U.S. ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF INSPECTOR GENERAL

EPA Needs to Improve Air Emissions Data for the Oil and Natural Gas Production Sector

Report No. 13-P-0161 **February 20, 2013**

Scan this mobile code to learn more about the EPA OIG.

Report Contributors: Rick Beusse, Chris Dunlap, Kevin Good, Erica Hauck, Renee McGhee-Lenart, Julie Narimatsu

Abbreviations

AERR	Air Emissions Reporting Requirements
CAA	Clean Air Act
CFR	Code of Federal Regulations
EIA	U.S. Department of Energy's Energy Information Administration
EPA	U.S. Environmental Protection Agency
ERT	Electronic reporting tool
FTE	Full-time equivalent
FY	Fiscal year
GAO	U.S. Government Accountability Office
GHG	Greenhouse gas
HAP	Hazardous Air Pollutants
NAAQS	National Ambient Air Quality Standards
NATA	National Air Toxics Assessment
NEI	National Emissions Inventory
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NOx	Nitrogen oxides
NSPS	New Source Performance Standards
OAP	Office of Atmospheric Programs
OAQPS	Office of Air Quality Planning and Standards
OAR	Office of Air and Radiation
OIG	Office of Inspector General
ORD	Office of Research and Development
$PM_{2.5}$	Fine particulate matter
PM_{10}	Inhalable coarse particulate matter
SIP	State implementation plan
VOC	Volatile organic compounds
WebFIRE	Web Factor and Information Retrieval System

Cover photo: A natural gas production facility next to a playground and housing development. (EPA photo)

Hotline

To report fraud, waste, or abuse, contact us through one of the following methods:

e-mail: OIG_Hotline@epa.gov
phone: 1-888-546-8740
fax: 202-566-2599
online: http://www.epa.gov/oig/hotline.htm

write: EPA Inspector General Hotline
1200 Pennsylvania Avenue, NW
Mailcode 2431T
Washington, DC 20460

U.S. Environmental Protection Agency
Office of Inspector General

13-P-0161
February 20, 2013

At a Glance

Why We Did This Review

We initiated this review to determine whether the U.S. Environmental Protection Agency (EPA) has the data needed to make key decisions regarding air emissions from oil and natural gas production. Key decisions include the need for regulations, enforcement and permitting decisions, and risk assessment, among others. Gas production in the United States has grown significantly in recent years. Between 1992 and 2010, about 210,000 new gas wells were drilled. The U.S. Department of Energy projects that onshore crude oil and natural gas production will increase 30 and 18 percent, respectively, from 2009 to 2025. The oil and gas production sector and its various production processes emit large amounts of harmful pollutants that impact air quality on local, regional, and global levels.

This report addresses the following EPA Goal or Cross-Cutting Strategy:

- *Taking action on climate change and improving air quality.*

For further information, contact our Office of Congressional and Public Affairs at (202) 566-2391.

The full report is at:
www.epa.gov/oig/reports/2013/20130220-13-P-0161.pdf

EPA Needs to Improve Air Emissions Data for the Oil and Natural Gas Production Sector

What We Found

High levels of growth in the oil and natural gas (gas) production sector, coupled with harmful pollutants emitted, have underscored the need for EPA to gain a better understanding of emissions and potential risks from the production of oil and gas. However, EPA has limited directly-measured air emissions data for air toxics and criteria pollutants for several important oil and gas production processes and sources, including well completions and evaporative ponds. Also, EPA does not have a comprehensive strategy for improving air emissions data for the oil and gas production sector; the Agency did not anticipate the tremendous growth of the sector, and previously only allocated limited resources to the issue.

In addition to their use in making a variety of key decisions, EPA uses air emissions data to develop emission factors. These are representative values that relate the quantity of a pollutant released with an activity associated with its release. States use EPA's emission factors to develop emission inventories, issue permits for facilities, and take enforcement actions. Limitations in EPA's air emissions data for a number of oil and gas production pollutants have contributed to emission factors of questionable quality. About half of EPA's Web Factor and Information Retrieval System oil and gas production emission factors are rated below average or unrated because they are based on insufficient or low quality data.

EPA uses its National Emissions Inventory (NEI) to assess risks, track trends, and analyze envisioned regulatory controls. However, oil and gas production emissions data in the 2008 NEI are incomplete for a number of key air pollutants. For example, only nine states submitted criteria pollutant emissions data for small stationary sources. Because so few states submitted data for this sector, we believe the NEI likely underestimates oil and gas emissions. This hampers EPA's ability to accurately assess risks and air quality impacts from oil and gas production activities.

Recommendations and Planned Agency Corrective Actions

We recommend that EPA develop and implement a comprehensive strategy for improving air emissions data for the oil and gas production sector, prioritize which oil and gas production emission factors need to be improved, develop additional emission factors as appropriate, and ensure the NEI data for this industry sector are complete. EPA concurred with our recommendations to develop a comprehensive strategy, improve and prioritize emission factors, and develop default nonpoint emission estimates. The Agency did not concur with our recommendations to ensure that states submit required data and develop default calculation guidance. These recommendations are unresolved pending the Agency's final report response.

Noteworthy Achievements

EPA is conducting field studies to develop new methods to measure emissions and investing in a new Emissions Inventory System.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

THE INSPECTOR GENERAL

February 20, 2013

MEMORANDUM

SUBJECT: EPA Needs to Improve Air Emissions Data for the Oil and Natural Gas Production Sector
Report No. 13-P-0161

FROM: Arthur A. Elkins, Jr.

TO: Gina McCarthy
Assistant Administrator for Air and Radiation

Lek Kadeli
Acting Assistant Administrator for Research and Development

This is our report on the subject evaluation conducted by the Office of Inspector General (OIG) of the U.S. Environmental Protection Agency (EPA). This report contains findings that describe the problems the OIG has identified and corrective actions the OIG recommends. The Agency disagreed with two of our recommendations, which are unresolved pending the Agency's final report response. This report represents the opinion of the OIG and does not necessarily represent the final EPA position. Final determinations on matters in this report will be made by EPA managers in accordance with established audit resolution procedures.

Action Required

In accordance with EPA Manual 2750, you are required to provide a written response to this report within 60 calendar days. You should include a corrective actions plan for agreed-upon actions, including milestone dates. Your response will be posted on the OIG's public website, along with our memorandum commenting on your response. Your response should be provided as an Adobe PDF file that complies with the accessibility requirements of Section 508 of the Rehabilitation Act of 1973, as amended. The final response should not contain data that you do not want to be released to the public; if your response contains such data, you should identify the data for redaction or removal. Please e-mail your response to Carolyn Copper, Assistant Inspector General for Program Evaluation, at copper.carolyn@epa.gov. We have no objections to the further release of this report to the public. We will post this report to our website at http://www.epa.gov/oig.

If you or your staff have any questions regarding this report, please contact Carolyn Copper at (202) 566-0829 or copper.carolyn@epa.gov; or Rick Beusse, Director for Air and Research Evaluations, at (919) 541-5747 or beusse.rick@epa.gov.

Table of Contents

Chapters

Appendices

Chapter 1
Introduction

Purpose

We conducted this evaluation to determine whether the U.S. Environmental Protection Agency (EPA) has the data needed to make key decisions regarding air emissions from oil and natural gas (gas) production activities. These decisions include establishing regulations, determining applicability of sources to regulations, permitting facilities, evaluating the adequacy and cost-effectiveness of regulatory controls, assessing residual risks from facilities,[1] evaluating State Implementation Plans (SIPs),[2] and taking enforcement actions.

Background

Industry Growth

Gas production in the United States has grown significantly in recent years. From 1992 to 2010,[3] the number of producing gas wells increased by 76 percent. Onshore gross withdrawals of gas increased by about 43 percent. About 11,000 new wells were drilled annually from 1992 to 2010, on average. According to a 2011 EPA fact sheet,[4] the United States had nearly 1.1 million producing oil and gas wells in 2009. Growth in gas production has been particularly significant in areas covered by EPA Regions 3, 6, and 8. For example, in Region 8, the number of gas wells increased by 416 percent and gross withdrawals increased by 163 percent between 1992 and 2010.

Unlike gas production, onshore production of crude oil decreased from 2.28 billion barrels in 1992 to 1.4 billion barrels in 2010, but is expected to increase in future years. The U.S. Department of Energy's Energy Information Administration (EIA)[5] projects that both onshore crude oil and gas production will increase by 30 percent and 18 percent, respectively, between 2009 and 2025. In addition, the EIA projects that about 39,000 new gas wells will be drilled per

[1] Comprehensive risk assessments involve a number of activities and types of information beyond emissions data, including dispersion modeling, human exposure assessments, and dose-response relationships. We focused only on oil and gas production emissions data. We did not evaluate the limitations or uncertainties associated with the other types of information used in comprehensive risk assessments.
[2] A SIP is a state's blueprint for how it will attain and/or maintain the National Ambient Air Quality Standards. It contains the state's proposed control measures and strategies, subject to EPA review and approval.
[3] 2010 was the most recent year for which data were available at the time we conducted our analysis.
[4] EPA Fact Sheet, *Proposed Amendments to Air Regulations for the Oil and Natural Gas Industry*, July 2011.
[5] EIA collects, analyzes, and disseminates independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment. By law, EIA's data, analyses, and forecasts are independent of approval by any other officer or employee of the U.S. Government. Source: http://www.eia.gov/about/mission_overview.cfm.

year during the same period. Appendix C provides more details on the growth in oil and gas production.

Oil and Gas Processes and Sources of Airborne Emissions

The oil and natural gas sector includes operations involved in the extraction and production of oil and natural gas, as well as the processing, transmission, and distribution of natural gas. Specifically for oil, the sector includes all operations from the well to the point of custody transfer at a petroleum refinery. For natural gas, the sector includes all operations from the well to the customer.

Our evaluation focused on activities associated with onshore oil and gas production. Production involves the extraction of oil and gas from underground formations and the initial separation of crude oil and gas from other components in the hydrocarbon stream coming from the ground. These activities are commonly referred to as upstream activities.

As shown in table 1, the sources of airborne emissions from oil and gas production (upstream) activities can be broken down into three major categories.

Table 1: Source categories of airborne emissions from upstream activities

Category	Type of emissions	Sources of emissions
Combustion sources	Nitrogen oxides (NOx)[a,b] and carbon monoxide resulting from the burning of hydrocarbon (fossil) fuels. Air toxics, particulate matter (PM), uncombusted volatile organic compounds, and methane are also emitted.	Engines, heaters, flares, incinerators, and turbines.
Vented sources	Volatile organic compounds (VOCs)[a,b], air toxics, and methane resulting from direct releases to the atmosphere.	Pneumatic devices, dehydration processes, gas sweetening processes, chemical injection pumps, compressors, tanks, and well testing, completions, and workovers.
Fugitive sources	VOCs[a,b], air toxics, and methane resulting from uncontrolled and under-controlled emissions.	Equipment leaks through valves, connectors, flanges, compressor seals, and related equipment and evaporative sources including wastewater treatment, pits, and impoundments.

Source: Office of Inspector General (OIG)-developed table from the American Petroleum Institute's *Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Gas Industry, 2009* and selected other sources.

[a]Fine particulate matter ($PM_{2.5}$) emissions can be created by secondary formation due to chemical reaction in the atmosphere from precursor emissions such as NOx and VOCs.
[b]Ozone emissions can be created by secondary formation due to photochemical reactions in the atmosphere from precursor emissions such as NOx and VOCs. Winter ozone exceedances in western states have been linked to oil and gas drilling.

Pollutants Emitted and Associated Health Risks

Oil and gas production processes and sources emit large amounts of harmful pollutants that can impact air quality globally, regionally, and locally. Table 2

describes the health impacts of some significant pollutants emitted from the oil and gas production sector.

Table 2: Health impacts of significant pollutants emitted from upstream oil and gas production activities

Pollutant(s)	Health impacts
Greenhouse gases (methane/ carbon dioxide)	Potential health impacts related to climate change will vary, but threats include increased incidence of serious infectious disease, extreme temperatures that lead directly to loss of life, and warmer temperatures that can increase air and water pollution and result in human health impacts.
NOx and VOCs, which contribute to ground-level ozone	Health impacts may include reduction of lung function, inflammation of airways, aggravation of asthma, increased susceptibility to respiratory illnesses (e.g., pneumonia and bronchitis) and premature death. Vulnerable populations (e.g., people with lung disease, children, and the elderly) are especially at risk.
Fine particulate matter ($PM_{2.5}$)	Health impacts may include worsening of lung function, asthma attacks, bronchitis, increased susceptibility to respiratory infections, and premature death.
Air toxics including benzene, toluene, ethylbenzene, and xylenes	Health impacts from short-term exposure may include skin and sensory irritation, central nervous system problems, and respiratory problems. Health impacts from long-term exposure may include problems with kidney, liver, and blood systems. For example, benzene is a human carcinogen and health impacts from short-term exposure may include drowsiness, dizziness, headaches, and irritation of the eyes, skin, and respiratory tract. Long-term exposure has been linked to various blood disorders, reproductive effects, and increased incidence of leukemia.

Source: OIG-developed table.

Methods for Quantifying Emissions

Quantifying air emissions is important to achieving effective control and oversight of sources of air emissions. Several methods exist for quantifying emissions, including direct measurement of sources and estimation techniques such as emission factors and engineering calculations:

- Direct measurement involves measuring actual emissions and collecting empirical or directly-measured data from a source or process.

- Emission factors are representative values that relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. EPA and states use emission factors to produce emission estimates for specific sources or processes at a facility.

- Engineering calculations refer to the estimation of emissions using engineering parameters.

EPA's Emissions Inventories

Emissions inventories identify, by source, the air pollutant emissions in a specific geographic area for a specific time interval. EPA and states use emissions inventories to evaluate air pollution problems and assess the effectiveness of air pollution policy. Inventories represent an estimate of total emissions and are based to a large extent on data derived from emission factors. EPA has two

primary emissions inventories that reflect emissions from oil and gas production: the National Emissions Inventory (NEI) and the Inventory of U.S. Greenhouse Gas (GHG) Emissions and Sinks (known as the GHG Inventory):

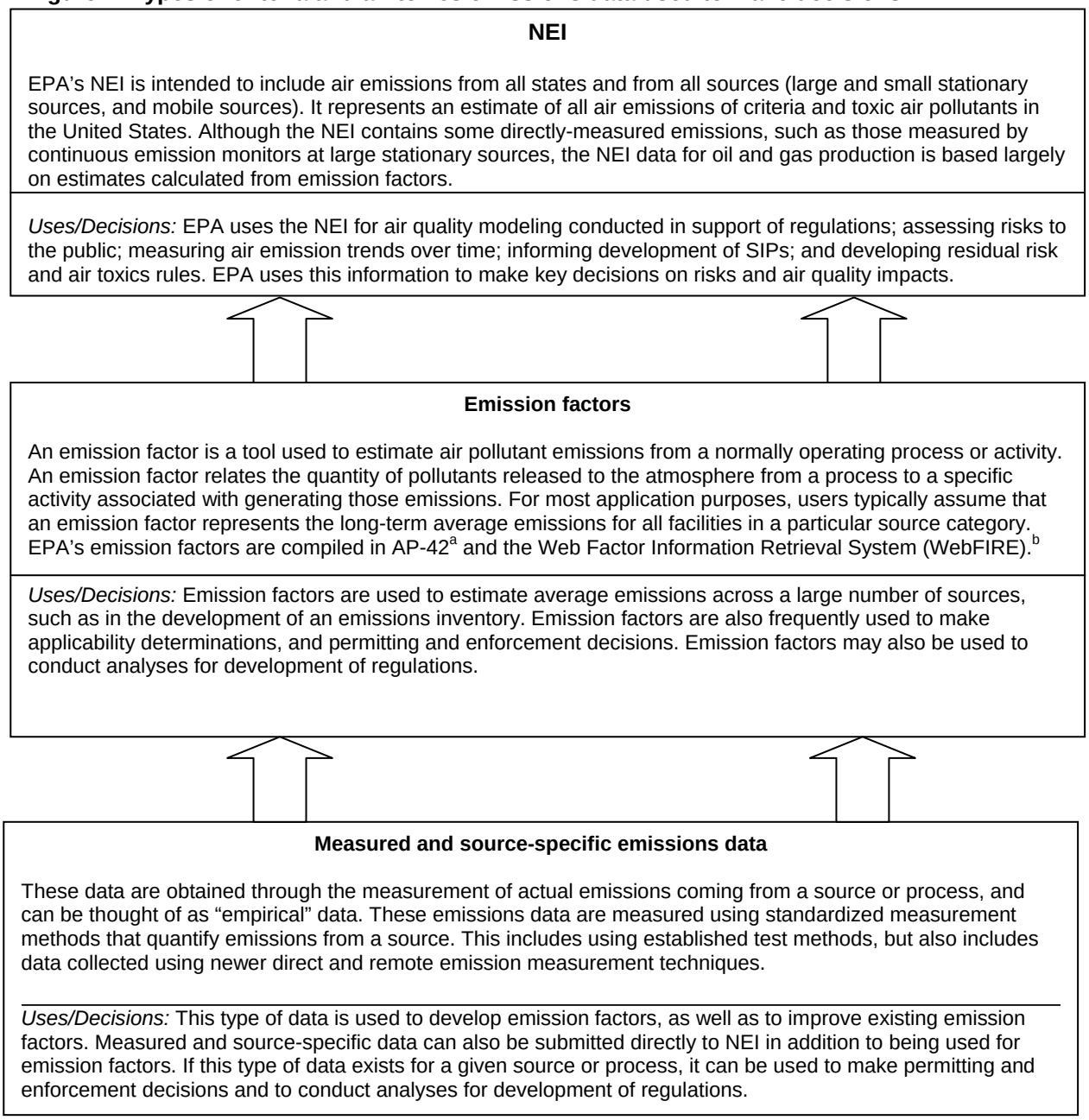
- EPA's NEI is a nationwide inventory containing detailed estimates of both criteria[6] and toxic air emissions from all sources of air emissions. The NEI is based primarily on emissions data submitted by state, local, and tribal air pollution control agencies. The NEI is compiled every 3 years, with the most recent inventory representing emissions in 2008. EPA uses the NEI for a variety of purposes, including developing regulations, modeling efforts to support rulemakings, characterizing risks from air toxic emissions, and assessing emission trends over time. The environmental staff from one state said that they use the NEI for modeling efforts to support their SIP proposal process.[7]

- For GHGs, EPA annually prepares the national *GHG Inventory Report*, which provides estimates of the amount of domestic GHGs emitted into and removed from the atmosphere. Primarily, the GHG Inventory Report fulfills the United States' commitment to the United Nations Framework Convention on Climate Change (1992), which requires parties to develop national inventories of anthropogenic GHG emissions and GHG removals.

Figure 1 explains how emissions data, emission factors, and emissions inventories for air toxics and criteria pollutants are related and used to make key decisions.

[6] The Clean Air Act requires EPA to set National Ambient Air Quality Standards for six common air pollutants. These commonly found air pollutants (also known as "criteria pollutants") are ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead.
[7] States may use NEI data to develop their SIP proposals; however, SIP proposals must undergo public review and comment before they are approved.

Figure 1: Types of criteria and air toxics emissions data used to make decisions



Source: OIG-developed figure.

[a]AP-42, *Compilation of Air Pollutant Emission Factors*, is EPA's primary compilation of emission factor information. It contains emission factors and process information for more than 200 air pollution source categories.

[b]WebFIRE is EPA's online repository of recommended emission factors.

Complexity of Oil and Gas Emissions

The complexity of oil and gas emissions presents a challenge to estimating air emissions as well as overseeing the industry. Examples of this complexity include:

- Different geological formations can produce different types of fluids and gases with different air emissions. For example, coal bed methane wells produce less VOCs than conventional gas wells. VOC and hazardous air pollutants (HAP) content of gas and condensate can also vary from location to location, according to EPA.

- Emissions can differ among wells in the same formation and in the same field. Well production and pressure decline over time. Flow rates of wells next to each other can vary at different times.

- The level of emissions may also vary by season and temperature. For example, colder conditions require heaters, which produce additional emissions.

- Well pressure also impacts the effectiveness of control options. If there is not enough pressure to push the emissions out of the ground, efforts to capture the emissions might be technically infeasible.

Clean Air Act Regulations That Affect Oil and Gas Production

A number of Clean Air Act (CAA) regulations affect the oil and gas industry. These include EPA's newly revised New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP) rules for the oil and gas sector issued in April 2012.[8] The previous NSPS and NESHAP rules focused primarily on larger oil and gas facilities, such as gas processing plants. The revised rules will regulate emissions from several upstream sources and processes not covered by the previous rules, most notably well completions. For well completions, the rules will address new wells that are hydraulically fractured and existing wells as they are refractured. See appendix D for more details on the final revised 2012 NSPS and NESHAP rules. Other existing rules that affect engines used in oil and gas production include the NSPS rule for Stationary Spark Ignition Internal Combustion Engines and the NESHAP rule for Reciprocating Internal Combustion Engines.

With respect to GHGs, EPA issued the Mandatory Reporting of Greenhouse Gases rule[9] ("GHG Reporting Rule") in October 2009 that requires facilities to report their GHG emissions annually to EPA if they meet a certain emission threshold. Subpart W of the GHG Reporting Rule, issued in November 2010, requires oil and natural gas facilities to track and report equipment leaks and vented emissions for calendar year 2011 and submit that information in September 2012. Starting in 2013, reports must be submitted to EPA by March 31 of each year. Subpart W also provides methodologies for calculating emissions from each source type.

[8] 40 CFR Parts 60 and 63.
[9] 40 CFR Part 98.

EPA's Budget and Resources for Oil and Gas Production Activities

EPA's Office of Air and Radiation (OAR)—specifically, the Office of Air Quality Planning and Standards (OAQPS) and Office of Atmospheric Programs (OAP)—and the Office of Research and Development (ORD) are responsible for collecting emissions data and developing methods to measure and/or estimate emissions.

EPA does not maintain precise budget data on its expenditures by industry sector. However, Agency officials were able to estimate the resources devoted to oil and gas production activities in most instances. From fiscal year (FY) 2008 to FY 2011, ORD allocated about $455,000 in extramural funds and about 0.5 full-time equivalents (FTEs) per year to oil and gas production-related research. In that same period, OAQPS allocated an estimated $2.7 million to oil and gas production activities. From FYs 2010 to 2011, OAQPS had about 5 FTEs per year devoted to oil and gas activities such as rulemaking development. OAP staff were not able to break out specific budget figures and FTEs used directly to address oil and gas production emissions, although they did provide higher level budget information for the broader programs that include oil and gas production activities.

Noteworthy Achievements

ORD and OAR Collaborative Research: ORD and OAQPS as well as their EPA regional and state partners conducted field studies to develop new methods to measure fugitive and other emissions from well production pads and evaporative ponds. These studies focused on remote emission assessment techniques that allow for offsite data collection.

Emissions Inventory System: EPA has invested in the new Emissions Inventory System to improve the data collection process and enhance the quality of the NEI. According to OAQPS staff, the system allowed EPA to compile the NEI using fewer resources for the actual collection of data. Therefore, more resources were allocated to ensuring data quality. The Emissions Inventory System helps to ensure consistency by comparing state-reported emissions data to emissions data in the system, as well as comparing state data year to year.

Emission Factors: In response to the OIG's 2006 report[10], EPA has developed the Electronic Reporting Tool (ERT), incorporated electronic reporting requirements into a number of rulemakings, and created an electronic data portal for sources to submit data electronically directly to EPA. EPA has also issued a draft report on "Recommended Procedures for Development of Emissions Factors and Use of the WebFIRE Emissions Factor Database" (December 17, 2010).

Natural Gas STAR: Initiated in 1993, EPA's Natural Gas STAR program is a voluntary program that partners with oil and gas companies to reduce methane

[10] EPA OIG Report No. 06-P-00017, *EPA Can Improve Emissions Factors Development and Management*, March 22, 2006.

emissions through the development of technologies and best practices. The program offers its partners guidance and technical assistance. According to EPA, the program currently has 130 partners and has eliminated a total of 994 billion cubic feet of methane since its inception. In 2010, EPA reported that 73.1 billion cubic feet of methane reductions came from oil and gas production sector partners (78 percent of total methane emission reductions).

Greenhouse Gas Reporting Program: EPA issued the GHG Reporting Rule on October 30, 2009. It requires the annual reporting of greenhouse gas emissions. EPA issued the rule requiring the reporting of GHG emissions from the petroleum and natural gas industry (Subpart W) on November 30, 2010. According to EPA, these data will improve EPA's understanding of the location and magnitude of GHG emissions from oil and gas systems across the United States.

Scope and Methodology

To assess whether EPA has the data needed to make key decisions regarding air emissions from oil and gas production activities, we obtained and reviewed applicable EPA, Office of Management and Budget, and other federal policies, procedures, and guidance documents. We obtained and reviewed EPA, state, and local studies pertaining to oil and gas emissions and associated risks, and interviewed managers and staff from OAQPS, ORD, OAP, the Office of Enforcement and Compliance Assurance, and EPA Regions 3, 6, and 8. We discussed and obtained corroborating data and documents about air emissions from the oil and gas production sector, including legislative and regulatory developments, recent and ongoing research, emission factors, emissions inventories, measurement methods and techniques, quality assurance processes, budget and resource issues, and permitting, compliance, and enforcement (at both the state and federal levels).We interviewed managers and staff from four states that have experienced recent growth in oil and/or gas production:

- Wyoming Department of Environmental Quality
- Texas Commission on Environmental Quality
- Pennsylvania Department of Environmental Protection
- Colorado Department of Public Health and Environment

We also interviewed representatives from the Western Regional Air Partnership and Natural Resources Defense Council due to their expertise on oil and gas production issues.

We reviewed EPA’s oil and gas production sector emission factors, as compiled in AP-42 and Web Factor and Information Retrieval System (WebFIRE). In addition, we analyzed oil and gas production emissions data from the 2008 NEI (Version 1.5), provided by OAQPS staff.

We conducted our work from March 2011 to September 2012 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform our review to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our objectives.

Prior Reports

Prior reports by EPA OIG and the U.S. Government Accountability Office (GAO) applicable to this evaluation included:

- GAO Report No. 11-34: *Federal Oil and Gas Leases: Opportunities Exist to Capture Vented and Flared Natural Gas, Which Would Increase Royalty Payments and Reduce Greenhouse Gases*, October 29, 2010
- GAO Report No. 09-872: *Energy Policy Act of 2005: Greater Clarity Needed to Address Concerns with Categorical Exclusions for Oil and Gas Development under Section 390 of the Act*, September 16, 2009
- EPA OIG Report No. 08-P-0206, *Voluntary Greenhouse Gas Reduction Programs Have Limited Potential*, July 23, 2008
- EPA OIG Report No. 08-P-0020, *Improvements in Air Toxics Emissions Data Needed to Conduct Residual Risk Assessments*, October 31, 2007
- EPA OIG Report No. 07-B-00002, *Assessment of EPA's Projected Pollutant Reductions Resulting from Enforcement Actions and Settlements*, July 24, 2007
- EPA OIG Report No. 06-P-00017, *EPA Can Improve Emissions Factors Development and Management*, March 22, 2006
- EPA OIG Report No. 04-P-00021, *EPA Needs to Improve Tracking of National Petroleum Refinery Compliance Program Progress and Impacts*, June 22, 2004

Chapter 2
Limited Air Emissions Data for Oil and Gas Production Hampers EPA's Ability to Assess Airborne Risks

EPA has limited directly measured air emissions data on criteria and air toxic pollutants for several important oil and gas production processes and sources. This type of data is used to develop emission factors, which EPA and states rely on to estimate air emissions. However, about half of EPA's WebFIRE emission factors for oil and gas production are rated poor, below average, or are unrated. EPA has also developed a nationwide inventory of air emissions, NEI, from large and small stationary sources, and mobile sources for criteria and some air toxic pollutants, but the data in the NEI are also incomplete. EPA acknowledges that better data for several key processes are needed. However, we found that EPA does not have a comprehensive strategy for improving air emissions data for the oil and gas production sector. The Agency has not addressed these issues because it did not anticipate the tremendous growth of the sector and had allocated limited resources to it. Limited data from direct measurements, poor quality emission factors, and incomplete NEI data hamper EPA's ability to assess air quality impacts from oil and gas production activities. With limited data, human health risks are uncertain, states may design incorrect or ineffective emission control strategies, and EPA's decisions about regulating industry may be misinformed.

EPA Has Limited Air Emissions Data for Several Key Oil and Gas Production Processes and Sources

EPA has limited directly measured air emissions data for criteria and air toxic pollutants for several key oil and gas production processes and sources. For example, OAQPS lacked data on well completions and evaporative ponds in conducting analyses for the proposed revised 2011 NSPS and NESHAP rules.[11] Due to the lack of directly measured VOC data, OAQPS staff used GHG inventory estimates of methane emissions to derive estimates of VOC emissions coming from well completions. In addition, EPA stated in the proposed rules that it could not regulate evaporative ponds (fugitive emissions) due to a lack of emissions data. The Agency solicited comments on methods for calculating such emissions. Appendix E provides descriptions of key oil and gas production sources and processes.

EPA Lacks Direct Measurement Methods But Studies Are Being Conducted

EPA has not developed methods for directly measuring criteria and air toxic pollutant emissions from certain oil and gas production sources and processes

[11]EPA issued final regulations in 2012. *See* 40 CFR Parts 60 and 63.

such as well completions. However, the Agency has developed methods for measuring methane, one of the GHGs, from oil and gas sources. ORD staff stated that direct measurement methods are the most accurate measurement techniques. The disadvantages of onsite direct measurement techniques include the need for access to the well production site, the expense of testing, and the potential risk of injury (e.g., needing to climb to the top of a tank to measure emissions). Nonetheless, according to ORD staff, they are in the process of developing direct measurement methods for measuring air emissions from oil and gas production sources for criteria and air toxic pollutants.

Due to the disadvantages of onsite direct measurement methods for some sources, EPA has conducted and continues to conduct studies to develop remote sensing and mobile monitoring methods. These methods do not require onsite measurement. ORD staff said that these methods are likely the only way to directly measure emissions from well completions. They may also be useful for measuring fugitive emissions from evaporative ponds. ORD recently developed a measurement method to measure emissions from well production pads. ORD staff plan to submit the remote measurement method to EPA's Emission Measurement Center in OAQPS for possible inclusion in its list of approved test methods. ORD has also initiated a study of condensate and produced water tanks, and is considering a study in collaboration with EPA Region 3 to understand the impacts of oil and gas emissions in the Marcellus Shale region. While progress continues, more research is needed to develop additional methods for several oil and gas production processes.

EPA Has Allocated Limited Resources to Oil and Gas Production Research and Studies

According to ORD staff, EPA did not previously place a priority on oil and gas production research, but EPA's priority for oil and gas research is rising. Over the last 4 fiscal years, ORD's National Risk Management Research Lab[12] and OAR's OAQPS have averaged less than one full FTE per year to oil and gas production-related studies. From FY 2008 to 2011, ORD allocated about $455,000 total in extramural funds to oil and gas production-related research. OAQPS allocated about $540,000 for measurements and methods development. ORD has relied on research funding from Regional Applied Research Effort grants and funding from other offices, such as OAQPS.

EPA Lacks a Coordinated, Cross-Office Strategy for Improving the Collection of Data

EPA does not have a coordinated, cross-office strategy or national approach to improve the collection of air emissions data for oil and gas production. According to OAP staff, OAR has a GHG data collection strategy in the GHG Reporting

[12] This laboratory is ORD's laboratory for risk management research. Its mission is to advance scientific and engineering solutions to manage current and future environmental risk.

Rule (Subpart W).[13] While Subpart W requires oil and gas production facilities to report GHG data by September 2012, in our view, this is one part of an effort to address GHGs from this industry sector. It is not a coordinated, cross-office strategy for improving the collection of all types of air emissions data for oil and gas production sources commensurate with recent and projected growth in this industry sector.

According to an ORD manager, ORD has made a concerted effort to identify the highest priorities for inventory data development. ORD's Air, Climate, and Energy Research Action Plan includes multiple projects that support the research needs of EPA offices, including those involved with the oil and gas sector. The plan provides information about the need for collaboration with partners. According to EPA, the research plan was developed with considerable input from Agency offices that address oil and gas production issues, but it was developed to guide only ORD's efforts. Further, the plan does not specifically address oil and gas data limitations. While a step in the right direction, the plan is not a cross-office strategy or national approach to improving the collection of air emissions data for oil and gas production sources.

In April 2012, EPA and the Departments of Energy and the Interior signed a Memorandum of Agreement to form a multi-agency working group. It will address the high priority research questions associated with the development of unconventional shale gas and tight oil resources. One component of this effort is developing a cross-agency, formal, multi-year research plan that will, among other things, identify gaps in available data and appropriate activities to address them.

EPA Lacks Data to Develop and Improve Emission Factors Impacting Key Decisions for Many Oil and Gas Processes

Historically, EPA has not received directly measured data, also called source testing data, from state and local agencies to develop and improve its emission factors because states and local agencies were not required to provide the data to EPA. For that reason, EPA has focused on developing the Electronic Reporting Tool (ERT), which provides an electronic format for facilities to send their direct measurement results directly to EPA. OAQPS staff stated that their focus has been on development of the ERT tool and not independently developing new or improving existing emission factors.

EPA needs to develop new WebFIRE emission factors for certain key oil and gas production processes/sources and pollutants that lack them. Many of EPA's existing oil and gas production emission factors are of questionable quality because they are based on limited and/or low quality data. Even so, states and facilities use EPA emission factors to develop emissions inventories and make

[13] 40 CFR §§ 98.230 to 98.238.

key permitting and enforcement decisions. Emission factors are used because they are the least expensive method for estimating emissions. Developing new emission factors and improving existing ones would help ensure that EPA regions and the states have accurate emission estimates to complete these tasks.

EPA Has Not Developed New Emission Factors

Due to lack of state data and EPA's focus on ERT, the Agency has not developed new WebFIRE emission factors for certain oil and gas production processes and sources. For example, we did not identify any emission factors for evaporative ponds. According to a 2009 Department of Energy report, in semiarid regions, hot, dry air moving from a land surface will result in high evaporation rates for small evaporation ponds. We also did not identify emission factors for criteria and air toxic pollutants for produced water tanks, well completions, or pneumatic devices. Table 3 lists the key oil and gas production processes and sources that have and do not have EPA emission factors/models to estimate emissions.

Table 3: Key emission sources with EPA emission factors or models (or EPA-approved models)

Emission sources	Nitrogen oxides	VOC	Carbon monoxide	Fine particulate matter ($PM_{2.5}$) and inhalable coarse particulate matter (PM_{10})	Sulfur oxides	Air toxics	GHGs[a]
Internal combustion engines	Yes	Yes	Yes	Yes	Yes	Yes[b]	Yes
Process heaters	Yes	Yes	Yes	PM_{10} – Yes $PM_{2.5}$ – No	Yes	Yes[b]	Yes
Flares and enclosed combustors	No	Yes	No	No	No	No	No
Dehydrators	No	Yes-Model GRI-GLYCalc	No	No	No	Yes-Model GRI-GLYCalc	
Tanks (condensate, storage, oil, etc.)	Not applicable	Yes-Models E&P TANK GRI-HAPCalc EPA's TANK	Not applicable	Not applicable	Not applicable	Yes-Models E&P TANK GRI-HAPCalc EPA's TANK	Yes-Model E&P TANK
Amine treaters	No	Yes- Model AMINECalc	No	No	Yes	Yes-Model AMINECalc	
Evaporative ponds	Not applicable	No	Not applicable	Not applicable	Not applicable	No	No
Produced water tanks	Not applicable	No[c]	Not applicable	Not applicable	Not applicable	No[c]	Yes
Well completions	Not applicable	No[c]	Not applicable	Not applicable	Not applicable	No[c]	Yes
Pneumatic devices	Not applicable	No[c]	Not applicable	Not applicable	Not applicable	No[c]	Yes

Source: OIG-developed table from AP-42, WebFIRE, and interviews with OAR staff.

[a] Emission factor exists for methane, carbon dioxide, and/or nitrous oxide.
[b] Emission factors exist for at least some air toxics.
[c] OAP staff stated that if a methane emission factor exists for a process and the gas constituents of the well are known, then VOCs and air toxics can be calculated.

We identified 495 existing emission factors for oil and gas production in WebFIRE. Of the 495 emission factors, 75 percent (371) are for internal combustion engines and 22 percent (111) are for process heaters (including steam generators). Except for GHGs, we did not identify any existing emission factors for produced water tanks, well completions, or pneumatic devices. EPA needs to

develop new emission factors for other sources besides internal combustion engines and process heaters.

Many Existing Emission Factors Are of Low or Unknown Quality

Many of EPA's existing WebFIRE oil and gas production emission factors are of questionable quality because they are based on limited and/or low quality data. Each emission factor in WebFIRE receives a ranking of 'A' (Excellent) through 'E' (Poor), or is unrated by OAQPS. A key aspect of the ranking of the emission factors is the amount of data upon which an emission factor is based.[14] An emission factor is ranked higher if it is based on a larger amount of high quality data and is ranked lower if it is based on a smaller amount of lesser quality data. As shown in table 4, about half of EPA's emission factors for oil and gas production in WebFIRE (248 of 495) are rated below average or poor, or are unrated. This means they are based on limited or insufficient data.

Table 4: Ratings for EPA's oil and gas production emission factors

Emission factor rating	No. of emission factors	Percentage of emission factors
A – Excellent	86	17%
B – Good	29	6
C – Average	132	27
D – Below Average	53	11
E – Poor	83	17
U – Unrated	112	23
Total	**495**	**101%[a]**

Source: OIG-developed table from EPA's WebFIRE database.

[a]Total not equal to 100 percent due to rounding.

Although half of the oil and gas production emission factors we reviewed were rated below average or were unrated, this is slightly better than what we reported for all emission factors in the 2006 EPA OIG report, *EPA Can Improve Emissions Factors Management and Development*. In that report, we noted that the percentage of all AP-42 emission factors[15] rated below average or poor was 62 percent.

State agencies and facility owners/operators may use lower ranking emission factors in decision-making when no other data on the source are available. For example, one state agency recommends that the facilities in its state calculate emissions for their permits using 18 different emission factors that are rated below average or lower. Emission factors are the least expensive method of estimating emissions.

[14] EPA uses other criteria in the rating process. For example, EPA also looks at how well the data represents the industry.
[15] The OIG reported on all AP-42 emission factors in its 2006 report, not just oil and gas production emission factors.

EPA Has Developed a Tool to Collect Data, But Gaps Remain

EPA has developed the ERT for criteria and air toxic pollutants, which provides an electronic format for facilities to document source test results. EPA's WebFIRE database will be able to store the data that has been submitted electronically. According to the revised 2012 NSPS and NESHAP rules for the oil and gas sector, the overall quality of the existing and newly developed emission factors will greatly improve by supplementing the pool of emissions test data and by ensuring that the factors are more representative of current industry operational procedures.

Starting in January 2012, facility owners or operators subject to certain EPA regulations, including those of oil and gas operations, are required to submit selected source test data directly to EPA. EPA is developing amendments to existing rules to require similar electronic reporting requirements for rules codified in 40 CFR Parts 60, 63, and 65. It is important to note that the requirement to report data electronically only applies to data collected with a test method supported by the ERT and only if the regulation requires its collection. For example, the final 2012 NSPS and NESHAP rules for the oil and gas sector require electronic reporting of specific source tests. While the ERT may improve EPA's data from some sources, the rules do not require source tests for all processes and sources covered by the rules, such as combustors. Therefore, the results of any source tests performed on combustors are not required to be reported electronically to EPA. Thus, EPA will likely not receive this data and the rule will not contribute to the improvement of emission factors for these sources.

Developing New Emission Factors and Improving Existing Emission Factors Will Lead to Better Information to Make Key Decisions

Developing new emission factors and improving existing ones could significantly enhance the information that EPA and the states have to make key decisions. For example, in the technical support document for Subpart W of the GHG Reporting Rule[16], EPA revised the methane emission factors for well completions and workovers. For unconventional well completions, the emission factor went from 0.02 metric tons/year to 177 metric tons/year (8,849 times greater). For unconventional well workovers, the emission factor increased from 0.05 metric tons/year to 177 metric tons/year (3,539 times greater).[17]

Oil and Gas Production Emissions Data in EPA's NEI Are Incomplete

Emissions data for oil and gas production in EPA's NEI are incomplete, particularly for smaller sources and for air toxics. The Air Emissions Reporting

[16] 40 CFR §§ 98.230 to 98.238.
[17] The 2006 GHG Inventory increase was also due in part to the revision in the liquids unloading emission factor.

Requirements (AERR)[18] rule requires states to report emissions of criteria pollutants and ozone precursors (e.g., VOCs) from a variety of sources to EPA's NEI. These sources include large stationary sources called point sources,[19] small stationary sources called nonpoint sources, and mobile sources. States are not required to report air toxic emissions, although some do voluntarily. Emissions from point sources are reported on a facility-specific basis. Emissions from nonpoint sources can be based on estimates and aggregated by industry sector at the county level. Examples of point sources in the oil and gas sector are gas processing plants and compressor stations. Examples of nonpoint sources include smaller, upstream sources and processes, such as well production pads.

Nonpoint sources are significant sources of emissions in the oil and gas production industry. However, few states submitted data on these sources to EPA for inclusion in the most recent 2008 NEI. While 35 states submitted oil and gas production emissions data for point sources to the 2008 NEI, only 9 submitted emissions data for nonpoint sources.[20] Meanwhile, emissions from these smaller sources accounted for the majority of total oil and gas emissions in the 2008 NEI. For example, nonpoint sources accounted for 98 percent of all oil and gas VOC emissions in the 2008 NEI, while larger point sources accounted for only 2 percent. Due to the cumulatively high emissions from this collection of smaller sources and the limited reporting of emissions from these sources, the NEI likely underestimates actual criteria pollutant emissions from oil and gas production sources.

Data for air toxic emissions in the NEI are also incomplete. Of the 35 states that submitted oil and gas production emissions data to the 2008 EPA NEI, 12 states did not report air toxic data for point sources and 32 states did not report air toxic data for nonpoint sources. Given the lack of air toxic data in the NEI, particularly for nonpoint sources, these emissions are also most likely understated in the NEI. As stated above, the AERR does not require states to report air toxic data to the NEI.

EPA Efforts to Fill Data Gaps for Specific Decision-Making Purposes

EPA has adjusted existing NEI data to fill significant gaps for specific decision-making purposes. For example, in conducting its 2011 regulatory impact assessment for the proposed revised NSPS and NESHAP rules, EPA found that

[18] The AERR replaced the requirements of the Consolidated Emissions Reporting Rule, which was in effect at the time the data for the 2008 NEI were collected. The Consolidated Emission Reporting Rule also required states to report emissions of criteria pollutants and ozone precursors (e.g., VOCs) from both large stationary sources, small stationary sources, and mobile sources to EPA for purposes of developing the NEI.

[19] Point sources are stationary sources that have the potential to emit criteria pollutants, VOCs, and ammonia at levels at or above specific thresholds. Nonpoint sources are stationary sources that do not meet the emission thresholds for point sources.

[20] Some states may report some nonpoint source data emissions as point source data emissions. This is especially true in states that have their own reporting requirements and regulations for oil and gas facilities that are more stringent than EPA's regulations. In these cases, emissions that would otherwise be included in the nonpoint emissions inventory are actually included in the point source inventory.

emissions data for well completions were significantly undercounted in the 2008 NEI. EPA found that the 2008 NEI contained only about 21,000 tons of VOC emissions from well completions. In contrast, EPA estimated as part of its engineering analysis for the 2011 proposed NSPS and NESHAP rulemaking that well completions emit about 510,000 tons of VOCs a year. This amount was nearly 25 times as much as had previously been contained in EPA's 2008 NEI. As a result, EPA added about 480,000 tons of VOC emissions to the 2008 NEI in order to develop a baseline for VOC emissions.

In another example, while conducting a residual risk assessment of facilities covered by the existing NESHAP rules for oil and gas, EPA found that 75 percent of the facilities did not have emissions data for key air toxics, which include benzene, toluene, ethylbenzene, and xylenes, in the NEI. In the absence of these data, EPA developed air toxic estimates by applying certain percentage ratios to facilities' reported VOC emissions. EPA then assigned these surrogate emission estimates to the facilities with missing air toxic data.

In addition, EPA has augmented existing oil and gas data in the NEI for air modeling purposes. Specifically, OAQPS staff incorporated emissions data from the 2006 Western Regional Air Partnership inventory in its most recent modeling platform to support regulatory analyses. OAQPS staff told us that EPA hired a contractor to identify and obtain all available oil and gas emissions data that are not already in the NEI. However, EPA staff said the only data the contractor identified were the Western Regional Air Partnership data.

Multiple Factors Contribute to Oil and Gas Data Gaps in the NEI

The following factors contribute to the oil and gas emissions data gaps in the NEI:

- **EPA has not developed default emission estimates for oil and gas nonpoint sources.** For the 2008 NEI, EPA developed default emission estimates for 76 types of nonpoint sources for selected industry sectors that could be used in the absence of state-reported data. However, the oil and gas production sector was not among those 76 categories. Thus, nonpoint emissions for oil and gas remained "0" in the NEI if states did not submit data. According to OAQPS staff, EPA has not developed a default emission methodology for the oil and gas production sector because the sector was not as large prior to 2008. OAQPS staff also stated that developing such a methodology in time for the 2008 NEI was not feasible because (1) resources had been diverted to the Agency's transition to the Emissions Inventory System for the 2008 NEI, (2) the industry grew significantly during this time, and (3) there was a lack of emission factors data on new exploration methods.

  According to OAQPS staff, EPA has formed a national workgroup of oil and gas sector experts to develop default emissions estimates. The workgroup has written a white paper outlining an approach for creating a national default

method that would allow for variability by basin. According to EPA, OAQPS has allocated $85,000 to develop default emissions estimates from the nonpoint upstream oil and gas sector. This tool will have the capability to estimate 2011 and future year emissions on the county level for criteria pollutants, HAP, ammonia, and GHGs. According to OAQPS staff, states can either accept the default estimates developed by EPA or can submit their own emissions data to the NEI.

- **EPA has not ensured state submission of nonpoint source oil and gas data as required by AERR.** As discussed above, only nine states submitted emissions data for nonpoint oil and gas sources. OAQPS staff stated that they have not reviewed states' submissions from a compliance standpoint. Instead, OAQPS staff tries to influence states to submit data so that the emissions inventory is complete.

- **Some states are not collecting emissions data from smaller (i.e., nonpoint) oil and gas production facilities due to a lack of permitting requirements.** According to OAQPS staff, some states do not have data to submit to the NEI because they do not have regulations in place to require small facilities to be permitted. In states where these smaller sources are unpermitted and/or unregulated, states are not likely to obtain emissions data from these sources to submit to the NEI.

- **Developing a robust inventory that would cover these numerous small, unregulated sources is resource intensive**. This is particularly true for emission sources and processes that do not have established emission factors or other estimation techniques that the states can use to estimate emissions.

Incomplete NEI Data Affect EPA's Ability to Assess Risks and Air Quality Impacts from Oil and Gas Production Emissions

EPA uses the NEI to assess risks from air toxics through its National Air Toxics Assessment (NATA) and to model air quality in support of regulatory impact assessments for National Ambient Air Quality Standards (NAAQS)[21] rules and revisions. Without complete emissions data, EPA cannot accurately assess risks and air quality impacts associated with oil and gas production emissions.

The NATA provides broad estimates of cancer risk and other serious health effects resulting from air toxics. Modeling conducted for the NATA relies primarily on air toxic emissions data in the NEI. If air toxic emissions data for oil and gas activities are not included in the NEI, potential risks from these emissions will not be identified in the NATA.

[21] NAAQS establish maximum permissible concentrations of criteria pollutants in the air. The ozone NAAQS is of concern for the oil and gas production industry because oil and gas production activities emit significant amounts of VOCs, which contribute to the formation of ozone.

In order to demonstrate progress towards NAAQS attainment, or show maintenance of the NAAQS once attained, states need to conduct air quality modeling pertaining to the NAAQS. This is particularly true for ozone, as oil and gas production activities emit significant amounts of VOCs and NOx that contribute to ozone formation. For example, a staff person responsible for ozone modeling from a state air control agency said his agency has to rely on NEI data from other states in conducting ozone modeling to represent the transport of ozone-forming pollutants. Incomplete emissions data, such as the gaps described above for nonpoint sources, will lead to modeling results that underestimate the air quality impacts from oil and gas production activities.

Limited Data Could Affect Decision-Making Impacting Human Health and the Environment

Directly measured data, including source test data, provide EPA with the most accurate information to develop new emission factors and improve existing emission factors. Limited data and limited emission factors impact the development of SIPs. The CAA requires states that fail to meet NAAQS to develop SIPs that describe how the state will attain and maintain the NAAQS. EPA then evaluates SIPs to determine whether states have proper control strategies in place to achieve attainment. To properly develop and evaluate SIPs, EPA and states need emissions data and emission estimates to understand air emissions from the oil and gas production sector. In areas with high oil and gas production activity, emissions from this industry may significantly affect ozone levels and attainment of the ozone NAAQS. Without adequate data and emission estimates for oil and gas emissions, states may rely on industry sectors other than oil and gas production to obtain emission reductions. EPA may then approve SIPs that place an inequitable burden on industries other than oil and gas production. Limited data could affect decision-making impacting human health and the environment.

Conclusions

Recent and projected growth in the oil and gas production sector has underscored the need for EPA to gain a better understanding of emissions and potential risks from this industry sector. Harmful pollutants emitted from this industry include air toxics such as benzene, toluene, ethylbenzene, and xylene; criteria pollutants and ozone precursors such as NOx and VOCs; and greenhouse gases such as methane. These pollutants can result in serious health impacts such as cancer, respiratory disease, aggravation of respiratory illnesses, and premature death. However, EPA has limited directly-measured air emissions data on criteria and toxic air pollutants for several important oil and gas production processes. This limited data, coupled with poor quality and insufficient emission factors and incomplete NEI data, hamper EPA’s ability to assess air quality impacts from selected oil and gas production activities.

EPA is currently engaging in efforts to collect additional emissions data, but these studies have been limited in scope and future funding is uncertain. The Agency does not have a comprehensive, cross-office strategy for prioritizing air emissions data needs and developing action plans to address those needs. In our view, a comprehensive strategy would help EPA better manage the collection of needed data on air emissions from the oil and gas production sector.

Recommendations

We recommend that the Assistant Administrator for Air and Radiation and the Assistant Administrator for Research and Development:

1. Develop and implement a joint comprehensive cross-office strategy for improving data for the oil and gas production sector. The strategy should:

    a. Identify gaps and limitations in (1) existing oil and gas air emissions data, (2) emission factors, and (3) measurement techniques, including direct and remote measurement methods.

    b. Prioritize what data limitations are most significant and develop specific action plans for how EPA will address these gaps and limitations.

We recommend that the Assistant Administrator for Air and Radiation:

2. Prioritize and update existing oil and gas production emission factors that are in greatest need of improvement and develop emission factors for key oil and gas production processes that do not currently have emission factors.

3. Ensure that the data in NEI are complete by:

    a. Monitoring the states' submission of oil and gas emissions data for point sources and nonpoint sources pursuant to the requirements of the AERR and assisting states in complying with the rule.

    b. Completing the development of a method for calculating default nonpoint emission estimates to enter into the NEI when states do not submit nonpoint data for oil and gas production.

    c. Developing default calculation guidance for states to use to estimate oil and gas nonpoint source emissions.

Agency Comments and OIG Evaluation

The Agency concurred with our recommendations 1, 2, and 3b to develop a comprehensive strategy, prioritize and develop emission factors, and develop a default method for calculating nonpoint emissions, respectively. The Agency did not provide milestone dates or identify the responsible party for implementing the planned corrective actions for these recommendations and, as such, they are considered unresolved pending receipt of this information. The OIG and the Agency have not agreed on a course of action to remedy and/or address recommendations 3a and 3c. These recommendations are unresolved pending the Agency's final report response. Appendix A contains the Agency's response to our draft report. Appendix B contains our detailed evaluation of that response.

Status of Recommendations and Potential Monetary Benefits

RECOMMENDATIONS						POTENTIAL MONETARY BENEFITS (in $000s)	
Rec. No.	Page No.	Subject	Status[1]	Action Official	Planned Completion Date	Claimed Amount	Agreed-To Amount
1	21	Develop and implement a joint comprehensive cross-office strategy for improving data for the oil and gas production sector. The strategy should:		Assistant Administrator for Air and Radiation and Assistant Administrator for Research and Development			
		a. Identify gaps and limitations in (1) existing oil and gas air emissions data, (2) emission factors, and (3) measurement techniques, including direct and remote measurement methods.	U				
		b. Prioritize what data limitations are most significant and develop specific action plans for how EPA will address these gaps and limitations.	U				
2	21	Prioritize and update existing oil and gas production emission factors that are in greatest need of improvement and develop new emission factors for key oil and gas production processes that do not currently have emission factors.	U	Assistant Administrator for Air and Radiation			
3	21	Ensure that the data in NEI are complete by:		Assistant Administrator for Air and Radiation			
		a. Monitoring the states' submission of oil and gas emissions data for point sources and nonpoint sources pursuant to the requirements of the AERR and assisting states in complying with the rule.	U				
		b. Completing the development of a method for calculating default nonpoint emission estimates to enter into the NEI when states do not submit nonpoint data for oil and gas production.	U				
		c. Developing default calculation guidance for states to use to estimate oil and gas nonpoint source emissions.	U				

[1] O = recommendation is open with agreed-to corrective actions pending
C = recommendation is closed with all agreed-to actions completed
U = recommendation is unresolved with resolution efforts in progress

Appendix A

Agency Comments on Draft Report

November 16, 2012

MEMORANDUM

SUBJECT: Response to Draft Report, *EPA Needs to Improve Air Emissions Data for the Oil and Natural Gas Production Sector,* Project No. OPE-FY11-0010

FROM: Gina McCarthy
Assistant Administrator
Office of Air and Radiation (OAR)

Lek G. Kadeli
Deputy Assistant Administrator
Office of Research and Development (ORD)

TO: Carolyn Copper
Assistant Inspector General for Program Evaluation
Office of Inspector General (OIG)

Thank you for the opportunity to comment on the OIG draft report, *EPA Needs to Improve Air Emissions Data for the Oil and Natural Gas Production Sector,* Project No. OPE-FY11-0010, dated September 26, 2012. This review was initiated to determine whether OAR and ORD could improve air emissions data necessary for making key decisions associated with oil and natural gas production processes, including the need for regulations, and enforcement and permitting decisions.

We appreciate the OIG's efforts to gain a thorough understanding of the complexity of the oil and natural gas production sector and the many emission sources and pollutants involved. The OIG review makes several recommendations regarding ways in which OAR and ORD can improve the EPA's body of knowledge on air emissions from this sector. These recommendations, along with our responses, are presented below. Additional comments pertaining to the draft report text are attached in a separate document.

Recommendation 1: *We recommend that the Assistant Administrator for Air and Radiation and the Assistant Administrator for Research and Development:*

1. Develop and implement a joint comprehensive cross-office strategy for improving data for the oil and gas production sector. The strategy should:

a. Identify gaps and limitations in

(1) existing oil and gas air emissions data;

(2) emission factors; and

(3) measurement techniques, including direct and remote measurement methods.

b. Prioritize what data limitations are most significant and develop specific action plans for how EPA will address these gaps and limitations.

Response: We concur with this recommendation and will take the necessary steps to develop a cross-office strategy. Implementing such a strategy will be contingent upon the availability of future resources.

We have identified emissions information for oil and natural gas production as a critical need and, as a result, have several ongoing activities that informally address the key OIG recommendations for a data improvement strategy. For example, OAR, ORD, and several Regional Offices have been working together over the past few years to develop methods and collect data on emissions from oil and natural gas production operations. In addition, EPA's Greenhouse Gas (GHG) Reporting Program was developed in coordination with offices across EPA and will provide comprehensive GHG emissions data for oil and natural gas systems across the U.S. Further, EPA is partnering with other federal agencies, specifically the Department of Energy and the Department of Interior, under a 2013 initiative focusing on unconventional oil and natural gas development. This collaborative effort is planned to provide emissions, exposure and effects information related to the growing use of hydraulic fracturing to increase domestic yields of natural gas and, more recently, oil. We can use these efforts as the basis for a formal, written cross-office strategy.

With regard to a formal cross-office strategy, ORD and OAR will build on work already under way or completed to develop and implement a strategy for improving data. The offices will establish a dedicated cross-office team to:

1) describe in detail gaps and limitations identified in ongoing agency research planning activities;
2) leverage existing data sources;
3) prioritize the data limitations; and
4) propose actions to address data gaps and limitations, beginning with those considered as highest priority.

Examples of some areas for which we have already identified a need for new or improved emissions information include:

1) liquid unloading of gas wells (to be updated in the 2013 U.S. GHG Inventory);
2) hydraulically fractured oil wells;
3) hybrid (oil and natural gas) wells; and
4) evaporation ponds and pits.

In addition to our own efforts, we are following work being done by a number of outside organizations and entities to identify and collect data that will be useful in better characterizing emissions and will further inform our own studies in this sector. These entities include regional planning organizations, states, industry, environmental groups and academic institutions. For example, we are tracking studies being carried out by the Central Regional Air Planning Association (CENRAP), the Western Regional Air Partnership (WRAP), and several states that may provide potentially valuable data on this sector.

See Appendix B, Note 1, for OIG Response

Recommendation 2: *We recommend that the Assistant Administrator for Air and Radiation:*

2. Prioritize and update existing oil and gas production emission factors that are in greatest need of improvement and develop emission factors for key oil and gas production processes that do not currently have emission factors.

Response: We agree that emission factors should be reviewed for oil and natural gas production processes and revised as appropriate. We are developing an e-reporting program to expedite the development of emission factors for all industrial source categories. We have made substantial progress and have begun incorporating into our regulations requirements that affected sources submit certain data to us electronically. This includes a requirement to report electronically the results of emission tests when they are conducted on certain emission points covered in the recently promulgated oil and natural gas rules.

We recognize the recent interest and new data available (with more data coming) on several key sources in the natural gas sector, particularly natural gas production. The *Inventory of U.S. Greenhouse Gas Emissions and Sinks* annual development process results in updates to emissions factors on an ongoing basis and we will continue to improve our estimates as new data become available.

See Appendix B, Note 2, for OIG Response

Recommendation 3: *We recommend that the Assistant Administrator for Air and Radiation:*

3. Ensure that the data in National Emissions Inventory (NEI) is complete by:

- *a. ensuring that states submit point source and nonpoint source data pursuant to the Air Emissions Reporting Requirements (AERR) rule;*
- *b. completing the development of a method for calculating default nonpoint emission estimates to enter into the NEI when states do not submit nonpoint data for oil and gas production; and*
- *c. developing default calculation guidance for states to use to estimate oil and gas nonpoint source emissions.*

Response (3a): We concur that having a complete NEI is in the best interest of the agency and the public; however, we are concerned that this recommendation (as worded) suggests that states are not complying with the AERR rule reporting requirements. Our experience is that states comply with the AERR rule and send emission data to EPA when it is available to them. Data from the oil and gas sector is becoming increasingly available, and we expect the states will submit more data to us. Limited state resources and the lack of data availability have contributed to past data gaps. However, the emissions tool described in our response to Recommendation 3b below will largely resolve emissions data gaps for this sector. Changing the word “ensure” in this recommendation to “encourage and assist” would greatly improve this recommendation.

See Appendix B, Note 3, for OIG Response

Response (3b): We concur and continue to pursue the development of a tool for calculating nonpoint emissions for oil and natural gas production. We intend to have a draft tool available during early 2013 for estimation of emissions in the 2011 NEI. We will continue to enhance the tool, as resources allow, for future NEI versions. Annual oil and natural gas activity updates to the tool are possible and would require purchase of an industry database for $30K per year. Additional improvements require additional resources.

See Appendix B, Note 4, for OIG Response

Response (3c): We agree that states need more information on estimating emissions from this sector, but we disagree that a "guidance document" will have additional benefit over the tool described in our response to recommendation 3b. Producing a separate guidance document will create an additional resource burden on EPA to keep the tool and guidance document in sync. These resources can be better used updating the tool. If out of sync, two separate sources of disparate information will add confusion, not clarity. Therefore, we believe that the tool described in our response to Recommendation 3b and the associated documentation are sufficient for meeting the needs of this recommendation. This recommendation could be improved by acknowledging that the tool with appropriate documentation can effectively serve as sufficient guidance.

See Appendix B, Note 5, for OIG Response

Again, we appreciate the efforts undertaken by the OIG to conduct a thorough review and to provide recommendations for improvement of the EPA's information on air emissions from the oil and natural gas production sector. Please feel free to contact us with any questions.

Attachment

Appendix B

OIG Evaluation of Agency Comments

We appreciate the Agency's comments and its recognition of our efforts to gain a thorough understanding of the complexity of the oil and natural gas production sector. Our comments concerning the draft report recommendations are below. We also received a number of technical comments from the Agency and made changes to the final report as appropriate.

Note 1- Response to Recommendation 1:

The Agency concurred with our recommendation to develop and implement a joint comprehensive cross-office strategy for improving data for the oil and gas production sector. However, it stated that such implementation would be contingent upon the availability of future resources. We understand that resources are limited, but our report reflects the need for the Agency to make the oil and gas production sector a priority. Indeed, the Agency states that it has identified emissions information for this industry as a "critical need" and has several efforts underway to informally address our recommendations. These efforts include a cross-office work group on developing methods to measure emissions, the Greenhouse Gas Reporting Program, and interagency collaboration on unconventional oil and natural gas development. The Agency states that it commits to establishing a cross-office team to undertake tasks that will build the foundation for a comprehensive strategy. We agree with these planned actions and recommend that the Agency provide the timeframes for completing these tasks, as well as the party/office responsible for the corresponding recommendations, in its response to the OIG final report. We consider this recommendation unresolved pending receipt of this information.

Note 2 – Response to Recommendation 2:

EPA agreed that emission factors should be reviewed for oil and natural gas production processes and revised as appropriate. The Agency clarified in the exit conference that it concurred with recommendation 2. In our view, the recent and projected growth in this industry sector establishes the need to prioritize emissions factor improvements for this sector over other stable or dwindling industry sectors. Additionally, the Agency discusses the development of an e-reporting program to support emission factor development. As stated in the OIG draft report, the requirement to report data electronically only applies to data collected with a test method supported by the ERT and only if the regulation requires its collection. Therefore, certain sources that may need new or updated emission factors are not currently addressed by the ERT. In the Agency's final response, it will need to provide the estimated completion dates and the responsible party/office. We consider this recommendation unresolved pending receipt of this information.

Note 3 – Response to Recommendation 3a:

The Agency disagreed with the language the OIG uses in recommendation 3a, "Ensuring that states submit point source and nonpoint source data pursuant to the AERR." As stated in the OIG draft report, only nine states submitted emissions data for nonpoint oil and gas sources. We do

not agree with the Agency's recommendation to change the word "ensuring" to "encourage and assist." We believe that the Agency should monitor states' submissions of the data pursuant to the AERR and assist states in complying with the rule. We revised this recommendation accordingly. The Agency should further discuss how they will use the tool described in their response to recommendation 3b to help states submit the required data. We consider this recommendation unresolved.

Note 4: Response to Recommendation 3b:

The Agency concurred with recommendation 3b and provided details of the corrective actions it has ongoing and planned. EPA is developing a method for calculating default nonpoint emission estimates for the NEI and intends to have a draft tool ready in early 2013. Specifically, EPA noted that it plans to have a draft tool available during 2013 for estimation of emissions in the 2011 NEI, and that it will continue to enhance the tool, as resources allow, for future NEI versions. We accept the Agency's planned corrective actions in response to this recommendation. In the Agency's final response, the Agency will need to provide the OIG with estimated completion dates and the responsible party/office for its planned actions. We consider this recommendation unresolved pending receipt of this information.

Note 5: Response to Recommendation 3c:

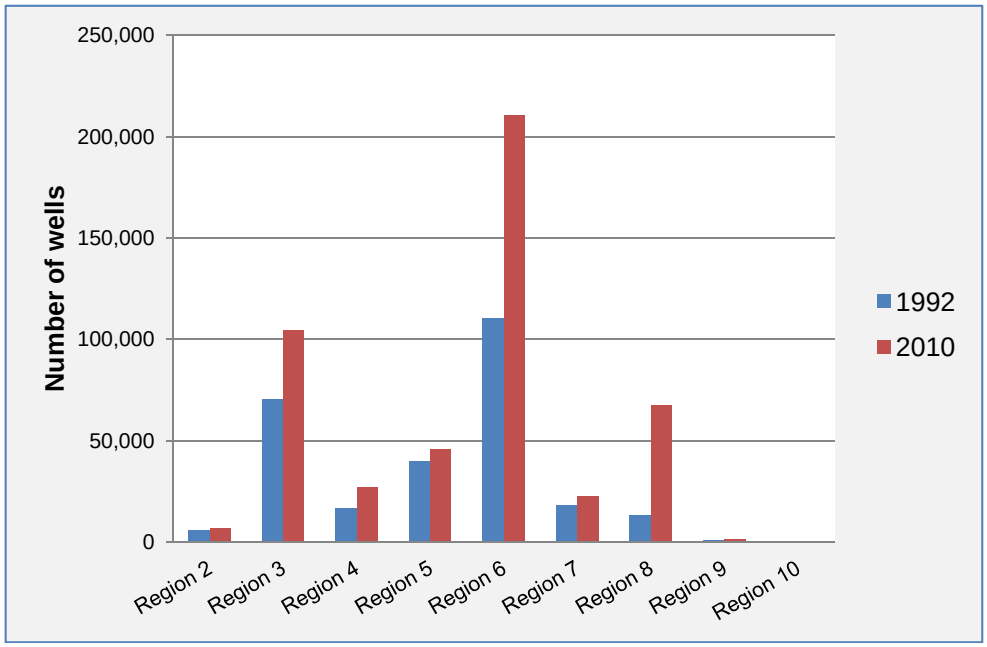
The Agency disagrees that states need a separate guidance document aside from the tool and associated documents from recommendation 3b. In our view, it is pivotal that state users have the guidance needed to implement the tool created in response to recommendation 3b. When we review the Agency's final response for recommendation 3b, we will assess whether the associated documentation planned for the tool described in the Agency's response to recommendation 3b meets the intent of recommendation 3c. We consider this recommendation unresolved.

Growth in Oil and Gas Production Industry

Natural gas production has increased greatly over the past two decades. Much of this growth is due to recent development of natural gas from shale formations.

The growth in natural gas production has been most pronounced in areas of the United States covered by EPA Regions 3, 6, and 8. Region 3 includes the recently developed high-growth area of the Marcellus Shale. Region 6 encompasses numerous high-producing areas in Texas, Louisiana, Oklahoma, and New Mexico, including the Barnett Shale and Haynesville Shale. High-producing areas covered by Region 8 include the Uinta Basin in Utah and the Denver-Julesberg Basin in Colorado. Figure C-1 shows the number of producing gas wells in 1992 and 2010 by EPA region. As shown, the number of wells increased in all regions, with the largest increases in Regions 3, 6, and 8.

Figure C-1: Number of producing natural gas wells by EPA Region, 1992–2010

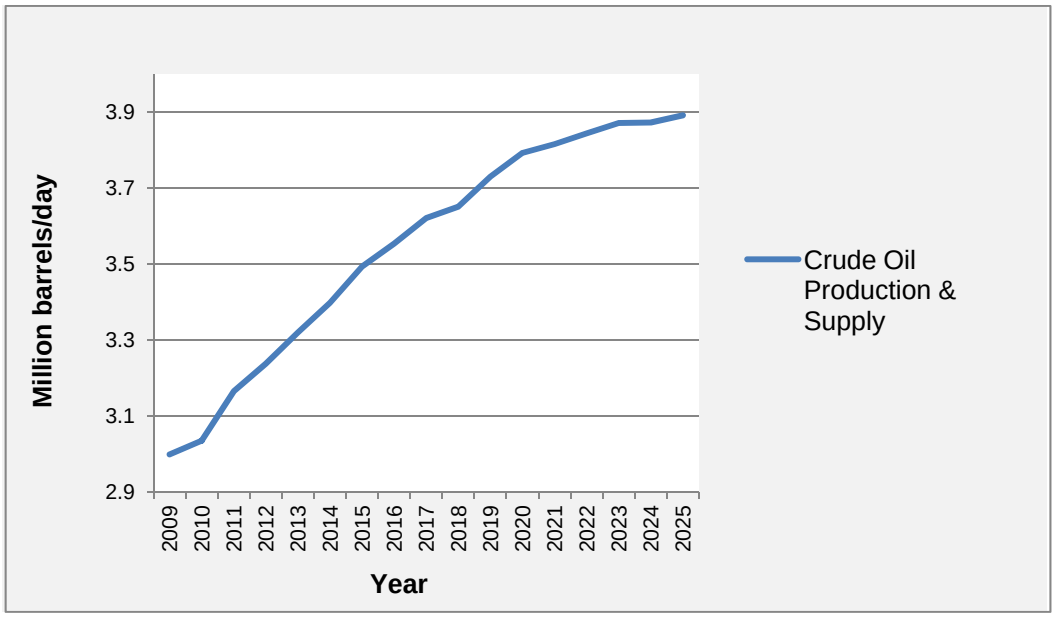


Source: OIG-developed graph based on data from the EIA.

Note: The states covered by each EPA region are as follows: Region 2: New Jersey and New York; Region 3: Delaware, Washington DC, Maryland, Pennsylvania, Virginia, and West Virginia; Region 4: Alabama, Georgia, Florida, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee; Region 5: Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin; Region 6: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas; Region 7: Iowa, Kansas, Missouri, and Nebraska; Region 8: Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming; Region 9: Arizona, California, Hawaii, and Nevada; Region 10: Alaska, Idaho, Oregon, and Washington. There are no gas-producing states in Region 1, which includes Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island, and Vermont.

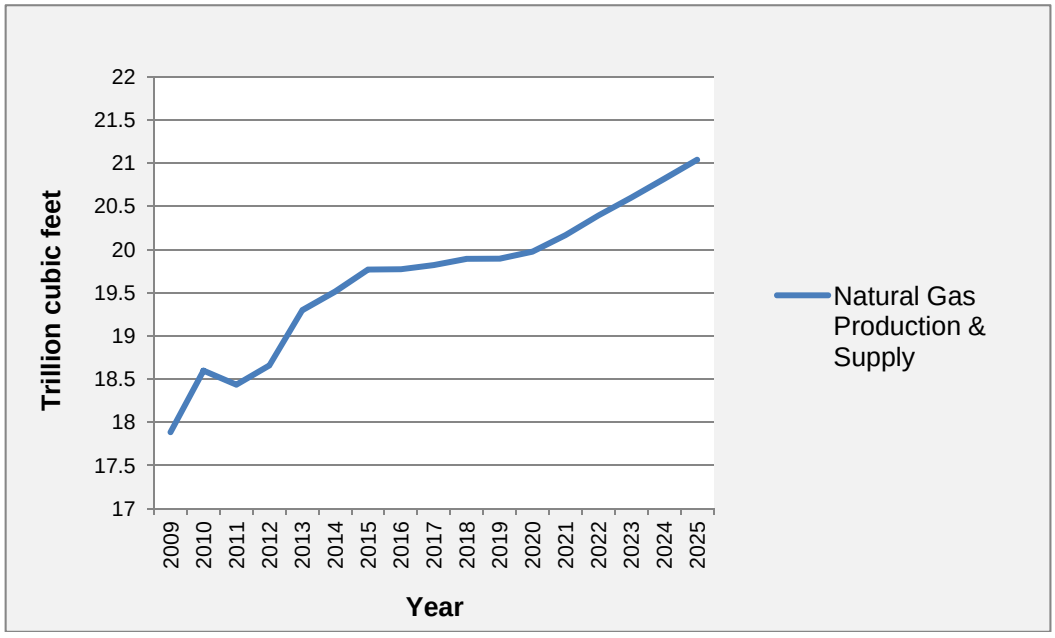
EIA projects that production of both natural gas and crude oil will increase steadily in the future. Figure C-2 shows the projected growth for crude oil production while Figure C-3 shows the projected growth in natural gas production from 2009 to 2025.

Figure C-2: Estimated increase in crude oil production and supply, 2009–2025



Source: OIG-developed graph based on EIA data.

Figure C-3: Estimated increase in gas production and supply, 2009–2025



Source: OIG-developed graph based on EIA data.

Final Revised 2012 NSPS and NESHAP Rules

On April 17, 2012, EPA issued revisions to the existing NSPS and NESHAPs rules for the oil and gas industry. EPA's review and revision of the existing rules were conducted in response to a lawsuit filed against the Agency for failing to meet certain provisions of the CAA that require periodic review of NSPS and NESHAP rules. The new revisions will require emission controls and reductions for several types of oil and gas sources and processes that are not currently controlled by the existing rules. These include the following:

NSPS Revisions

- *Well Completions at New Hydraulically Fractured Gas Wells (VOC reductions)*: The new rules include a two-phased approach for controlling VOCs from these completions:

    - During *Phase 1* (before January 1, 2015), operators must reduce VOC emissions by (1) flaring using a combustion device, or (2) capturing the gas using green completions with a combustion device.
    - During *Phase 2* (starting January 1, 2015), operators are required to conduct green completions at all new hydraulically fracked wells, except for new exploratory and delineation wells, and hydraulically fractured low-pressure wells. For those wells, combustion of the gas is required, unless combustion would cause a safety hazard or is prohibited by state or local regulation.

- *Well Completions at Refractured Gas Wells (VOC reductions)*: Operators may reduce emissions through flaring until January 15, 2015. After that date, they must use green completions.

- *Pneumatic Devices (VOC reductions)*: For pneumatic devices at the well site and at gathering and boosting stations, the rule sets a gas bleed limit of 6 standard cubic feet per hour.

- *Centrifugal Compressors (VOC reductions)*: The new revised rule requires a 95 percent reduction in VOC emissions from compressors with wet seal systems, which can be accomplished through flaring or by routing captured gas back to a compressor suction or fuel system.

- *Reciprocating Compressors (VOC reductions)*: The new revised rule requires the replacement of the rod packing (1) after every 26,000 hours of operation, or (2) every 36 months.

- *Storage Vessels (VOC reductions*): New storage tanks with VOC emissions of 6 tons a year or more must reduce VOC emissions by at least 95 percent, which will generally be accomplished by routing emissions to a combustion device.

- *Leak Detection and Repair at Gas Processing Plants (VOC reductions)*: The new revised rule includes strengthened leak detection and repair at processing plants.

- *Sweetening Units at Gas Processing Plants (SO_2 reductions)*: Sweetening units with a sulfur production rate of at least five long tons per day are required to reduce SO_2 emissions by 99.9 percent.

NESHAP Revisions

- *Glycol Dehydrators (HAP reductions)*: Emissions limits for benzene, toluene, ethylbenzene, and xylene will apply to existing and new smaller dehydrators.

The NSPS revisions will generally apply only to new sources in the industry, while the NESHAP revisions will apply to all new and existing sources that meet the emissions thresholds for major sources of Hazardous Air Pollutant emissions.[22] EPA estimates that the new revised NSPS and NESHAP rules will result in reductions of 190,000 tons of VOCs, 12,000 tons of Hazardous Air Pollutants, and 1 million tons per year of methane.

[22] "Major sources" are sources that emit or have the potential to emit 10 tons per year of a single HAP, or 25 tons per year or more of any combination of Hazardous Air Pollutants.

Appendix E

Descriptions of Equipment and Processes for Oil and Gas Production

Equipment or process	Description of equipment or process
Compressor	Any machine that raises the pressure of gas or carbon dioxide by drawing in low pressure gas or carbon dioxide and discharging significantly higher pressure gas or carbon dioxide.
Condensate	Hydrocarbon and other liquids, including both water and hydrocarbon liquids, separated from gas that condense due to changes in the temperature, pressure, or both, and remain liquid at storage conditions.
Dehydrator	A device in which a liquid absorbent (including desiccant, ethylene glycol, diethylene glycol, or triethylene glycol) directly contacts a gas stream to absorb water vapor.
Glycol dehydration unit	A device in which a liquid glycol absorbent directly contacts a gas stream and absorbs water in a contact tower or absorption column (absorber).
Horizontal drilling	The process of drilling and completing, for production, a well that begins as a vertical or inclined linear bore which extends from the surface to a subsurface location just above the target oil or gas reservoir. The well then bears off on an arc to intersect the reservoir at the "entry point," and, thereafter, continues at a near-horizontal attitude tangent to the arc, to substantially or entirely remain within the reservoir until the desired bottom hole location is reached.
Hydraulic fracturing (also referred to as “fracking”)	The process of directing pressurized fluids containing any combination of water, proppant, and any added chemicals to penetrate tight formations, such as shale or coal formations, that subsequently require high rate, extended flowback to expel fracture fluids and solids during completions.
Internal combustion	The combustion of a fuel that occurs with an oxidizer (usually air) in a combustion chamber. In an internal combustion engine, the expansion of the high-temperature and high-pressure gases produced by combustion applies direct force to a component of the engine, such as pistons, turbine blades, or a nozzle. This force moves the component over a distance, generating useful mechanical energy. Internal combustion equipment may include gasoline and diesel industrial engines, natural gas-fired reciprocating engines, and gas turbines.
Pneumatic Devices	*High-bleed pneumatic devices* – Automated, continuous bleed flow control devices powered by pressurized gas and used for maintaining a process condition such as liquid level, pressure, and temperature. Part of the gas power stream that is regulated by the process condition flows to a valve actuator controller where it vents continuously (bleeds) to the atmosphere at a rate in excess of 6 standard cubic feet per hour. *Intermittent bleed pneumatic devices* – Automated flow control devices powered by pressurized gas and used for maintaining a process condition such as liquid level, pressure, and temperature. These are snap-acting or throttling devices that discharge the full volume of the actuator intermittently when control action is necessary, but does not bleed continuously. *Low-bleed pneumatic devices* – Automated flow control devices powered by pressurized gas and used for maintaining a process condition such as liquid level, pressure, and temperature. Part of the gas power stream that is regulated by the process condition flows to a valve actuator controller

	where it vents continuously (bleeds) to the atmosphere at a rate equal to or less than 6 standard cubic feet per hour.
Produced water	Water that is extracted from the earth from an oil or gas production well, or that is separated from crude oil, condensate, or gas after extraction.
Produced water evaporative ponds	Ponds usually with a large surface area that contain produced water, which is allowed to evaporate from the surface.
Production casing	The deepest section of casing in a well. Well casing consists of a series of metal tubes installed in a freshly-drilled hole. Casing strengthens the sides of the well hole, ensures that no oil or gas seeps out of the well hole as it is brought to the surface, and keeps other fluids or gases from seeping into the formation through the well. Production casing is installed last. This is the casing that provides a conduit from the surface of the well to the petroleum-producing formation.
Production well	A hole drilled in the earth from which crude oil, condensate, or field gas is extracted.
Pump	A device used to raise pressure, drive, or increase flow of liquid streams in closed or open conduits.
Separator	A vessel in which streams of liquid of multiple phases are gravity-separated into individual streams of single phase.
Sour gas	Gas that contains significant concentrations of hydrogen sulfide and/or carbon dioxide that exceed the concentrations specified for commercially saleable natural gas delivered from transmission and distribution pipelines.
Sweet gas	Gas with low concentrations of hydrogen sulfide and/or carbon dioxide that does not require (or has already had) acid gas treatment to meet pipeline corrosion-prevention specifications for transmission and distribution.
Well completions	The process that allows for the flow of petroleum or natural gas from newly-drilled wells to expel drilling and reservoir fluids and test the reservoir flow characteristics. These steps may vent produced gas to the atmosphere via an open pit or tank. Well completion also involves connecting the well bore to the reservoir, which may include treating the formation or installing tubing, packer(s), or lifting equipment. These steps do not significantly vent natural gas to the atmosphere. This process may also include high-rate flowback of injected gas, water, oil, and proppant used to fracture or re-fracture and prop open new fractures in existing lower permeable gas reservoirs. These steps may vent large quantities of produced gas to the atmosphere.

Sources: OIG developed table using GHG Technical Support Document; 1993 Department of Energy Information Administration report entitled *Drilling Sideways – A Review of Horizontal Well Technology and its Domestic Application;* 2009 Argonne National Laboratory Study entitled *Produced Water Volumes and Management Practices in the United States;* final revised NSPS and NESHAP rules for the oil and gas industry issued April 2012; and NaturalGas.org (production casing definition).

Appendix F

Distribution

Office of the Administrator
Assistant Administrator for Air and Radiation
Assistant Administrator for Research and Development
Agency Follow-Up Official (the CFO)
Agency Follow-Up Coordinator
General Counsel
Associate Administrator for Congressional and Intergovernmental Relations
Associate Administrator for External Affairs and Environmental Education
Audit Follow-Up Coordinator, Office of Air and Radiation
Audit Follow-Up Coordinator, Office of Research and Development