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Joseph Minott
Clean Air Council in Philadelphia

Jonathan Skinner
University of Colorado Law School

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Fugitive Emissions: The Marcellus Shale and the Clean Air Act

Joseph Minott and Jonathan Skinner

The Marcellus Shale is an organic-rich, black shale formation spanning 95,000 square miles and extending from New York into Pennsylvania, Maryland, Ohio, Virginia, and West Virginia at a depth of 4,000–8,500 feet with an average thickness of 50–200 feet. Like many gas shale formations, or shale plays, the Marcellus Shale is both a source and a reservoir for significant reserves of natural gas. As recently as 2009, the U.S. Department of Energy reported that the Marcellus Shale contains an estimated 1,500 trillion cubic feet (cf) of natural gas reserves from which 262 trillion cf is currently recoverable through unconventional horizontal drilling and hydraulic fracturing techniques. U.S. Dep't. of Energy, Modern Shale Gas Development in the United States: A Primer, at 17 (2009). This makes the Marcellus Shale potentially the largest U.S. natural gas reserve and twice as rich as the second most abundant shale play in the United States—good news for energy independence and security. And when burned, natural gas releases fewer pollutants and greenhouse gases than traditional fossil fuels.

This article focuses on shale gas extracted within the Pennsylvania stretch of the Marcellus Shale. Approximately 60 percent of Pennsylvania's land mass rests above the shale play, and in 2010 produced nearly 1.3 billion cf of natural gas per day. A 2011 Pennsylvania State University study found that natural gas development in Pennsylvania generated almost $11.2 billion in value added and supported nearly 140,000 jobs; the study projected both figures would rise significantly in the ensuing years. And as a basis for the dramatic growth, Penn State researchers credit the "advanced well stimulation techniques that are dramatically increasing well productivity." Timothy J. Considine et al., The Pennsylvania Marcellus Natural Gas Industry: Status, Economic Impacts and Future Potential, at iv (2011). But to the extent that unconventional extraction methods grant access to vast reserves of natural gas, these methods also burden regional air quality.

The complex natural gas system is an extraction, production, and transmission network composed of wellbores, compressors, processing plants, storage facilities, pipelines, and other means of transportation. At each node in the system, air pollutants are released or escape as fugitive emissions.

The U.S. Environmental Protection Agency (EPA) defines fugitive emissions as any unintentional emissions from systems that extract, process, and deliver fossil fuels. U.S. Envtl. Prot. Agency, Greenhouse Gas Emissions Reporting from the Petroleum and Natural Gas Industry: Background Technical Support Document, at 7 (2009). In the natural gas system, the EPA identified fugitive emissions from compressor stations, production facilities, gas plants, metering and pressure regulating stations, customer meter sets, and underground pipelines. The EPA found a second category of fugitive emissions: intentional releases, or vented emissions, from pneumatic devices, blow and purge, dehydrator glycol pumps, dehydrator vents, and chemical injection pumps. A third category of emissions arise from compressor exhausts—the large diesel or methane powered engines that compress natural gas or the engines that drive hydraulic fracturing fluid.

Together, these emissions can significantly impair local and regional air quality. A 2008 analysis by the Colorado Department of Public Health and Environment concluded that smog-forming emissions from local oil and gas operations exceeded vehicle emissions for the entire state. *See* Col. Dep't. of Public Health & Env't, Oil and Gas Emission Sources Presentation for the Air Quality Control Commission Retreat, at 3-4 (2008). Similarly, a Southern Methodist University study projected that summertime oil and gas sector emissions of smog-forming pollutants in the Dallas–Fort Worth region exceeded emissions from motor vehicles. *See* Al Armendariz, *Emissions from Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements*, Report for the Environmental Defense Fund (Southern Methodist University, 2009). In 2009, Wyoming's growing oil and gas sector caused the state to fail to meet federal health-based standards for air pollution for the first time. Wyo. Dep't. of Envtl. Quality, Technical Support Document I for Recommended 8-Hour Ozone Designation for the Upper Green River Basin, at viii (2009). In northeastern Utah, the state Bureau of Land Management identified the multitude of oil and gas wells in the region as the primary cause of unprecedented ozone levels in the Uintah Basin. *See* Scott Streater, *Air Quality Concerns May Dictate Uintah Basin's Natural Gas Drilling Future*, N.Y. Times,Oct. 1, 2010. And a recent study by Cornell ecologist, Dr. Robert Howarth, found that methane leakage from hydraulic fracturing offsets the lower carbon emissions from burning natural gas in comparison to other fossil fuels. *See* Robert W. Howarth et al., *Methane and the Greenhouse-Gas Footprint of Natural Gas From Shale Formations: A Letter*, Climatic Change Letters, DOI 10.1007/s10584-011-0061-5 (2011).

Despite the significant environmental impact of natural gas operations, the system of wellbores, compressors, and

Mr. Minott is the executive director of the Clean Air Council in Philadelphia and may be reached at joe_minott@cleanair.org. Mr. Skinner is an attorney with the Clean Air Council in Philadelphia and may be reached at jskinner@cleanair.org.

processing plants avoids triggering the Clean Air Act's Title V permitting requirements. Each step in the production of natural gas—extraction, dehydration, compression, and transmission—releases air pollution, though emission levels at each stage of the overall process may be below major source thresholds. If these sources are not aggregated and treated as a single source, they usually avoid triggering Title V, Prevention of Significant Deterioration (PSD), and New Source Review (NSR) requirements and related limits on emissions.

Hydraulic fracturing, or hydrofracing, was developed in the early 1940s and has been used in oil and gas wells worldwide. But the technique was not applied extensively to shale deposits until the 1990s with the large-scale development of the Barnett Shale play in the Fort Worth, Texas, region. In just 10 years, annual natural gas production in the Barnett Shale increased exponentially from less than 50 billion cf in 1998 to nearly 1,100 billion cf in 2007. This success inspired the development of several other shale plays, including the Antrim in Michigan, Fayetteville in Arkansas, Haynesville in Louisiana, New Albany in Indiana, and the Woodford in Oklahoma, among others. In 2003, Range Resources, LLC, brought horizontal drilling and hydrofracing to Pennsylvania and began producing Marcellus Shale gas in 2005. *See* John A. Harper, *The Marcellus Shale—An Old "New" Gas Reservoir in Pennsylvania*, PENN. GEOLOGY, Spring 2008, at 9.

Unlike traditional vertical drilling, horizontal hydrofracing allows multiple wellbores to be created on a single platform—substantially increasing the productivity of a well pad. The process is relatively simple to explain. Drillers bore a hole about a mile into the earth and proceed horizontally through a shale deposit. The well is cased with cement and a steel pipe. A perforating gun is lowered into the well that blasts holes into the steel, cement, and shale where natural gas is trapped. Pressurized fracking fluid—a mixture of water, sand, and chemicals—is then pumped into the well and shale, which causes the shale formation to fracture and release natural gas. Subterranean pressures force the gas and fracing fluid back through the pipe and to the surface, leaving behind grains of sand inside the fractures to keep them from collapsing. This process may be repeated to create additional fractures and fresh wells. The recovered natural gas is then separated from residual fracing fluids and dehydrated before the gas is processed, compressed, and distributed.

During the extraction or production phase, internal combustion engines provide power to run compressors that assist in stimulating the extraction of natural gas and also power compressors that move gas to and from processing plants and through the pipeline network. Most engines are between 100 and 500 horsepower in size, but some large engines may be more than 1,000 horsepower. The mixture of gas and fluids that is brought to the surface must also be separated in condensate and oil tanks. The mixtures are stored in tanks that allow gas to be collected at the top of the separator, while heavier liquids fall to the bottom and are stored on site in storage tanks.

Once the gas is separated, it is sent to a processing station for refining. Processing plants often have glycol dehydrators, that is, the units that dry the natural gas and remove water and other hydrocarbons. The emissions profile at the processing phase varies with the type of gas that is extracted. Natural gas comes in two general states: "dry" and "wet." Commercial natural gas is primarily methane and is known as "dry" gas. Dry gas requires minimal processing and is found in the northeastern region of Pennsylvania. Marcellus gas obtained in southwestern Pennsylvania, however, contains dissolved hydrocarbons such as propane, ethane, butane, and other heavier gases—"wet" gas requires more processing before being sold to gas distribution companies and utilities.

In order to transport natural gas from processing facilities to utilities or other consumers, dry natural gas must be compressed; and to ensure that the natural gas flowing through any one pipeline remains pressurized, compressor stations must be placed in intervals along the pipeline. Distances between compressor stations vary significantly—they can be located within a few miles of a processing plant or wellbore to up to 100 miles for interstate shipments.

Processing and compressor stations are typically the larger sources for emissions that affect air quality, but they are also connected to thousands of wells across the region by a network of pipelines. Natural gas system air pollutants include volatile organic compounds (VOCs), nitrogen oxides, particulates, ground-level ozone, hazardous air pollutants (HAPs), and even natural gas, or methane, a potent greenhouse gas with a 20-year global warming potential (GWP) 56 times the GWP of carbon dioxide.

The Laws and Regulations Affecting Natural Gas Operations

In the United States, natural gas operations may be regulated under federal, state, and local laws. In Pennsylvania, the Department of Environmental Protection (DEP) works with EPA to carry out Pennsylvania's obligations under federal environmental law—and for air quality programs, those obligations are found in the federal Clean Air Act.

The Clean Air Act (CAA) authorizes EPA to control and regulate air pollution across the nation and from a variety of sources. The CAA is divided into seven major titles: Title I contains most of the federal requirements for controlling air pollution from the types of sources of greatest interest to communities; Title II addresses vehicle emission controls, or "mobile sources"; Title III deals with hazardous air pollutants; Title IV is EPA's acid rain program; Title V creates the national permitting program; Title VI relates to preserving and restoring the earth's protective ozone layer; and Title VII contains provisions for citizen and government enforcement of the CAA.

At the federal level, a number of the CAA's programs apply to natural gas operations. For example, New Source Performance Standards (NSPS), 40 C.F.R. pt. 60, National Emission Standards for Hazardous Air Pollutants (NESHAPS), 40 C.F.R. pt. 63, NSR/PSD, 40 C.F.R. 51.165-.166, and the Greenhouse Gas (GHG) Tailoring Rule may apply to certain equipment if and when the emissions thresholds or dates of

construction are triggered, 40 C.F.R. pts. 51, 52, 70, and 71. EPA is also currently updating oil and gas sector NSPS and NESHAPS, collecting GHG data through the reporting programs, and encouraging emissions reductions through voluntary partnerships with gas operating companies.

Under Title I, Section 109(a), EPA must set National Ambient Air Quality Standards, or NAAQS, for certain air pollutants. These standards are health based and provide protection from adverse effects on the public health and welfare. As of 1998, EPA released and periodically adjusts NAAQS for carbon monoxide, sulfur dioxide, nitrogen oxides, ground-level ozone, fine particulates, and lead. Where regions are in attainment of a particular NAAQS, the CAA's prevention of significant deterioration (PSD) permitting program applies, and in nonattainment areas, the program is called new source review (New Source Review) permitting.

> Although drilling operations at a single site will not cause the region to exceed NAAQS, the "combined effects from many of these operations in an area . . . may contribute to exceedances or violations of the [NAAQS]."

Through Title V, EPA administers a single federal permit, which contains all air pollution control and monitoring requirements applicable to a regulated source. This makes the job of assessing the source's impact on a community's air and the source's compliance with air quality laws easier for citizens and regulators. Title V also provides essential opportunities for citizens and other interested parties to have input in the permitting process.

Once EPA has established a national ambient air quality standard, the CAA leaves it up to each state to devise a plan for how that state will attain and maintain the national health standard. The attainment plan submitted by the state is known as a State Implementation Plan (SIP) and must be approved by EPA. But in order to administer its own PSD, NSR, and Title V permit programs, the Pennsylvania DEP's regulations must be at least as stringent as EPA's requirements for each program. 40 C.F.R. Ch. 52.

The Pennsylvania State Implementation Plan

Pennsylvania received final and full approval from EPA to operate its own SIP, which includes the Plan Approval and Operating Permit Program, on July 30, 1996. The process of obtaining an air permit generally consists of two steps. *See* PA. CODE §§ 127.11, 127.402. The first step is obtaining a pre-construction permit authorization, known as a Plan Approval, from the Pennsylvania DEP. A Plan Approval is a permit that authorizes construction, installation, or modification of any air pollution source or facility. The second step is obtaining an Operating Permit to allow actual operations at the facility. Not all air contamination sources require a Plan Approval or Operating Permit; some may be exempt under Pennsylvania regulations, and some may be granted an exemption on a case-by-case basis.

In 2003, however, the Pennsylvania DEP revised its minor source Plan Approval and Operating Permit Exemptions list. In accordance with state law, DEP determined that approvals and permits would not be required for "[o]il and gas exploration and production facilities and operations that include wells and associated equipment and processes used either to: (a) drill or alter oil and gas wells; (b) extract, process and deliver crude oil and natural gas . . . [but not including] gas compressor station engines equal to or greater than 100 [horsepower] or gas extraction wells at landfills." PA. DEP'T. ENVTL. PROT., AIR QUALITY PERMIT EXEMPTIONS (July 26, 2003).

The Pennsylvania DEP proposed amending the exemption list again in 2010 and accepted public comment through May 26, 2011. The proposed revision would no longer categorically exempt oil and gas exploration and production facilities and operations from Title V, but would continue to exempt plan approvals for "[o]il and gas exploration and production facilities and operations (include [sic] wells and associated equipment and processes), not located at a major source" and meeting a variety of emissions conditions. PA. DEP'T. ENVTL. PROT., AIR QUALITY PERMIT EXEMPTIONS (Feb. 25, 2010). Though not a per se exemption, the proposed revision does not require most natural gas operations to submit a Request for Determination (RFD) form.

The process used to obtain a case-by-case exemption requires that an RFD form be submitted. The RFD form is the mechanism by which the department evaluates a case-by-case exemption request. Through submitting a completed RFD, a company, essentially, asks the Pennsylvania DEP to make a judgment about whether the owner or operator must obtain a Plan Approval or Operating Permit or modify an existing Operating Permit in order to proceed with the proposed project. However, by conditionally exempting most natural gas operations and not defaulting to a case-by-case analysis, the Pennsylvania DEP will likely not have the information necessary to identify the potential sources of emissions at proposed natural gas operations. Without this information, it will be difficult to determine whether the operation is a major source of emissions.

Major Source Determinations

Whether a facility or operation triggers federal requirements is a threshold determination based on the emissions characteristics and volume related to the source operation. Under the CAA, only "major sources" are required to achieve

performance standards and receive Title V operating permits. Moreover, the source must have the potential to emit 100 tons per year (tpy) or more of carbon monoxide, nitrogen oxides, sulfur oxides, or particulate matter, 50 tpy of VOCs, 10 tpy of a single HAP, or 25 tpy of combined HAPs.

The EPA defines a major source as "any building, structure, facility, or installation which emits or may emit a regulated . . . pollutant." 40 C.F.R. § 51.165(a)(1)(ii). In identifying whether these sources trigger major source requirements, state agencies charged with administering environmental permits must consider emissions from emission units that (1) are under common control, (2) are continugous or adjacent to the facility for which a permit is sought, and (3) belong to the same industrial grouping. *See* 40 C.F.R. § 51.165(a)(1)(ii). For natural gas operations in Pennsylvania, however, this determination is being circumvented through contractual agreements and corporate control groups.

For instance, company A owns a number of wells that are connected by pipelines to a compressor station owned by company B or a compressor station owned by company C. Company A's wellbores have a potential to emit (PTE) 15 tpy of VOCs. Company B's compressor station has a PTE of 45 tpy of VOCs, and company C's compressor station has a PTE of 40 tpy of VOCs. The entire operation has a PTE of 100 TPY of VOCs, twice the major source emissions threshold regulated by the CAA's Title V permitting program. But under Pennsylvania's source determination approach, these sources would be independently evaluated and all three companies would be exempt from any major source permitting requirements. Consequently, companies B and C would be permitted as minor sources and company A would be exempt altogether. *See* Group Against Smog and Pollution, Comments Regarding Proposed Guidance for Performing Single Stationary Source Determinations for the Oil and Gas Industries (2011).

These companies, however, are not entirely independent and distinct. For example, after the Pennsylvania DEP determined that a compressor station was not a major source of emissions, one advocacy group identified more than 70 nearby permitted wells operated by a parent entity that, through a network of subsidiaries and joint ventures, possessed a 49 percent ownership interest in the compressor station permittee. In addition to the parent company's significant ownership interest in the compressor station and wellbores, the parent company's Securities and Exchange Commission 10-K filing also disclosed gathering agreements that obligated the subsidiary wellbores to send extracted gas to a subsidiary compressor station, all through subsidiary-owned pipelines.

Through these legal relationships, the operation's emissions should have been aggregated by the Pennsylvania DEP. To use the above example, contractual obligations between A and B would net a PTE of 60 tpy of VOCs and, therefore, exceed Title V's emissions triggers. Of course, mere ownership would not necessarily classify an operation as a major source, without a further determination that the operations are contiguous or adjacent to the permittee facility.

EPA does not impose a bright line rule for determining whether operations are contiguous or adjacent and instead uses a case-by-case, multifactor analysis. Over the last 30 years, EPA has focused on proximity, dependency, or interdependence, and the existence of a physical connection between facilities when identifying a major source. These considerations conform to a common sense notion of a plant, which underlies the three core factors of source determination and may be weighed flexibly. In fact, EPA has aggregated emissions for operations as far as 44 miles apart, because those operations were deemed functionally interdependent. *See* Memo from Richard R. Long, U.S. EPA Region 8, to Dennis Myers, Colo. Dep't. of Public Health and the Env't. (Apr. 20, 1999). In the context of natural gas extraction and production, wells and compressor stations may be a few miles apart but are connected by pipelines and contractual obligations. However, because many natural gas emission units may be geographically detached, permitting authorities might presume that the system is disjointed and determine that the sources are not contiguous or adjacent.

The final factor in the major source analysis is the common industrial grouping of a primary emission unit and any support facilities. EPA explains that a support facility will belong to the same industrial grouping if it typically conveys, stores, or otherwise assists in the production of the principal product. *See* 45 Fed. Reg. 52,695 (Aug. 7, 1980). "Each source is to be classified according to its primary activity, which is determined by its principal product or group of products produced or distributed, or services rendered." *Id.* In the natural gas system, compressor stations release the greatest amount of emissions, followed by production and processing (depending on whether dry or wet gas is extracted). But without a regular conveyance of extracted gas from wellbores and processing facilities, compressor stations would not have a product to distribute. The relationship between these nodes is sufficiently dependent that they are unlikely to require a separate industrial grouping. Rather, this third factor is likely to be a nominal issue in a major source analysis.

The Benefits of Adequate Source Determinations

A January 2011 study from the Pennsylvania DEP concluded that although drilling operations at a single site will not cause the region to exceed NAAQS, the "combined effects from many of these operations in an area . . . may contribute to exceedances or violations of the [National Ambient Air Quality Standards] or interfere with the maintenance of the health-based standards in attainment areas." Pa. Dep't. Envtl. Prot., Northeastern Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report, at 21 (Jan. 12, 2011). This cautionary statement only confirms the necessity to adequately assess aggregate natural gas operations in Pennsylvania—particularly when many regions in Pennsylvania are already in nonattainment for ground-level ozone, particulate matter, lead, and sulfur dioxide. *See* U.S. Dep't Envtl.Prot. Agency, Currently Designated Nonattainment Areas for All Criteria Pollutants (Apr. 2, 2011), www.epa.gov/oaqps001/greenbk/ancl3.html. But various administrative

state-level exclusions and source determinations allow natural gas operations in Pennsylvania to avoid the vast majority of the CAA's regulatory requirements, pending a determination that Pennsylvania's SIP is no longer in compliance with the CAA or that individual permit decisions are flawed. To exempt the industry from air quality regulations may lead Pennsylvania down the path already documented by Colorado, Texas, Utah, and Wyoming.

Proper aggregation will yield significant benefits to Pennsylvania, industry, and the public. An adequate aggregation program provides a uniform and efficient mechanism that the Pennsylvania DEP can use to consolidate and administer provisions of the CAA and state laws; Title V permits enhance monitoring, recordkeeping, and reporting obligations. By aggregating emission units in the natural gas system into a major source for one or more NSR pollutants, natural gas operations will be required to purchase emission reduction credits and apply the lowest achievable emissions rate to that source, which would have a beneficial impact on air quality in that area.

Further, major sources are required to provide emissions reports to their permitting authorities at least semi-annually and must certify their compliance status annually. This improved industrial compliance with emissions standards would help Pennsylvania meet EPA-established NAAQS. At the same time, the natural gas industry would benefit from having a single air permit inclusive of all applicable obligations, and other industries could benefit through exchanging emission reductions.

Finally, members of the public would benefit from improved air quality, increased access to information about pollution control equipment, and enhanced opportunities for active participation in the permitting process. Under Title V, the Pennsylvania DEP must provide EPA with a copy of each permit application, and the EPA administrator has a 45-day review period to make a written objection, after which citizens may also petition EPA for further review. Neighboring states could also review and object to permits because of an operation's negative impact on that state's air quality. This whole process would ensure better oversight and consistent regulation of air emissions involved in Marcellus Shale natural gas drilling.

By aggregating natural gas extraction emissions with processing and compressor emissions, the Pennsylvania DEP could accurately identify the total load of emissions contributed by the natural gas industry. Considering that in Pennsylvania alone thousands of wells will be needed to extract natural gas from the Marcellus Shale, the Pennsylvania DEP must account for the contractual and physical relationships inherent in the natural gas system to minimize the environmental harm that shale gas extraction has caused in western shale plays. This will assist the Pennsylvania DEP in achieving national public health standards for air quality and reduce the emissions burden of other industries or operators.

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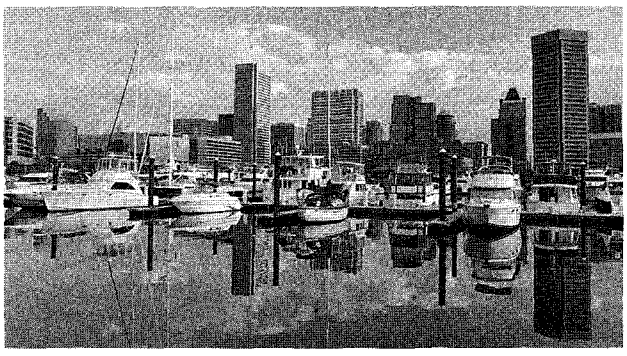

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