U.S. Caps Emissions in Drilling for Fuel

New federal air pollution standards are the first covering hydraulic fracturing, or fracking, in places like Susquehanna County, Pa.
By JOHN M. BRODER
Published: April 18, 2012

EPA To Regulate Air Emissions from Hydraulic Fracturing As Industry Comes Under Scrutiny
By Adam Otrfod
May 29, 2012

The Future of Fracking: New Rules Target Air Emissions for Cleaner Natural Gas Production
By Bob Weinhold
Outline

Completions
Flowback
Emissions
Regulations

Aerial photo of a gas well site. © iStockphoto / Edward Todd.
What is a Completion?

To perform activities in the final stages of well construction to prepare a well for production. The well is completed once zones of interest have been identified.

Source: Schlumberger Oil Field Glossary - http://www.glossary.oilfield.slb.com/
What is a Completion?

A generic term used to describe the assembly of downhole tubulars and equipment required to enable safe and efficient production from an oil or gas well. The point at which the completion process begins may depend on the type and design of well. However, there are many options applied or actions performed during the construction phase of a well that have significant impact on the productivity of the well.

Source: Schlumberger Oil Field Glossary - http://www.glossary.oilfield.slb.com/
What is a Completion?

CONVENTIONAL PERFORATED COMPLETION

Open Hole Completion

Sand Exclusion Completion

DRAINHOLE COMPLETION

Multiple Zone Completion
Emissions During a Completion

Inventory of U.S. Greenhouse Gas Emissions and Sinks:
1990 – 2011

Emissions from Completions Grouped into Three Categories:

- Gas Well Completions without Hydraulic Fracturing
- Gas Well Completions with Hydraulic Fracturing
- Oil Well Completion Venting
Completions without Hydraulic Fracturing

733 scf methane/completion
(assuming 98% control from flaring)

Methane Emissions from the Natural Gas Industry. EPA/GRI (1996)
Completions with Hydraulic Fracturing

Measurements of methane emissions at natural gas production sites in the United States


Methane and the greenhouse-gas footprint of natural gas from shale formations
A letter

Robert W. Howarth, Renee Santoro, Anthony Ingraffea

Emissions from Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements

report by:
Al Armendariz, Ph.D.
Department of Environmental and Civil Engineering
Southern Methodist University
P.O. Box 750340
Dallas, Texas, 75275-0340

Green Completions
Lessons Learned from Natural Gas STAR
Producers Technology Transfer Workshop
ExxonMobil Production Company, American Petroleum Institute and EPA Natural Gas STAR Program
September 21, 2004

Characterizing Pivotal Sources of Methane Emissions from Natural Gas Production
Summary and Analysis of API and ANGA Survey Responses

Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use

The world’s leading sustainability consultancy
Completion Definition

40 CFR 60, subpart OOOO

*Well completion* means the process that allows for the **flowback** of petroleum or natural gas from newly drilled wells to expel drilling and reservoir fluids and tests the reservoir flow characteristics, which may vent produced hydrocarbons to the atmosphere via an open pit or tank.
What is Flowback?

Flowback: The process of allowing fluids to flow from the well following a treatment, either in preparation for a subsequent phase of treatment or in preparation for cleanup and returning the well to production.

Source: Schlumberger Oil Field Glossary - http://www.glossary.oilfield.slb.com/
What is Flowback?

The flowback period begins when material introduced into the well during the treatment returns to the surface immediately following hydraulic fracturing or refracturing.

The flowback period ends with either well shut in or when the well is producing continuously to the flow line or to a storage vessel for collection, whichever occurs first.
Flowback Emissions

Flowback Emissions

GREENHOUSE GAS EMISSIONS REPORTING FROM THE PETROLEUM AND NATURAL GAS INDUSTRY

BACKGROUND TECHNICAL SUPPORT DOCUMENT
Flowback Emissions

Subpart W Background Document

- **6,000 Mcf/completion**
  - Natural Gas STAR presentation reported 45 Bcf emissions in 2002 from all completions
  - Six steps of assumptions using number and type of wells completed

- **10,000 Mcf/completion**
  - Natural Gas STAR partner reported average volume of recovered methane per well
  - Assumed 90% capture

- **700 Mcf/completion**
  - Vendor/service provider of REC provided recovered gas for 3 completions
  - Assumed 90% capture

- **20,000 Mcf/completion**
  - Average flowback reported by a Natural Gas START partner rounded to nearest 10,000 Mcf

Average of these four values = **9,175 Mcf/completion**

Also used for National Inventory & NSPS Subpart OOOO Background
Flowback Emissions – Natural Gas STAR

<table>
<thead>
<tr>
<th>Estimated Well Completion Emissions (Mcf gas/completion)*</th>
<th>Company</th>
<th>Year of Presentation (Reference #)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24,400</td>
<td>Williams</td>
<td>2007 (1)</td>
</tr>
<tr>
<td>3,700</td>
<td>BP</td>
<td>2004 (2)</td>
</tr>
<tr>
<td>700</td>
<td>Weatherford</td>
<td>2004 (2)</td>
</tr>
<tr>
<td>13,200</td>
<td>Devon</td>
<td>2008 (3)</td>
</tr>
<tr>
<td>4,900</td>
<td>Anadarko</td>
<td>2008 (3)</td>
</tr>
<tr>
<td>9,000</td>
<td>Anadarko</td>
<td>2010 (3)</td>
</tr>
</tbody>
</table>

* Values calculated from information provided in Natural Gas STAR presentations. Where the reported value was gas recovered, an assumption was made that the gas recovered represented 90% of the total emissions from the completion.
## Flowback Emissions – Other Sources Cited

<table>
<thead>
<tr>
<th>Reference (#)</th>
<th>Completion Emissions Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Green Completions&quot; Fact Sheet (5)</td>
<td>3,000 Mcf NG/completion</td>
</tr>
<tr>
<td>ENVIRON (6)</td>
<td>1,000 – 5,000 Mcf NG/well</td>
</tr>
<tr>
<td>Fernandez (7)</td>
<td>7,000 Mcf NG/completion</td>
</tr>
<tr>
<td>Eckhardt (8)</td>
<td>6,800 Mcf methane/ completion</td>
</tr>
<tr>
<td>Green Completions. Lessons Learned (9)</td>
<td>370 Mcf methane/ completion</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>24,400 Mcf NG/completion</td>
</tr>
<tr>
<td>3</td>
<td>4,900 Mcf NG/completion</td>
</tr>
<tr>
<td>4</td>
<td>9,000 Mcf NG/completion</td>
</tr>
<tr>
<td>9</td>
<td>3,700 700 13,200 Mcf Ng/completion</td>
</tr>
</tbody>
</table>
Flowback Emissions

Natural Gas Emissions (Msf/completion)

- Emissions range from 0 to 30,000 Msf/completion.
- The data points indicate varying levels of emissions across different completions.
Flowback Emissions

Summary

- Reasonable to expect large variations due to many factors including gas and liquid composition and reservoir characteristics
- “Data” very limited
- Poorly documented
Flowback Emissions

Measurements of methane emissions at natural gas production sites in the United States (2013)

■ Direct measurements at 190 onshore natural gas sites
■ 27 well completions measured
■ Average uncontrolled methane emission rate was 20% lower than level used for national inventory (based on 9,175 Mscf/event)
■ More control in place than assumed in national inventory
Controls

**Completion combustion device** means any ignition device, installed horizontally or vertically, used in exploration and production operations to combust otherwise vented emissions from completions. **NSPS Subpart OOOO**

**Reduced emissions completion** means a well completion following fracturing or refracturing where gas flowback that is otherwise vented is captured, cleaned, and routed to the flow line or collection system, re-injected into the well or another well, used as an on-site fuel source, or used for other useful purpose that a purchased fuel or raw material would serve, with no direct release to the atmosphere. **NSPS Subpart OOOO**

**GREEN COMPLETION PRACTICES** shall mean those practices intended to reduce emissions of salable gas and condensate vapors during cleanout and flowback operations prior to the well being placed on production.

Code of Colorado Regulations 2 CCR 404-1, 10 Series Definitions
Green completion practices are required on oil and gas wells where reservoir pressure, formation productivity, and wellbore conditions are likely to enable the well to be capable of naturally flowing hydrocarbon gas in flammable or greater concentrations at a stabilized rate in excess of five hundred (500) MCFD to the surface against an induced surface backpressure of five hundred (500) psig or sales line pressure, whichever is greater. Green completion practices are not required for exploratory wells, where the wells are not sufficiently proximate to sales lines, or where green completion practices are otherwise not technically and economically feasible.
Emissions of volatile organic compounds (VOC) and hazardous air pollutants (HAP) associated with the flaring and venting of hydrocarbon fluids (liquids and gas) associated with well completion and re-completion activities shall be eliminated to the extent practicable by routing the recovered liquids into storage tanks and routing the recovered gas into a gas sales line or collection system.
### Affected Facility

Each gas well

Revised definition for gas well: **“onshore well drilled principally for production of natural gas”**

Preamble Language: **“… four formation types generally accepted as gas-producing formations: (1) High-permeability gas, (2) shale gas, (3) other tight reservoir rock or (4) coal seam.”**

**Low-pressure well - formula provided in definition:**

function \[ (\text{vertical depth}, \text{reservoir pressure}) \text{ relative to sales line pressure} \]

Rule also defines **wildcat** and **delineation** well types
### Control Requirements

- If emissions cannot be directed to gathering line they must be captured and vented to a completion combustion device with reliable/continuous ignition source (*exclusions* for fire hazard, negative environmental impacts)
- “General duty” to maximize recovery & minimize releases
- Includes “Wildcat”, “delineation”, and “low pressure” gas wells

### Key Compliance Provisions

- Email notification ≥ 2 days prior to commencement of well completion (*notification to local authority satisfies requirement*)
- Keep daily completion logs
- Annual reporting - all the records required for completions and deviations (location, duration of flows, reasons for venting, exemption claims)

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**Affected Facility**

- Each gas well

**Applicability Criteria**

- All hydraulically fractured well completions and workovers

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**Phase I – Applies to Gas Wells Completed Until December 31, 2014**
Phase II – Applies to Gas Wells Completed on January 1, 2015 or after

Control Requirements

- Recovered liquids: route to storage vessels or re-inject
- Recovered gas: route into a gas gathering line or collection system, re-inject, or use for fuel / useful purpose
- All salable quality gas: route to gas gathering line as soon as practicable
- If emissions cannot be directed to flow line, capture and direct to completion combustion device with reliable continuous ignition source
- “General duty” to maximize recovery & minimize releases
- “Wildcat”, “delineation”, and “low pressure” gas wells – capture or route to combustion device

Key Compliance Provisions

- Email notification > 2 days prior to commencement of well completion (notification to local authority satisfies requirement)
- Keep daily completion logs
- Annual Reporting
- Photos of recovery/control equipment

Affected Facility

Each gas well

Applicability Criteria

All hydraulically fractured well completions and workovers
Beginning January 1, 2015 NSPS Subpart OOOO requires:

For the **duration of flowback**, route the recovered liquids into one or more storage vessels or re-inject the recovered liquids into the well or another well, and route the recovered gas into a gas flow line or collection system, re-inject the recovered gas into the well or another well, use the recovered gas as an on-site fuel source, or use the recovered gas for another useful purpose that a purchased fuel or raw material would serve, with **no direct release to the atmosphere**.
The flowback period begins when material introduced into the well during the treatment returns to the surface immediately following hydraulic fracturing or refracturing.
Duration of Flowback?

Excerpts from 9/28/13 EPA Letter to API

"flowback emissions," . . . refers to the recovered gas and vapor after separation that cannot be directed to the flow line.

the initial gas and vapor are not "flowback emissions,"
Duration of Flowback?

Source: Measurements of Methane Emissions at Natural Gas Production Sites in the United States - Supporting Information, Center for Energy and Environmental Resources, University of Texas at Austin
Duration of Flowback?

NSPS Subpart OOOO

The flowback period ends with either well shut in or when the well is producing continuously to the flow line or to a storage vessel.

First Date of Production - The date permanent production equipment is in place and product is consistently flowing to sales lines, gathering lines or storage tanks. Production occurring during well completion activities which is routed to temporary production equipment is considered to occur prior to the First Date of Production.

Source: OIL AND GAS PRODUCTION FACILITIES, CHAPTER 6, SECTION 2, PERMITTING GUIDANCE WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY AIR QUALITY DIVISION
Duration of Flowback?

Beginning January 1, 2015 NSPS Subpart OOOO requires:

For the duration of flowback, route the recovered liquids into one or more storage vessels or re-inject the recovered liquids into the well or another well, and route the recovered gas into a gas flow line or collection system, re-inject the recovered gas into the well or another well, use the recovered gas as an on-site fuel source, or use the recovered gas for another useful purpose that a purchased fuel or raw material would serve, with no direct release to the atmosphere.

Storage vessel excludes temporary vessels.
Duration of Flowback?

During flowback you must produce to a storage vessel

Flowback ends when producing to storage vessel
## NSPS Subpart OOOO - Impacts

<table>
<thead>
<tr>
<th>Type of Pollutant</th>
<th>Gas Well Fracked Completion Emission Reductions (tons/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>1,400,000</td>
</tr>
<tr>
<td>VOC</td>
<td>200,000</td>
</tr>
<tr>
<td>HAP</td>
<td>15,000</td>
</tr>
</tbody>
</table>

Flowback Emissions - GHGRP Subpart W

Requires reporting of emissions from Gas well venting during well workovers with hydraulic fracturing

Many Reporters Used Best Available Monitoring Methods for 2011 and 2012 reporting

Most Reporters Will Have Full Compliance for 2013 and Beyond
Flowback Emissions – GHGRP Subpart W

For Each “Bucket”

Flowback for every well measured OR Representative flowback measured or calculated:

- One for less than or equal to 25 completions
- Two for 26 to 50 completions
- Three for 51 to 100 completions
- Four for 101 to 250 completions
- Five for greater than 250 completions
Flowback Emissions – The Future

Better emission estimates

More regulation and control

Lower emissions

More refined life cycle analyses
<table>
<thead>
<tr>
<th>Number</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Reduced Emissions Completions in DJ Basin and Natural Buttes. Producers Technology Transfer Workshop. May 1, 2008. Rock Springs, WY.</td>
</tr>
</tbody>
</table>
## References

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</table>
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