Assessing Fatalities in Oil and Gas Extraction Workers
SPE, HSSE Study Group, Denver, April 2016

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National Institute for Occupational Safety and Health

The findings and conclusions in this report are those of the author(s) and do not necessarily represent the views of the National Institute for Occupational Safety and Health.
1. Fatality Rates & Leading Causes of Death
2. Impact of Automated Rigs on Injury Rates
3. Development of “FOG” and using FOG to identify emerging hazard
4. Current project
National Institute for Occupational Safety & Health (NIOSH)

• Part of the Centers for Disease Control & Prevention (CDC)
• Research-focused, not regulatory
• Created an Oil and Gas Sector Program in 2007 (Epi/Surveillance, Exposure Assessment, Engineering Controls, Communications)
1. Fatality Rates & Leading Causes of Death
Upstream has the Highest Fatality Rate in the U.S. Oil & Gas Industry, 2014

Upstream
36% of total workers
Fatality Rate = 22.9

Midstream
17% of total workers
Fatality Rate = 4.1

Downstream
60% of total workers
Fatality Rate = 4.2

Source: BLS/CFOI and BLS/QCEW. All rates calculated per 100,000 workers. 2014 data are preliminary.
The U.S. Oil and Gas Extraction Industry

Operators

Drilling Contractors

Well Servicing Companies

Oil and Gas Extraction Industry
The oil and gas workforce doubled and the number of drilling rigs increased 71% from 2003-2013.

**Well Servicing Companies**
- 2003: 120,536 workers
- 2013: 296,891 workers
- 245% Increase

**Oil and Gas Operators**
- 2003: 121,124 workers
- 2013: 196,732 workers
- 62% Increase

**Drilling Contractors**
- 2003: 48,596 workers
- 2013: 93,261 workers
- 92% Increase
Methods

Rate Calculation

BLS CFOI Number of Fatalities
(NAICS: 211, 213111, 213112)

\[ \text{Fatality Rate per 100,000 Workers} = \text{Rate} \times 100,000 \]

BLS Quarterly Census of Employment and Wages
(Not Full Time Equivalent [FTE])

Statistical Test

Negative Binomial Regression

Difference in Rates over time

June 8, 2015
Note: Fatality counts from BLS Census of Fatal Occupational Injuries. Worker Estimates from BLS Quarterly Census of Employment and Wages (2013). Rate per 100,000 workers per year. Includes NAICS 211, 213111, 213112. *Data for 2014 are preliminary.
Number and Rate of Fatal Work Injuries
U.S. Oil & Gas Extraction Industry, 2003-2013

Note: Fatality counts from BLS Census of Fatal Occupational Injuries. Worker Estimates from BLS Quarterly Census of Employment and Wages (2013). Rate per 100,000 workers per year. Includes NAICS 211, 213111, 213112. *Data for 2013 are preliminary.
Trends in Fatality Rate by Company Type, 2003-2013

**Oil and Gas Operators**
- 58% Fatalities
- Statistically Significant

**Well Servicing Companies**
- 33% Fatalities
- Statistically Significant

**Drilling Contractors**
- 27% Fatalities
- Not Statistically Significant

June 8, 2015
Possible Reasons for Improvement

• Development of STEPS Networks.
• Creation of transportation safety groups (e.g. Appalachian Shale Transportation Group).
• Development of the NIOSH NORA Oil and Gas Council.
• The OSHA Oil and Gas Safety and Health Conference.
• New ALLIANCE between STEPS/OSHA/NIOSH.
Most Frequent Fatal Events
U.S. Oil & Gas Extraction Industry, 2003-2014

- **Fires/Explosions**: 14% (187) fatalities
- **Exposure**: 9% (114) fatalities
- **Falls**: 8% (109) fatalities
- **Other**: 2% (33) fatalities
- **Contact with Objects/Equipment**: 26% (340) fatalities
- **Transportation**: 41% (548) fatalities

Total Fatalities: 1331

Data Source: BLS CFOI
2. Impact of Automated Rigs on Injury Rates
Impact of engineering controls on injury rates at an international drilling company (H&P)

• Largest drilling contractor in U.S.
  – 15% of person-hours among onshore drilling contractors

• OSHA recordable injuries among employers and contractors, 2003–2012
  – New and old rigs used during this time
One or more engineering controls designed to reduce exposure to rig hazards:

- Top drive
- Hydraulic catwalk
- Power tongs

...and an AC-drive motor
“Old” Rigs - defined

- Mechanical rigs
- Silicon-controlled rectifier (SCR) rigs
- Includes conventional rigs on which drillers use mechanical brake handle to operate drawworks from rig floor
Manual Tongs

Automated Tongs (i.e. Iron Roughneck)
H&P operated 321 rigs during 2003–2012

Results

Old Rigs: 19.5 million person hours
New Rigs: 57.9 million person hours
Injury rate on new rigs was 33% lower than on old rigs.
Results - Injury Severity

Medical Attention only:
30% lower injury rates on new rigs (P<.01)

Restricted Work Duty:
41% lower injury rates on new rigs (P<.01)

Lost Time Incidents:
45% lower injury rates on new rigs (p=.03)

*Rate per 200,000 manhours.
Results - Injury by Job Type

Floormen:  
33% lower injury rates on new rigs (P<.01)

Derrickmen:  
40% lower injury rates on new rigs (P=.02)

Motormen:  
45% lower injury rates on new rigs (p<.01)
Conclusions

• First study focused on relationship between rig technology and injury rates within land-based oil and gas extraction industry

• For this large drilling contractor, new rigs appear to provide safer work environment
3. Development of FOG and using FOG to identify emerging hazard
Different risks for different basins?  

Are some vehicles more dangerous?  

Is distraction or fatigue a factor?  

Struck by what?  

Do they work where they live?  

What are the most common ignition sources?  

What are the most dangerous operations?
The details needed to answer these questions are not in available data sources (BLS CFOI)
# Fatalities in Oil and Gas (FOG) database

New internal database collecting detailed information about oil and gas worker fatalities in the U.S.

<table>
<thead>
<tr>
<th>Includes</th>
<th>Excludes</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>All identified fatal events to U.S. oil and gas extraction workers</td>
<td>Midstream, downstream, non-fatal injuries</td>
<td>Off-site motor vehicle incidents, work-related chronic illness</td>
</tr>
<tr>
<td>• Land-based</td>
<td>• Motor vehicle incidents</td>
<td></td>
</tr>
<tr>
<td>• Offshore</td>
<td>• Non-traditional commutes</td>
<td></td>
</tr>
<tr>
<td>• Common O&amp;G NAICS</td>
<td>• Cardiac events</td>
<td></td>
</tr>
<tr>
<td>• Uncommon O&amp;G NAICS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Data Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSHA, media, crash reports, autopsy reports, industry etc.</td>
</tr>
</tbody>
</table>
Fatalities in Oil and Gas (FOG) database

50 Variables per Incident
- Operation
- Basin
- Fatigue Related
- Weather Related
- Offshore Incidents

FOG collects the details that are missing from other data sources

41 Variables per Worker
- Occupation
- Years in Oilfield
- English as a Second Language
- Task
In 2013, NIOSH contacted by Dr. Bob Harrison regarding 2 deaths where inhalation of petroleum hydrocarbon gases and vapors suspected.

NIOSH reviewed fatalities (2010-2014) in FOG and monitored deaths closely.

Published 1st Science Blog in May 2014 (following 2 more deaths).
When hatches on production tanks are opened by a worker (to gauge or collect sample), a plume of hydrocarbon gases and vapors can be rapidly released due to the internal pressure present in the tank.

- Propane
- Butane
- Ethane
- Benzene
– Asphyxiation – Oxygen deficient atmosphere
– Narcotic Effects Resulting in
  • Disorientation
  • Dizziness
  • Light-headedness
  • Cardiac arrhythmia (irregular heartbeat)
  • Respiratory depression (reduced breathing rate and inadequate ventilation of the lungs)
– Explosive
Fatality Case Definition

• Non-traumatic
• Worker in proximity to a known and concentrated source of hydrocarbon gases and vapors. (open hatch)
• Hydrogen Sulfide (H$_2$S) was ruled out.
• Not confined space.
• Not fires/explosions.
• Case by Case Review conducted by OSHA/NIOSH.
## Fatalities on Oil and Gas Well Sites Involving an Open Thief Hatch, 2010-2014

<table>
<thead>
<tr>
<th>Year of death</th>
<th>Age, years</th>
<th>State</th>
<th>Description of how person was found</th>
<th>Coroner's stated cause of death</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2010</td>
<td>30</td>
<td>MO</td>
<td>Slumped over on the catwalk</td>
<td>Hypertensive and atherosclerotic cardiovascular disease</td>
</tr>
<tr>
<td>2 2012</td>
<td>21</td>
<td>ND</td>
<td>On catwalk next to open hatch</td>
<td>Hydrocarbon poisoning due to inhalation of petroleum vapors</td>
</tr>
<tr>
<td>3 2013</td>
<td>39</td>
<td>ND</td>
<td>Slumped over catwalk railing on knees in front of open hatch</td>
<td>Sudden cardiac arrhythmia (primary), morbid obesity and arteriosclerotic heart disease (contributory)</td>
</tr>
<tr>
<td>4 2014</td>
<td>57</td>
<td>OK</td>
<td>On catwalk next to tank slumped over</td>
<td>Undetermined (no autopsy performed)</td>
</tr>
<tr>
<td>5 2014</td>
<td>51</td>
<td>CO</td>
<td>Hanging from guardrail, hooked on by clothing</td>
<td>Sudden cardiac death due to ischemic heart disease</td>
</tr>
<tr>
<td>6 2014</td>
<td>57</td>
<td>CO</td>
<td>Collapsed over open hatch</td>
<td>Atherosclerotic cardiovascular disease</td>
</tr>
<tr>
<td>7 2014</td>
<td>59</td>
<td>CO</td>
<td>Collapsed over open hatch</td>
<td>Toxic gas inhalation and oxygen displacement by volatile hydrocarbons (primary), atherosclerotic cardiovascular disease and sudden cardiac death (contributory)</td>
</tr>
<tr>
<td>8 2014</td>
<td>63</td>
<td>TX</td>
<td>At the bottom of the catwalk stairs</td>
<td>Arteriosclerotic and hypertensive cardiovascular disease</td>
</tr>
<tr>
<td>9 2014</td>
<td>20</td>
<td>ND</td>
<td>Face down over open hatch</td>
<td>Cardiac arrhythmia, with cardiac hypertrophy, coronary artery hypogenesis, obesity and petroleum hydrocarbon vapors</td>
</tr>
</tbody>
</table>
## OSHA Health Response Team Results

### Table 1. Hydrocarbon Gas and Vapor Concentrations Measured by OSHA Approximately 1 Foot Above Open Production Tank Hatches (North Dakota, 2014).

<table>
<thead>
<tr>
<th>Gas or Vapor</th>
<th>Concentration (average ppm)</th>
<th>IDLH* (average ppm)</th>
<th>Severity**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propane</td>
<td>43,000</td>
<td>2,100</td>
<td>&gt;20 x</td>
</tr>
<tr>
<td>Butane(s)</td>
<td>100,000</td>
<td>1,900</td>
<td>&gt;50 x</td>
</tr>
<tr>
<td>Pentane(s)</td>
<td>28,000</td>
<td>1,500</td>
<td>&gt;20 x</td>
</tr>
<tr>
<td>n-Hexane</td>
<td>4,500</td>
<td>1,100</td>
<td>&gt;4 x</td>
</tr>
<tr>
<td>Benzene</td>
<td>100-400</td>
<td>500</td>
<td>&lt;1 x</td>
</tr>
</tbody>
</table>

*Immediately Dangerous to Life or Health concentrations expressed as 10% of the LEL

**Severity = Airborne Concentration Expressed as ppm / IDLH (ppm)
Dräger GasVisi X-am 2500 data from 11:30:41 am to 12:15:56 pm on 7/13/14

Source: Michael Kosnett MD, MPH
Suspected Inhalation Fatalities Involving Workers during Manual Tank Gauging, Sampling, and Fluid Transfer Operations

www.cdc.gov/niosh/topics/fog/publications.html
Current Recommendations

1. Implement alternative tank gauging and sampling procedures.
2. Retrofit existing tanks with dedicated sampling ports.
3. Install thief hatch pressure indicators.
5. Provide hazard communication training.
6. Ensure workers are trained and use calibrated multi-gas and oxygen monitors.
7. Do not permit employees to work alone.
8. Administrative controls: reduce tank pressure prior to gauging, ensure intrinsic safety of devices.
9. Wear flame-resistant clothing.
10. Establish and practice emergency procedures.
• Only one worker suspected death in 2015
• Established trend of deaths due to cardiac events on tanks
• Stopped resistance from industry group to create alert
• Aided in Colorado widow receiving benefits
Other Successes

BHP Billiton: Reducing Inhalation Risks
https://www.youtube.com/watch?v=L6Tg2V4Svjw

New American Petroleum Industry Standard:
18.2. Alternative Methods for Gauging/Sampling

Bureau of Land Management: Update Onshore Order 4 to allow for alternative methods
4. Current Projects
• 2 Key Areas of Focus: Respirable Silica; Hydrocarbon Gases and Vapors
• Engaging Engineers in Discussion of these controls
• Next Meeting: May 12-13, Texas
• Presentations on Controls for Each
• Contact: Rick Ingram: rickey.ingram1@bp.com
Objectives
- Identify health and safety concerns of workers
- Determine factors that contribute to motor vehicle incidents

Participants
500 oil and gas workers in 3 states

Content
General Topics
- Demographics
- Health and personal habits
- Workplace/Job characteristics
- Safety culture

Topics of Concern
- Tank gauging and sampling
- Driving behaviors
- Chemical exposures
- Respirable silica

Results
Guide interventions and future research
Concluding Thoughts

• The oil and gas extraction worker fatality rate is elevated
• Development of engineering controls are essential to improving safety and health among oil and gas workers
• SPE has been great venue to share information about hazards
NORA Oil & Gas Extraction Council Members
Resources

Fatalities in the Oil and Gas Extraction Industry (FOG) Website
http://www.cdc.gov/niosh/topics/fog/default.html

Oil and Gas Extraction Worker Fatalities 2014 Mid-Year Report: January 1, 2014- June 30, 2014
http://www.cdc.gov/niosh/docs/2015-239/default.html

Suspected Inhalation Fatalities Involving Workers during Manual Tank Gauging, Sampling, and Fluid Transfer Operations on Oil and Gas Well Sites, 2010-2014
http://www.cdc.gov/niosh/topics/fog/data.html

Hydrocarbon Exposures During Tank Gauging and Sampling Operations National STEPS Network Hazard Alert
http://www.nationalstepsnetwork.org/docs_tank_gauging/TankHazardInfographicFinal04_22_15.pdf

Occupational Fatalities During the Oil and Gas Boom – United States, 2003-2013
http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6420a4.htm
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