Impact of Unconventional Natural Gas Drilling Operations on the Environment and Public Health

Industry Practices and Perspectives

Russell White
American Petroleum Institute
February 18, 2014
API Standards

Since 1924, the American Petroleum Institute (API) has been developing equipment and operating standards for the oil and natural gas industry. API is accredited by the American National Standards Institute (ANSI).

API works with subject-matter experts to maintain over 600 standards and recommended practices and continues to strive to enhance safety operations, improve quality assurance, and best practices.
API Work on Hydraulic Fracturing

Over 65 operational standards directly applicable to horizontal drilling and well completions

“Hydraulic Fracturing Series”

– HF1, Well Construction and Integrity Guidelines (2009)
HF1– Well Construction and Integrity Guidelines

Regulated by Jurisdiction

- **Well construction**: material selection, performance, evaluation – e.g.,
  - Cement regulation
  - Casing and cementing depth
  - Cement circulation
  - Intermediate casing circulation
  - Production casing circulation

- **Well integrity**: Protect groundwater through a combination of redundant steel casing and cement sheaths, mechanical isolation devices

- **Well logging and other testing**: data gathering tools for formation evaluation, well design and construction
HF2: Water Management Associated with Hydraulic Fracturing

Best practices to minimize environmental and societal impacts associated with the acquisition, use, management, treatment and disposal of water and other fluids associated with the process of hydraulic fracturing.

- **Water Supply**
  - Source Water (comprehensive evaluation, impacts, transportation)
  - Fluid Handling (strive to minimize use of additives, disclosure)
  - Storage (safety and compliance)

- **Management & Disposal:**
  - Municipal & Industrial Waste Water Treatment Facilities
  - Flow Back Water Recycling / Reuse
  - Injection Wells
Gas-fired combined cycle power plants use much less water than thermal power plants with only a small contribution from gas production.


* Assumes closed loop cooling tower
** Other use includes water for other process uses such as emissions treatment, facilities
Flowback and Produced Water Management

- Clean Air Act – New Source Performance Standards

- On-site water recycling (closed loop systems for fluids vs. impoundments)

- Extensive prospective waste management plans in permitting – on-site storage, spill prevention, site remediation

- Greener fluids (more biodegradable)
HF3: Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing

- **Scale of Development** - regional collaboration, STRONGER, National Petroleum Council
- **Management of Chemicals & Materials** - total impact, surface handling, greener alternatives, disclosure through [www.fracfocus.org](http://www.fracfocus.org)
- **Transportation** – GPS units on vehicles, inspect equipment before moving
- **Equipment & Facilities** - maintenance & inspection
- **Minimization of Surface Disturbance** - air quality, noise abatement (distance, scheduling), road impacts (avoid peak hours, coordination)
Chemical additives range from 0.5 to 2 % by volume

Assuming 3 million gallons of fluid per well:
15,000 to 60,000 gallons of chemical additives

(DOE, 2009; GWPC and ALL Consulting, 2009; API, 2010b).
Texas


Pennsylvania
Department of Environmental Protection (2010) **Southwestern** Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report.
Department of Environmental Protection (2011) **Northeastern** Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report
Department of Environmental Protection (2011) **North Central** Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report

Colorado
Department of Public Health & Environment Air Pollution Control. Air Emissions Case Study Related To Oil And Gas Development In **Erie, Colorado** (December 5, 2012)
Texas


Pennsylvania
Department of Environmental Protection (2011) Northeastern Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report
Department of Environmental Protection (2011) North Central Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report

Colorado
Department of Public Health & Environment Air Pollution Control. Air Emissions Case Study Related To Oil And Gas Development In Erie, Colorado (December 5, 2012)
Barnett Shale Air Benzene Levels

Source: Texas Commission Environmental Quality
City of Fort Worth Study

Principal Tasks

- Fort Worth Natural Gas Air Quality Study
- Ambient Air Monitoring
- Point Source Testing
- Air Dispersion Modeling
- Public Health Evaluation
Results - Benzene

Benzene average was significantly higher at High Activity Site S-4 than other sites. Fence Line sites (S-6 and S-7) were the lowest.
Observations and Conclusions

- Of the 388 sites surveyed, over 736,000 valves, connectors and other fugitive equipment components and over 1,200 tanks were surveyed with the IR camera and or screened with the TVA.
- Of this equipment, there were over 1,300 large leaks detected by the IR camera and nearly 800 small leaks detected with the TVA.
- At 25% of the total sites (96 sites), no emissions were detected by the IR camera.
- At 12% of the total sites (46 sites), no emissions were detected by either the IR camera or TVA.
Fort Worth Study Conclusions

• A health-screening analysis of measured and modeled data found - Benzene, Acrolein, and Formaldehyde – as the most important from a risk perspective.

• But the concentrations measured or modeled did not reach levels of acute or chronic health concerns.

• Benzene and Formaldehyde concentrations in Fort Worth are no higher than other locations in Texas as measured by TCEQ.
Impact of Emissions from Natural Gas Production Facilities on Ambient Air Quality in the Barnett Shale Area: a Pilot Study (Desert Research Institute)
# Pennsylvania and Colorado

<table>
<thead>
<tr>
<th>Benzene ppbv</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PA-NC</strong></td>
<td>nd</td>
<td>nd</td>
<td>0.13</td>
<td>0.20</td>
<td>0.22</td>
<td>0.40</td>
<td>0.10</td>
<td>nd</td>
<td>0.12</td>
<td>0.37</td>
<td>0.16</td>
<td>0.54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PA-NE</strong></td>
<td>nd</td>
<td>nd</td>
<td>0.13</td>
<td>nd</td>
<td>0.11</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
<td>0.11</td>
<td>nd</td>
<td>0.20</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td><strong>PA-SW</strong></td>
<td>0.09</td>
<td>0.09</td>
<td>0.25</td>
<td>0.16</td>
<td>0.11</td>
<td>0.13</td>
<td>0.22</td>
<td>0.20</td>
<td>0.42</td>
<td>0.14</td>
<td>0.11</td>
<td>0.09</td>
<td>0.10</td>
<td>0.15</td>
<td>0.11</td>
</tr>
<tr>
<td><strong>Erie CO</strong></td>
<td>0.34</td>
<td>0.28</td>
<td>0.08</td>
<td>0.28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
California Air Resources Board
Statewide Benzene Concentrations

[Graph showing the decline of benzene concentrations from 1989 to 2012, with data points for 90th percentile, mean, and detection limit.]
Thank you for your attention

Any Questions?
Water Acquisition and Overall Use

Regulated by Jurisdiction

- Water management plans before permitting* (location, amount, impact, reporting)
- Other entities (e.g., River Basin Commissions)
- Source Water* (comprehensive evaluation,* impacts,* transportation*)

*Also covered by API Standards, Recommended Practices, or Guidance
Land Use and Energy Efficiency

- Natural gas has the smallest footprint of any energy source.
- Acres of land needed to produce the fuel and generate enough electricity to serve 1,000 households for one year.

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>0.3</td>
</tr>
<tr>
<td>Coal</td>
<td>0.4</td>
</tr>
<tr>
<td>Biomass</td>
<td>0.8</td>
</tr>
<tr>
<td>Nuclear</td>
<td>1.2</td>
</tr>
<tr>
<td>Wind</td>
<td>6</td>
</tr>
<tr>
<td>Solar</td>
<td>6</td>
</tr>
</tbody>
</table>
Timeline of a Well

EXPLORATION
3-5 years

PLANNING
12 – 18 months

SITE & WELL CONSTRUCTION
2-3 months

HYDRAULIC FRACTURING
3 – 5 DAYS

PRODUCTION
30 + Years
Horizontal wells

- Reduced footprint to recover same reserves
- Multi-well pads mean less infrastructure – fewer roads, fewer flowlines, and fewer drilling locations
- Flexible placement*
- Community engagement*
- Road and Traffic considerations*
- Remediation*

Regulated by Jurisdiction

- Pre-drilling seismic mapping*
- Permitting requirements* (safety, plans for fluid acquisition, use, and management)
- Well spacing
- Setbacks* for sites, tanks, etc.
- Water quality tests* / presumptive liability

* Also covered by API Standards, Recommended Practices, or Guidance
Seismicity challenges are manageable.
Production vs. Disposal

Regulated by Jurisdiction
- Microseismic mapping
- Well placement
- Well construction

The typical energy released in tremors triggered by fracking, "is the equivalent to a gallon of milk falling off the kitchen counter."
- Stanford University geophysicist Mark Zoback.
http://www.businessweek.com/ap/financialnews/D9QS6A2GZ.htm

UIC Wells (Disposal, Not Hydraulically Fractured)
- EPA and state regulated for over 30 years
- 800,0000 wells used by industries including chemical processing, wastewater treatment and mining, as well as oil and gas
California Air Resources Board
Statewide m and p-Xylene Concentrations