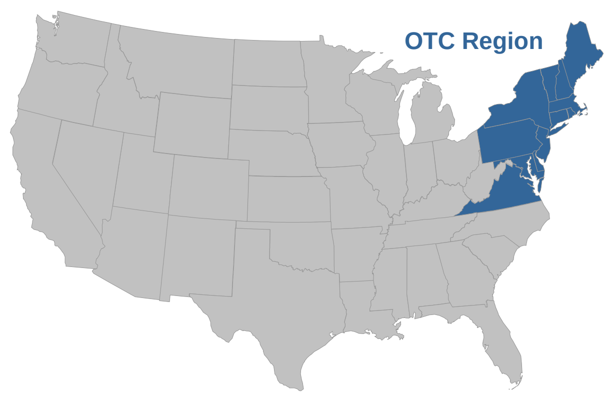
Northeast States Evaluate NOx Control Options for Regional Oil and Gas Development

The Ozone Transport Commission (OTC) is a multi-state organization responsible for advising EPA on air pollution transport issues and for developing and implementing regional solutions to the ground-level ozone problem in the Northeast and Mid-Atlantic regions. OTC recently released for public comment a draft technical assessment of options for controlling nitrogen oxide (NOx) emissions from oil and natural gas exploration and production, *Technical Information Oil and Gas Sector Significant Stationary Sources of NOx Emissions*. The assessment will provide the technical basis for the organization's efforts to explore developing one or more model rules for the control of NOx from engines used in the sector. Comments on the draft are due June 22.



Background

The Clean Air Act directs the Environmental Protection Agency (EPA) to establish national ambient air quality standards (NAAQS), or minimum air quality targets, for six pollutants, including ground-level ozone. After EPA establishes the NAAQS, each state is required to develop a plan to meet (attain) or maintain the standard, and compile each state's emissions-reduction measures into a federally-enforceable document. These plans are known as State Implementation Plans (SIPs). Regional authorities, such as OTC, seek to coordinate members' measures through model rules, which member states can adopt.

Facing 2015 attainment deadlines for the current ozone standard (0.075 ppm over eight hours, established in 2008) and a potentially-more stringent ozone standard after the next review (expected to commence in 2013), OTC and its member states are evaluating whether additional emissions reductions are possible from the oil and gas sector, particularly NOx from ancillary equipment and operations. As a first step, OTC prepared a technical support document (TSD) to provide background on emissions sources, potential controls, and existing rules.

Summary of Technical Information

In the TSD, OTC reviews NOx emissions from well drilling and completion, oil well pumps, oil pipeline pumps, coal bed methane pumps, oil well heaters, gas well heaters, and natural gas compressors. OTC found limited inventory data and emissions factors but determined that, collectively, the largest sources of NOx emissions are existing reciprocating engines and combustion turbines used to support oil and gas drilling activities. Based on this conclusion, OTC reviews NOx control technologies for existing sources, state-level rules and regulations for new and existing sources, and NOx reduction potential for reciprocating spark-ignition engines (two stroke lean burn, four stroke lean burn, and four stroke rich burn spark ignition engines); diesel engines; and combustion turbines. Table 1 summarizes OTC's findings.

Although the TSD does not estimate aggregate NOx emissions from oil and natural gas exploration and production activities, the document summarizes data on oil and gas operations in the OTC region (primarily in Pennsylvania and New York) including counts of drilling rigs, well starts, oil wells, crude oil production, gas wells, gas well withdrawals, natural gas storage facilities, natural gas pipeline compressors, natural gas pipelines, and natural gas consumption.

Key Takeaways

- Throughout the discussion of emission sources, OTC notes that there is an overall lack of comprehensive emissions data for NOx sources in the oil and gas sector. While the document's summary of oil and gas operations in the region could be a first step at reviewing potential inventory data, OTC does not indicate within the TSD that it plans to develop an inventory of emission sources.
- While focusing on emissions from oil and gas sector engines, OTC does include flaring during well completions as an additional source of NOx emissions. OTC does not attempt to quantify NOx emissions from flaring but references emissions factors for well completions developed by the Western Regional Air Partnership (WRAP) as part of its emissions inventory of non-point oil and gas emissions sources. That emissions factor is 0.85 to 1.5 tons NOx per well. Combining the WRAP well completion emissions factor with WRAP's drilling emissions factor (2.26 to 9.78 tons NOx per well) and an Energy Information Administration estimate of oil and gas wells drilled nationally in 2011, OTC estimates that total U.S. NOx emissions associated with well drilling and completions were in the range of 141,596 to 513,567 tons. According to OTC, the upper end of this range is larger than the combined NOx emissions from the 70 highest emitting coal-fired power plants in 2011.
- OTC does not evaluate NOx emissions from vehicles that service oil and gas operations. Emissions from these sources could be significant, particularly for hydraulic fracturing operations that require the transport of large volumes of water to and from the site. However, new onroad engines were regulated by EPA in 2010 and OTC may consider those rules sufficient.
- As noted by OTC in the TSD, it is technically possible to achieve NOx emission rates of 0.5 grams per brake horsepower-hour (g/bhp-hr) on existing engines greater than or equal to 250 horsepower and 3 g/bhp-hr on engines less than 250 horsepower. However, the cost of installing the required suite of technologies would be significant. In the TSD, OTC quotes costs for combustion system upgrades to lean-burn natural gas engines in the range of $245 to $1,400 per horsepower. For comparison, a new natural gas engine, which would incorporate most of the combustion system changes noted by OTC, would cost $250 to $500 per horsepower and be certified to 1.0 g/bhp-hr or less. If OTC drafts a model rule that requires 0.5 g/bhp-hr NOx from existing natural gas engines, the lowest cost strategy will likely be replacement as opposed to retrofit.

- OTC does not address emissions trade-offs associated with some of the technical options discussed. In particular, most of the upgrade options for lean-burn natural gas engines are based on achieving low NOx by increasing the air-to-fuel ratio (leaner combustion). In a lean-burn natural gas engine there is a trade-off between NOx and unburned fuel. NOx reduction retrofits will increase volatile organic compounds (VOCs) and methane emissions from these engines. For diesel engines, changes in fuel injection timing will reduce NOx but they are likely to increase particulate matter.
- At OTC's annual meeting on May 24, 2012, OTC commissioners expressed "disappointment" that EPA's recently finalized new source performance standards for emissions of ozone precursors from upstream oil and gas sources did not regulate sources of NOx. Thus, this TSD lays the groundwork for regional efforts to address these emissions. The Stationary Source Committee, which is in charge of reviewing comments on the TSD and developing potential model rules, will report out to the full OTC, possibly as soon as the Fall 2012 committee meeting. It may be clear at that time whether OTC believes sufficient information exists to begin the rule development process.

Table 1. Summary of OTC Findings on Control Strategies for NOx Emission Sources from Oil and Gas Operations

Emissions Source		NOx Control Strategy (Reduction Potential)	Example Existing Rules and Regulations	OTC Findings
Reciprocating Engines (spark ignition)	Two stroke lean burn (2SLB)	High energy ignition system (10%) Intake air upgrade (75%) Improved air/fuel mixing (90%) Pre-combustion chamber ignition system (90%) SCR (50-95%)	California South Coast Air Quality Management District (SCAQMD) Rule 1110.2 Colorado Regulation 7 Texas Commission on Environmental Quality (TCEQ) §106.352 and §117.105 Pennsylvania proposed revision to General Permit for Natural gas Production and Processing Facilities EPA 40 CFR Part 60, Subpart JJJJ	Achievable NOx emission rate limits: • 0.5 grams per brake horsepower hour (g/bhp-hr) for engines ≥250 hp • 3 g/bhp-hr for engines <250 hp For 2SLB OTC found the following costs: • Layered combustion: $0.18 to $0.46 million for 60-90% reduction from 100-250 hp engines and $2.2 to $3.6 million for 90% reduction from 2000-2500 hp engines • SCR: $1.1 to $1.2 million for 90% reduction from 2000-2500 hp engines For 4SLB OTC found the following costs: • Layered combustion: $0.18 to $0.46 million for 60-90% reduction from 100-250 hp engines and $0.14 to $4.7 million for 90% reduction from 500-1100 hp engines • SCR: $0.5 to $1.6 million for 90% reduction from 2000-2500 hp engines
	Four stroke lean burn (4SLB)	High energy ignition system (10%) Intake air upgrade (60-70%) Improved air/fuel mixing (90%) Pre-combustion chamber ignition system (90%) SCR (50-95%)		
	Four stroke rich burn (4SRB)	High energy ignition system (10%) NSCR (with air/fuel ratio controller)		Achievable NOx emission rate limit of 0.5 g/bhp-hr for engines ≥50 hp OTC found costs for retrofit NSCR of $0.017 to $0.36 million for 90% reduction from 50 to 8000 hp engines
Diesel engines		Fuel injection timing (10%) Emulsified fuel (10-20%) Exhaust gas recirculation (40-50%) SCR (75-90%)	California SCAQMD Rule 1110.2 EPA 40 CFR Part 60, Subpart IIII	No specific limit OTC found costs for SCR of $0.37 to $1.5 million for 75-90% reduction from 500-8,000 hp engines
Combustion turbines		Water injection (40%) Dry low NOx burners (60%) SCR (95%)	California SCAQMD Rule 1134 TCEQ §106.352 and §117.105 EPA 40 CFR Part 60, Subpart KKKK	No specific limit OTC found the following costs: • Water injection: $0.4 to $1.5 million for 40% reduction from 4-23 MW turbines • Low NOx combustors: $0.26 to $1.1 million for 60% reduction from 4-23 MW turbines • SCR: $0.9 to $2.4 million for 90% reduction from 5-25 MW turbines

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