Natural Gas Development, Including Hydraulic Fracturing ("Fracking") and Horizontal Drilling

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I. A Primer on Natural Gas “Fracking” and “Horizontal Drilling”

In the vernacular, the natural gas sector in the United States is broken up into three sections: upstream (exploration and production, i.e., drilling), midstream (gathering and cleaning/processing of the raw natural gas), and downstream (transmission and distribution of clean natural gas (pure methane) to its various end uses).

The techniques “hydraulic fracturing” (commonly referred to as “fracking”) and “horizontal drilling” occur in the upstream section of the natural gas sector, specifically in the drilling and production of raw natural gas and associated hydrocarbons. My company operates in the “midstream” space so we do not directly participate in the “fracking” process or in horizontal drilling, however, we do benefit from and have to contend with these technological developments by virtue of significantly increased volumes of hydrocarbon materials that are generated, including the need to site and operate new infrastructure to cope with the increased volumes of methane and hydrocarbons (e.g., new gathering pipelines, new compressor stations, new gas processing plants, etc.) to clean and process these materials for their intended end use.

So, what is this hydraulic fracturing, which people refer to as “fracking,” and what is this technique referred to as “horizontal drilling”? They are two separate industrial techniques, but today they work in concert. As explained in more detail, below, “fracking” is the process of hydraulically fracturing (i.e., breaking, on a micro-scale) geologic shale rock far underground, by high pressure injection of water, sand and small quantities of certain additives, which results in opening up the rock to release and promote the flow of hydrocarbons and methane into the well. Horizontal drilling uses modern drilling technologies to allow, rather than a single traditional vertical well to be drilled into a producing zone from a well pad, for multiple wells to be drilled from that same pad but, when those wells reach the producing zone, they fan-out horizontally in an array extending in different directions in that production zone, thereby increasing the area of coverage by the wells exponentially as compared to a single, traditional vertical well. Together – horizontal drilling of multiple wells and the use of hydraulic fracturing in each of those wells – has generated dramatic increases in produced hydrocarbons and methane as compared to traditional techniques that were the norm as recently as only five years or so ago.
The American Natural Gas Association provides on its website a more detailed description of hydraulic fracturing and horizontal drilling, titled “Hydraulic Fracturing 101”, as follows.

How the Process Works
The vast increases in our domestic natural gas supplies over the last several years have been made possible by two technologies that allow us to tap into deep supplies of natural gas that were once thought to be inaccessible.

The first of these technologies is horizontal drilling. That's pretty much exactly what it sounds like—we drill one vertical hole that can then branch out into several horizontal cuts once the correct depth has been achieved. This is an important advancement because it significantly reduces the surface impact of drilling activities by giving access to more of the natural gas formation underground from fewer wells above ground. Thanks to horizontal drilling, today’s average well site is just 30 percent of the size of its 1970s counterpart and can access 60 times more below-ground area. Continued technological advancements mean fewer wells recovering even greater reserves and creating less surface disturbance and waste.

The other technique that allows us to tap into new supplies of natural gas is hydraulic fracturing. As illustrated below, hydraulic fracturing or “fracking” takes place typically a mile or more below the earth's surface. Today, the process is minimally invasive and involves drilling a small hole (typically about 15" in diameter), which is lined with multiple layers of steel encased in cement to seal off development activities from any fresh water supplies and to allow for the safe extraction of natural gas. Then pressurized water, sand and additives (less than 0.5 percent of the overall mixture) are used to create small, often millimeter-thick fissures in carefully targeted sections of the shale rock. This releases the natural gas, allowing it to safely rise to the surface within the self-contained system.
These techniques are being, and likely will be, deployed in large areas of the country that are home to what are referred to as “unconventional resources” (e.g., shale gas, tight gas, and coalbed methane). The U.S. Energy Information Administration provides a national map of where hydraulic fracturing and horizontal drilling are presently being, and have the potential to be, utilized to develop natural gas from unconventional geologic resources, as follows.
The advent of this combination of well development techniques has dramatically increased the domestic production of natural gas. Historic natural gas production has, according to the U.S. Energy Information Administration, increased significantly in the past few years largely because of these techniques, and is expected to continue.\textsuperscript{iv}

The increased production of both oil and gas from use of these techniques is a boon for the industry and for the U.S. economy. Increases in supply have reduced certain marginal energy costs, drawing industry to the U.S. and generating other new consumptive uses of these resources. The dramatic increase in drilling and production, however, also raises a myriad of questions about how we in the U.S. should drill, produce, clean, transport and use these resources. Significant issues arise with the increased use of these techniques and the concomitant hydrocarbon volumes produced – issues, e.g., regarding land use for energy development, public health protection, air and water quality protection, and climate change protection – and the legal and regulatory community, along with industry and the public, will need to continue with the work of addressing these complex issues.
II. Natural Gas Development – Air Quality Issues

Why the development and use of natural gas is growing

The dramatic increase in the production and use of natural gas in the U.S. is largely driven by two elements: (i) the technological revolution of horizontal drilling and hydraulic fracturing, which has dramatically affected market supply of gas and oil, which in turn has affected pricing dynamics favoring the use of natural gas, and (ii) environmental and public health regulations that are generally favoring natural gas as a fuel of choice compared to coal or oil.

Technology and the market

There is a significant amount of current and historical information on energy supply, demand and pricing, to be found in U.S. Energy Information Administration (EIA) sources, including that for the natural gas sector. The EIA information provides excellent insight into energy production and consumption trends in the U.S.

Without going into significant detail, three figures are illustrative of certain of the elements that reflect or explain why and how natural gas and oil volumes have been increasing, and the impact on energy pricing. **Figure 1** reflects how use of horizontal drill rigs has increased dramatically, from more of a pilot or development use up to 2009, to a much more broad industrial application starting in 2010.\(^{(5)}\) Horizontal drill rigs substantially increase the number of wells drilled and, coupled with hydraulic fracturing, dramatically increases the volume of natural gas and oil produced by the sector. **Figure 2** from the EIA demonstrates the volume of oil and natural gas produced in the U.S., reflecting a dramatic increase in volumes particularly since 2010 (consistent with the advent of hydraulic fracturing and horizontal drilling techniques). **Figure 3** from the EIA reflects the energy pricing impact associated with increasing production volumes, reflecting natural gas prices that ranged roughly between $6 to $8 p/mmBtu in the 2003 to 2008 timeframe, to half that - $2 to $4 p/mmBtu – from roughly 2009 to present.\(^{(6)}\)
Figure 1 – type of drill rigs used in select U.S. basins

![Rig Count by Type](image1)

Figure 2 – production volumes

![US Production](image2)
With natural gas prices in the $2 to $4 p/MMBTU range, if that can be maintained to provide a stable pricing environment, it has and will lead to increased industrial usage of natural gas as a fuel source. Anecdotally, it is believed, for example, that such low fuel costs is resulting in some level of “on-shoring” of industrial activity that left the U.S. some time ago. Natural gas pricing under certain scenarios is favoring gas as a fuel source compared to coal, which is increasing its usage as a fuel of choice (see, e.g., Leveraging Natural Gas to Reduce Greenhouse Gas Emissions, pp. 11-17, Center for Climate and Energy Solutions (June 2013)).

Public Health and the Environment

Separate from market dynamics, public health and environmental drivers are also pushing towards increased use of natural gas as a fuel source, vs. traditional fuel sources like coal or fuel oil. For example, National Ambient Air Quality Standards (NAAQS) under the Clean Air Act (Sec. 42 U.S.C. 7409), e.g., for Ozone (O₃), fine particulate, or sulphur dioxide (SO₂), are driving states and industry to facilities that emit lower levels of NOₓ, particulate matter and SO₂, which natural gas provides as compared to traditional hydrocarbons. Natural gas emits comparatively less NOₓ, virtually eliminates emissions of SO₂, and has no metals emissions, all of which are products from burning coal or fuel oil for energy. As federal and state regulations drive lower levels of NOₓ, SO₂ or metal emissions like mercury, natural gas is an attractive low-emitting fuel source alternative.
In general, natural gas combustion emits roughly half of the carbon dioxide (CO₂) that is emitted from the combustion of coal as a fuel source, and about one third less CO₂ as compared to burning oil as a fuel source. In addition, burning natural gas as a fuel virtually eliminates the emissions of SO₂ and metals as compared to burning coal or oil, and has reduced emissions of NOₓ. For example, average emissions from electric power production using coal, natural gas or oil as the fuel source are as follows.

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>CO₂ (lbs/MWHR)</th>
<th>SO₂ (lbs/MWHR)</th>
<th>NOₓ (lbs/MWHR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>2,249</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>1,135</td>
<td>0.1</td>
<td>1.7</td>
</tr>
<tr>
<td>Oil</td>
<td>1,762</td>
<td>12</td>
<td>4</td>
</tr>
</tbody>
</table>

A real life example of how a state’s implementation of environmental quality regulations favored the large scale use of natural gas for electric energy production occurred in Colorado in 2010. Colorado was facing issues with respect to how it would comply with the new federal NAAQS for Ozone, and also with how it would meet its obligation to improve what is referred to as “Regional Haze” in pristine airsheds under the Clean Air Act. One solution that addressed both of these Clean Air Act requirements was to evaluate and propose a plan to reduce NOₓ, SO₂ and other pollutants by retiring and/or replacing or converting older coal-fired electric generating units with natural gas-fired electric generation. In 2010 and 2011 Colorado undertook a program to develop a methodical plan to retire, where warranted, certain older coal-fired power plant units and replace them with natural gas fired electric generation, and to control one of the regulated utility’s more modern coal-fired units – referred to as the Colorado “Clean Air Clean Jobs Act.” Sec. 40-3.2-201 et seq., Colorado Revised Statutes (Colorado HB10-1365). Although the final plan approved by the state Public Utilities Commission and the state Air Quality Control Commission was modestly revised in its final incarnation, the initial proposed plan with respect to 6 coal-fired units and 2 new combined cycle gas-fired plants by 2022 will provide a net reduction of NOₓ emissions from 18,000 tons per year (tpy) to 1,600 tpy (91% reduction), SO₂ emissions from 20,700 tpy to 2,200 tpy (89% reduction), and mercury emissions from 211 lbs./yr. to 16 lbs./yr. (92% reduction). These dramatic reductions in NOₓ emissions will assist the Front Range of Colorado in achieving compliance with federal ambient air quality standards for Ozone, and the NOₓ and SO₂ reductions combined are critical for the state in achieving its obligations to improve air quality under the federal Regional Haze regulations, both of which are part of the Clean Air Act.

Separate from reductions in traditional air pollutants, the advent of regulations relating to greenhouse gases (GHGs, the primary pollutant being carbon dioxide (CO₂)) will also be driving the federal government, states and industry to higher efficiency or low CO₂-emitting facilities and equipment. As noted, above, natural gas as a fuel source emits roughly half the CO₂ compared to burning coal. On average, a coal-fired power plant generates approximately 2,200 lbs. CO₂/MWHR compared to a natural gas-fired power plant at approximately 1,100 lbs./MWHR. EPA’s 2012 proposed regulation to reduce GHG emissions from new coal-fired power plants is an example of a regulation that will favor traditional use of coal as a fuel source and favor use of natural gas for its CO₂ and traditional emissions benefits (see, “New Source Performance Standards for Emissions of CO₂ from New Affected Fossil Fuel-Fired Electric Generating Units,” 77 Fed.Reg. 22392 (April 13, 2012)).
How is equipment used and part of the natural gas sector regulated from an air quality perspective

Air emissions from equipment utilized in the natural gas sector is regulated by a combination of direct federal emissions requirements, state requirements for particular pieces of equipment, and relevant air permitting requirements. These regulations serve to manage and reduce potential air emissions from the various equipment utilized in the industry – emissions of volatile organic compounds (VOCs) that can contribute to Ozone pollution, of NOx or SO2 that can affect Ozone or particulate matter pollution, of other Hazardous Air Pollutants like formaldehyde or benzene, and increasingly of methane (pure natural gas) which has notable greenhouse gas warming potential.

Direct federal regulations

EPA, and the States as agents of the EPA, directly regulate emissions of various “criteria pollutants” (e.g., NOx, SO2, particulate matter, volatile organic compounds as an Ozone precursor, carbon monoxide) and “Hazardous Air Pollutants” (e.g., volatile organic compounds that contain benzene, or formaldehyde) from equipment and facilities in the natural gas sector under various Clean Air Act programs, discussed below.

EPA and the States do not directly regulate, at this time, CO2 or greenhouse gases (i.e., methane, or CH4, which is ‘natural gas’) from the operation of oil and gas equipment and facilities, other than through federal Major Source permitting applied for or issued after July 2011 (42 U.S.C. 7475, and permitting regulations at 40 C.F.R. Part 52.21 et seq.; see also, “Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule,” 75 Fed.Reg. 31514 (June 3, 2010)). EPA and the states do collaterally, or indirectly, regulate CO2 and CH4 emissions as co-benefits of regulations to reduce emissions of, for example, volatile organic compounds. The federal Major Source permitting program was amended to regulate greenhouse gas emissions in starting in 2011, so proposals for a Major Source of greenhouse gases, or a Major Modification to an existing Major Source of greenhouse gases, must now undergo PSD permitting and a review for “Best Available Control Technology” for greenhouse gases – the applicability of these requirements, and the requirements themselves once deemed applicable for greenhouse gases, are very complex and require close attention to determine if and when these pre-construction permitting requirements apply.

The regulations that affect emissions from oil and gas sector equipment and facilities include those promulgated under Clean Air Act Section 111 “New Source Performance Standards” (see generally, 40 C.F.R. Part 60), and Section 112 “Maximum Available Control Technology” standards or “National Emissions Standards for Hazardous Air Pollutants” (see generally, 40 C.F.R. Parts 61 and 63).
The federal Clean Air Act, New Source Performance Standards (NSPS) under Sec. 111 of the Clean Air Act are found at 40 C.F.R. Part 60, and are focused on regulating emissions from particular processes or pieces of equipment that have emissions or regulated pollutants under the Clean Air Act, which, in the natural gas sector, typically includes regulations to reduce NOx, particulate matter, and volatile organic compounds (VOCs, or hydrocarbons) that can contribute to ozone formation or fine particulate matter pollution. The primary regulations that require controls or emissions reduction practices for equipment utilized in the natural gas sector include the following.

- **NSPS for Small Industrial, Commercial, Institutional Steam Generating Units, Subpart Dc (40 C.F.R. §§ 60.40c-48c)**
- **NSPS for Petroleum Liquids Storage Vessels, Subpart K (40 C.F.R. §§ 60.110-113)**
- **NSPS for Petroleum Liquids Storage Vessels, Subpart Ka (40 C.F.R. §§ 60.110a-115a)**
- **NSPS for Volatile Organic Liquids (Including Petroleum Liquids Storage Vessels), Subpart Kb (40 C.F.R. §§ 60.110b-117b)**
- **NSPS for Equipment Leaks of VOC from Onshore Natural Gas Processing Plants, Subpart KKK (40 C.F.R. §§ 60.630-636)**
- **NSPS for Onshore Natural Gas Processing, Amine and Sulfur Recovery Units, Subpart LLL (40 C.F.R. §§ 60.640-648)**
- **NSPS for Stationary Gas Turbines, Subpart GG (40 C.F.R. . §§ 60.330-335) (turbines constructed, modified or reconstructed after October 3, 1977 and before February 18, 2005)**
- **NSPS for Stationary Gas Turbines, Subpart KKKK (40 C.F.R. . §§ 60.4300-4420) (turbines constructed, modified or reconstructed after February 18, 2005)**
- **NSPS for Stationary Compression Ignition Internal Combustion Engines, Subpart IIII (40 C.F.R. . §§ 60.4200-4219)**
- **NSPS for Stationary Spark Ignition Internal Combustion Engines, 40 C.F.R. Part 60, Subpart JJJJ (40 C.F.R. . §§ 60.4230-4248)**
- **NSPS for Crude Oil and Natural Gas Production, Transmission and Distribution, Subpart OOOO (40 C.F.R. 5360-5430) – this is a new comprehensive regulation for various oil and gas equipment, including production equipment, promulgated in 2012 (see, 77 Fed.Reg. 49489 (August 16, 2012)). This regulation addresses:**
  - Standards for hydraulically fractured natural gas wells (“Reduced Emissions Completions”)
  - Standards for Compressors
  - Standards for Pneumatic Controllers
  - Standards for Storage Vessels
  - Standards for Equipment Leaks at Onshore Natural Gas Processing Plants
  - Standards for Sweetening Units at Onshore Natural Gas Processing Plants
  - Startup, Shutdown, Malfunction Provisions
- **NSPS flare performance standards, which apply indirectly via other applicable requirements (40 C.F.R. 60.18).**
The federal Clean Air Act, Maximum Available Control Technology regulations (MACT standards, otherwise known as National Emission Standards for Hazardous Air Pollutants, or NESHAPs, under Sec. 112 of the Clean Act) are found at 40 C.F.R. Parts 61 and 63, and are focused on regulating emissions of “Hazardous Air Pollutants” under the Clean Air Act. In the natural gas sector, these typically include regulations, for example, to reduce benzene or BTEX compounds (which are contained in “volatile organic compounds”), and formaldehyde. For the natural gas sector, the primary regulations include the following.

- NESHAP for Equipment Leaks (Fugitive Emission Sources), **Subpart V** (40 C.F.R. §§ 61.240-247)
- NESHAP (MACT) for Oil and Natural Gas Production Facilities, tanks, compressors, and ancillary equipment, **Subpart HH** (40 C.F.R. §§ 63.760-777) – *this is a recently revised and updated comprehensive regulation for various oil and gas equipment, including production equipment, promulgated in 2012* (see, 77 Fed.Reg. 49489 (August 16, 2012)). The regulations include requirements for the following equipment.
  - Standards for Glycol Dehydrators
  - Standards for Crude Oil and Condensate Storage Tanks
  - Standards for Equipment Leaks from Oil and Natural Gas Processing Facilities
  - Startup, Shutdown and Malfunction Provisions
- NESHAP (MACT) for Oil and Natural Gas Production Facilities, Dehydrators, **Subpart HHH** (40 C.F.R. §§ 63.1270-.1287)
- NESHAP (MACT) for Stationary Reciprocating Engines (“RICE”), **Subpart ZZZZ** (40 C.F.R. §§ 63.6580-6675)
- NESHAP (MACT) for Industrial, Commercial and Institutional Boilers and Process Heaters (Boiler MACT), **Subpart DDDDD** (40 C.F.R. §§ 63.7480-7575).
- NESHAP (MACT) for Stationary Combustion Turbines, **Subpart YYYY** (40 C.F.R. §§ 63.6080-.6175)
- NESHAP (MACT) for Site Remediation Requirements, **Subpart GGGG** (40 C.F.R. §§ 63.7880-.7957)

**Direct State regulations**

In addition to federal regulations, many oil producing states have promulgated specific state regulations to regulate or control air emissions associated with oil and gas sector equipment or operations. The specific state regulations would need to be reviewed, but these can entail particular requirements for activities/equipment, including, for example, the following.

- “Reduced Emissions Completions,” or green completion techniques for a newly-drilled well and production therefrom
- Condensate tank emission controls or operation requirements
- Dehydrator control requirements
- Pneumatic valves and controllers, replacement or repair
- Reciprocating Internal Combustion Engines (RICE) emission control or management requirements
- Flare requirements
- Presumptive emissions reduction standards for minor sources, which can include emissions standards/techniques for drill rigs, e.g., natural-gas fired vs. diesel-fired

*See*, for example, Colorado’s oil and gas air quality regulations at 5 C.C.R. 1001-9 (Regulation No. 7), including Sec. XII (for condensate tanks in the ozone non-attainment area), Sec. XVI (for reciprocating
engines in the ozone non-attainment area), Sec. XVII (statewide requirements for condensate tanks, dehydrators, and reciprocating engines), Sec. XVIII (pneumatic controllers in the non-attainment area). See also, Colorado Oil and Gas Conservation Commission, 805 Series Rules for air emissions and odor from oil and gas production activities. Also, see Wyoming Department of Environmental Quality regulations of oil and gas sources at “Oil and Gas Production Facilities,” Chapter 6, Section 2 Permitting Guidance (revised March 2010), for Best Available Control Technology (BACT) and Presumptive BACT standards for a variety of oil and gas production and processing equipment.

Permitting

Separate from, and in addition to these various direct regulations, equipment and facilities in the oil and gas sector (like other industrial sectors) are also subject to requirement to manage or reduce air emissions that are part of the air permits that must be obtained before construction or modification of the facility can take place. These permitting programs are very complex, and the specific regulations must be consulted to determine which permitting program requirements are triggered by the proposed facility or activity, and, based on that, which process and potential emissions control standards are triggered and applicable. These permitting programs include the following.

- Federal air permitting
  - PSD/NNSR Pre-Construction Permits
  - Title V Operating Permits
- State air permitting
  - Minor source permitting (w/associated requirements)

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1 The content of and opinions reflected in this paper are those of the author, and do not reflect the opinion or positions of DCP Midstream, LP.
2 *Hydraulic Fracturing 101*, American Natural Gas Association (ANGA) – reprinted herein with the permission of ANGA, and found under the association’s webpage tab for “Safe and Responsible Development” at: [http://www.anga.us/issues--policy/safe--responsible-development/hydraulic-fracturing-101#UazJHJgT_M](http://www.anga.us/issues--policy/safe--responsible-development/hydraulic-fracturing-101#UazJHJgT_M)
5 Source: [www.smithprodserv.com](http://www.smithprodserv.com) Smith Bits STATS
6 Natural gas prices are a function of a number of variables, and in the 2009 timeframe the economic downturn certainly influenced energy prices. Natural gas prices in the $2 to $4 range have been sustained since 2009, as the economy has improved, indicating that increased supply is helping to keep the price more consistently at these modest levels.
8 *Id*. An excellent discussion of the relative air emissions attributes and issues related to natural gas, and other fuel sources like coal or oil, can be found at “Leveraging Natural Gas to Reduce Greenhouse Gas Emissions,” June 2013, Center for Climate and Energy Solutions.

WDEQ oil and gas air quality guidance can be found at:
http://deq.state.wy.us/aqd/Oil%20and%20Gas/March%202010%20FINAL%20O%20G%20GUIDANCE.pdf