

Fatalities in the U.S. Oil & Gas Extraction Industry

Recent Trends & New Details

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The U.S. oil and gas extraction industry is a high-risk industry. A CDC analysis of oil and gas extraction worker fatalities for 2003 to 2006 found that workers were killed on the job at a rate seven times greater than the rate among all U.S. workers. Research also identified a positive correlation between the industry's fatality rate and industry activity (number of drilling rigs) (CDC, 2008). From 2003 to 2013, the number of active drilling rigs increased by 71%, resulting in a two-fold increase in the number of workers employed in the industry (Baker Hughes Inc.; DOL, 2014). The boom in activity and employment resulted in an increase in worker deaths as well. Within the industry, elevated fatality rates have been identified among contractors, workers in small companies and workers new to the industry (Retzer, Hill, Conway, 2009). The largest portion of fatalities is a result of transportation incidents, the majority of which are motor vehicle crashes (Retzer, Hill & Pratt, 2013). The leading cause of death for workers on-site is being struck by, crushed or caught in equipment (Retzer, Hill & Conway, 2009; Retzer, Hill & Pratt, 2013).

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Research

NIOSH began research that focused on the U.S. oil and gas extraction industry in response to an increase in the number of fatal injuries in the industry in 2004. As a result, NIOSH created an Oil and Gas Safety and Health Program, which focused its initial research activities on learning about the industry and collecting and analyzing data to describe the most frequent fatal events, the groups of workers most at risk and associated risk factors. Early NIOSH research projects targeted specific types of fatal events, such as motor vehicle crashes, workers struck by objects, falls, fires and explosions. The results and recommendations generated by these projects were published in scientific and trade journals, presented at professional conferences and meetings, and included in a series of training videos targeting specific risk factors and high-risk operations (NIOSH, 2015b).

Partnerships

Numerous collaborative efforts to improve safety and health for oil and gas extraction workers began during the past decade. In 2003, the Service, Transmission,

Exploration & Production Safety (STEPS) Network was founded in south Texas by OSHA and industry to share best practices in oil and gas safety and health. Since then, the [National STEPS Network](#) and 22 independent STEPS groups serving 15 oil and gas producing states have also formed. In 2008, the [National Occupational Research Agenda \(NORA\) Oil and Gas Extraction Sector Council](#) was created by NIOSH as a partnership program to stimulate OSH research in the U.S. oil and gas extraction industry. Since then, the NORA Council has identified priority research activities and created several safety products targeting high-risk workers and activities (NIOSH, 2015b).

Regional groups have formed as well. The Texas Oil and Gas Association joined Texas Mutual Insurance to create the [Texas Oil and Gas Safety Roundtable](#) whose mission is to collaborate with stakeholders to develop and disseminate best safety practices that address common industry hazards. Another regional group, the Appalachian Shale Transportation Safety Workgroup, was formed to identify and shares best practices in transportation safety in the Marcellus Shale Play.

The purpose of this article is to examine trends from 2003 to 2013 to determine if these research and partnership efforts may have had an impact in reducing the number and rate of fatal injuries in the oil and gas extraction industry. Secondly, the authors will provide an overview of a new NIOSH oil and gas fatality database and present preliminary results. The [Fatalities in Oil and Gas Extraction \(FOG\)](#) database was created in 2014 in response to the need for more detailed and timely information about oilfield fatalities. The goal of the FOG database is to increase the availability of important information about fatalities in the oil and gas extraction industry for use by safety and health professionals and others to develop targeted interventions that prevent future loss of life.

Recent Trends in Fatality Rates

Methods

NIOSH analyzed publicly available data from the Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injuries (CFOI) to identify the number and type of fatalities that occurred from 2003 to 2013. The North American Industrial Classification System (NAICS) identifies three types of companies in the oil and gas extraction industry and assigns a unique code to each: oil and gas operators who own or lease the rights to extract crude oil and natural gas (211), drilling contractors who drill the well (213111), and well servicing companies who perform a number of support operations, including stimulating and completing the well (213112). The CFOI includes a NAICS variable allowing for the identification

of fatalities by company type. Fatality rates were calculated using worker estimates from the BLS Quarterly Census of Employment and Wages (QCEW). Trends in fatality rates were calculated for the industry as a whole by company type and by the leading causes of death. Negative binomial regression was used to estimate rates.

Results

There were 1,183 workers who died from 2003 to 2013 while working in the U.S. oil and gas extraction industry. Table 1 shows the most frequent fatal events for workers, with transportation incidents accounting for 40% of all fatalities.

The rate of fatalities for the industry decreased significantly from 2003 to 2013 ($p < 0.001$), with an average annual reduction of 4%. While the number of fatalities increased during this time period, the number of workers increased at a greater pace, resulting in decreasing fatality rates. The overall fatality rate was approximately six times that of all U.S. workers.

All three company types experienced a decrease in fatality rates; however, only operators and well servicing companies had statistically significant reductions ($p < 0.05$). Fatality rates due to transportation incidents and contact with objects/equipment declined significantly during the time period examined. Contact injuries experienced the greatest decrease, with an average annual reduction of 9%.

Development of a New Fatality Database for Oil & Gas Extraction

The NIOSH Oil and Gas Safety and Health Program developed a database in 2014 to collect detailed information on fatalities in the U.S. land-based and offshore oil and gas extraction industry. The goal of the FOG database is to increase the availability of information about contributing factors leading to fatal events in the oilfield.

TABLE 1
Most Frequent Fatal Events in U.S. Oil & Gas Extraction Industry, 2003-2013

| Event Type | Number of Deaths (%) |
|----------------------------------|----------------------|
| Transportation | 479 (40.3) |
| Contact injuries | 308 (25.9%) |
| Fires/Explosions | 170 (14.3%) |
| Exposure to harmful environments | 105 (8.8%) |
| Falls | 97 (8.2%) |
| Other | 30 (2.5%) |
| Total | 1189 |

Note. (N = 1,189); 2013 data is preliminary; U.S. Department of Labor, Bureau of Labor Statistics, 2014.

This system identifies common themes and emerging issues that might not be identified through existing surveillance systems.

All fatalities that occur to oil and gas extraction workers are included and those currently in the database are described in more detail below. The outputs created from this database will include information and tools for OSH professionals to train workers and focus workplace initiatives.

Case Definition

The FOG database includes information on all fatal events related to the U.S. oil and gas extraction industry. While most of the fatalities in the industry occur to workers employed by a company assigned to one of the three NAICS described earlier (i.e., 211, 213111 and 213112), FOG also seeks to identify fatalities to workers conducting work related to oil and gas, but coded to another industry. Table 2 (p. 4) shows the industries (and NAICS codes) that conduct most oil and gas-related work and are included in FOG. In addition, most occupational surveillance systems do not collect information about injuries and fatalities that occur during commuting because they are not considered work-related. Because well sites are often located in rural areas, many oil and gas extraction workers drive long distances to report to work. For these reasons, FOG collects data on long distance commutes.

Data Sources & Limitations

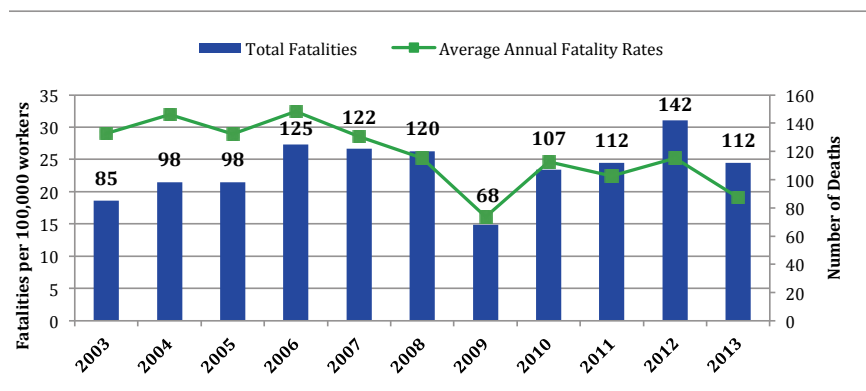
Data sources for FOG include: 1) OSHA preliminary descriptions, citations and closed investigations; 2) media reports; 3) formal investigations from federal, state and local agencies; 4) crash reports from **U.S. Department of Transportation** and local police; 5) emergency responder and police reports; 6) coroner and medical examiner reports; 7) death certificates, and; 8) **Bureau of Safety and Environmental Enforcement (BSEE)** investigation reports (offshore).

FOG does not currently capture all fatalities in this industry. Since the primary data sources for FOG are OSHA (land-based) and BSEE (offshore), events outside the scope of these agencies (e.g., highway crashes) will be underrepresented. In addition, FOG does not include fatalities that occur related to oil and gas pipelines (midstream) or refineries (downstream). FOG also does not collect data on nonfatal injuries and illnesses.

FOG Database Results

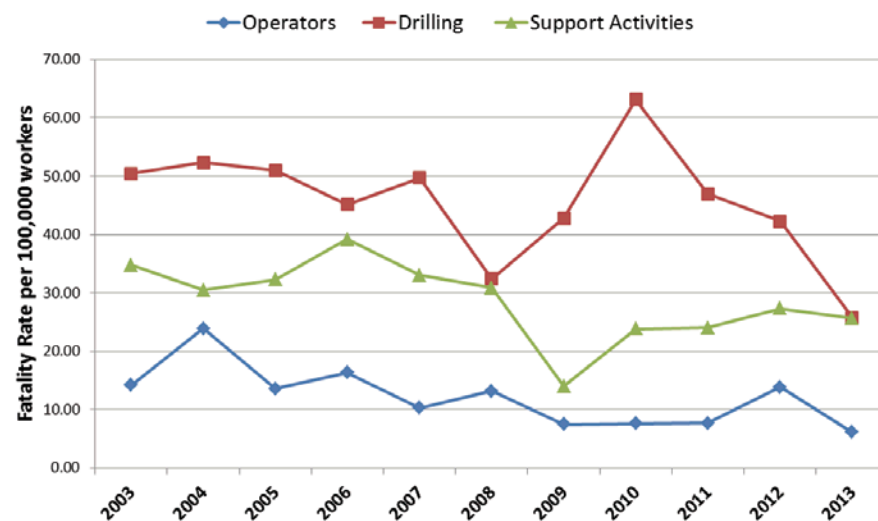
The NIOSH Oil and Gas Program will use FOG data to publish annual reports. These reports will include

FIGURE 1
U.S. Oil & Gas Extraction Industry Fatal Injuries, 2003-2013



Note. (N = 1,189); 2013 data is preliminary; U.S. Department of Labor, Bureau of Labor Statistics, 2003-2013, U.S. Department of Labor, Bureau of Labor Statistics (2014), Quarterly Census of Employment and Wages.

FIGURE 2
U.S. Oil & Gas Extraction Industry Worker Fatality Rates, 2003-2013



Note. U.S. Department of Labor, Bureau of Labor Statistics, (2003-2013); U.S. Department of Labor, Bureau of Labor Statistics, (2014), Quarterly Census of Employment and Wages.

preliminary descriptions of incidents by operation type, fatality characteristics and industry activity. Maps of fatality sites will also be included.

In addition to the annual NIOSH publications, FOG will be used to respond to specific requests for information by OSH professionals, researchers and others. Table 3 shows the operation types that were most frequently reported in the first half of 2014. The greatest number of fatal incidents occurred during the rig up/rig down process.

Table 3 shows the preliminary descriptions of the fatalities that occurred during rig up/rig down with all identifying information removed. Figure 3 (p. 5) shows the number of fatalities by month and the average number of rotary rigs by month. Fatalities spiked in April with 11 deaths. Figure 4 (p. 5) includes a map of the fatality sites by industry sector.

Tank Gauging/Sampling: An Area of Concern

In 2014, NIOSH learned about several worker fatalities associated with tank gauging in the Williston Basin (North Dakota and Montana) that appeared to have been the result of acute chemical exposures. This information came from media reports, OSHA officials, and members of the academic community (Snawder, Esse, King, et al., 2014). NIOSH reviewed data contained in the FOG database to determine if other similar fatalities had occurred. Fatalities due to confirmed hydrogen sulfide (H₂S), fires/explosions and confined spaces were excluded.

The review of FOG data revealed 11 fatalities potentially associated with acute inhalation of gaseous and volatile organic compounds (VOCs) and possible oxygen deficiency from 2010 to 2014 to workers who were gauging tanks, collecting samples and/or transferring fluids to trucks. A summary of these fatalities is below:

- Of the 11 worker fatalities, seven

occurred in 2014, one in 2013, two in 2012 and one in 2010.

- Four fatalities occurred in North Dakota, three in Colorado, two in Texas, one in Oklahoma and one in Montana.

- Nine of the fatalities occurred on crude oil (production) tanks. One fatality occurred on a produced water (flowback) tank. One fatality occurred on a salt-water tank.

- Five of the fatalities occurred during tank gauging. The other six fatalities occurred during sampling/fluid transfer by pumpers/truckers.

- While several cases remain open, available data indicate the primary cause of death in six fatalities was some type of cardiac event. The inhalation of lower molecular weight gaseous hydrocarbons and VOCs was ruled as the primary cause of death in one fatality and a contributory factor in two other deaths (where a cardiac

TABLE 2
Industry Sectors Included in the Fatalities in Oil & Gas Extraction Database

| NAICS code | Description |
|---------------------|--|
| 211, 213111, 213112 | Workers involved in the exploration for crude petroleum and natural gas; drilling, completing and equipping wells; operating separators, emulsion breakers, desilting equipment, and field gathering lines for crude petroleum and natural gas; and all other activities in the preparation of oil and gas up to the point of shipment from the producing property. This includes workers paid on a contract or fee basis. |
| 238910 | Workers involved in site preparation and related construction activities for oil and gas wells. |
| 484220, 484230 | Workers involved in specialized freight trucking, local and long distance, that includes hauling of materials for oil and gas extraction activities. |
| 541360 | Workers involved in performing geophysical surveying and mapping services for oil and gas on a contract or fee basis. |
| N/A | Workers who meet one of the above conditions and who are fatally injured in motor vehicle crashes that occur during nontraditional commutes (e.g., long distance commutes) to the work site or to temporary lodging camps. |
| N/A | Other workers involved in oil and gas extraction activities, irrespective of the NAICS code. |

TABLE 3
Most Frequent Fatalities by Oil & Gas Operation, January to June 2014

| Operation | Number of fatalities |
|--|----------------------|
| Rigging up/down | 6 |
| Unknown operations | 5 |
| Commuting | 4 |
| Material handling: Crane, forklift, winchtruck | 4 |
| General well servicing | 4 |
| Rig equipment repair/maintenance | 3 |
| Welding | 2 |
| Flowback operations | 2 |

event was the primary cause). The cause of death is still undetermined/not available in four cases.

- At least 10 of the fatalities occurred among employees who were working alone or not being observed.
- In at least one case, the victim had sought medical

evaluation for health effects (dizziness, disorientation) experienced during prior gauging activities.

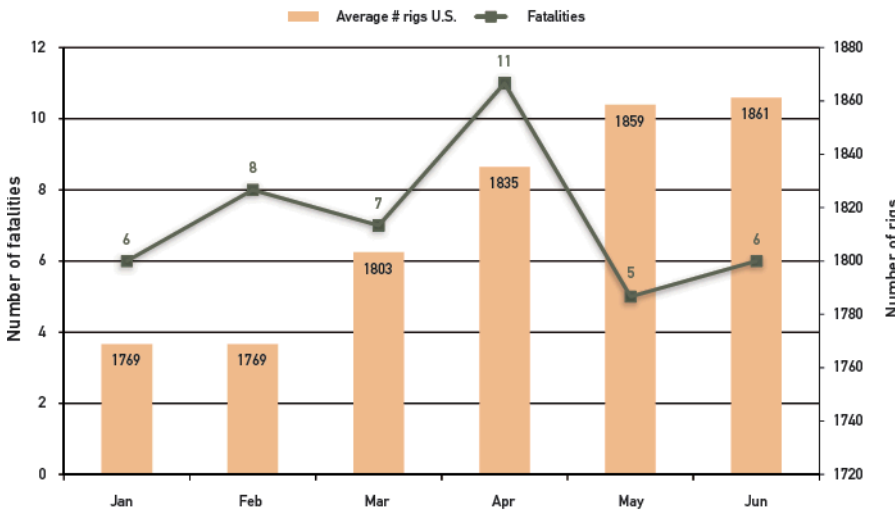
NIOSH works closely with OSHA to collect further details surrounding these deaths. Yet, evidence shows that manual gauging by unprotected workers poses significant hazards. These hazards include potential for inhalation of VOCs and oxygen deficiency hazards that could result in impaired judgment, disorientation, sudden death and risks for explosive/flammable conditions (Drummond, 1993). Collection and analysis of a limited number of personal breathing zone and area air samples taken above open thief hatches during gauging activities have indicated concentrations of VOCs (including benzene) in excess of occupational exposure limits and, in some cases, at levels immediately dangerous to life and health (Esswein, Snawder, King, et al., 2014).

Characterization of emissions using forward-looking infrared radiometer Infrared Imaging technology has shown that there are significant emissions of hydrocarbons released from thief hatches on production and flowback tanks (Jordan, 2014). Also, concentrations approaching 50% of the lower explosive limit were measured, indicating a flammable/explosion risk may be present.

Recommendations to keep workers safe while working around open thief hatches on production and flowback tanks have previously been outlined (Drummond, 1993; Esswein, Snawder, King, et al., 2014). These recommendations include:

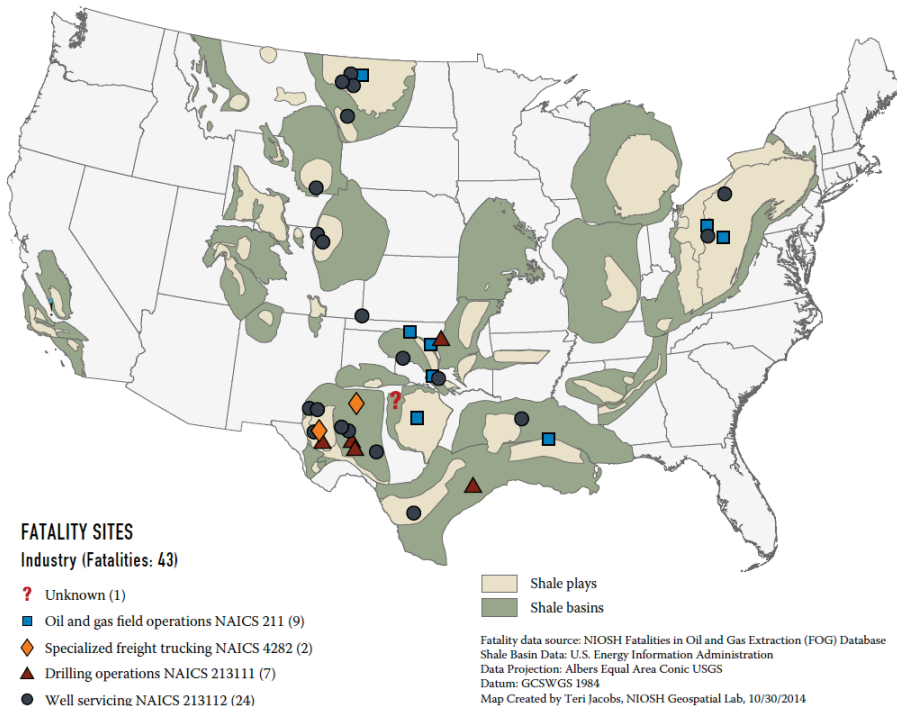
- 1) Develop alternative tank gauging procedures so workers do not have to routinely open hatches on the tops of the tanks and manually gauge the level of liquid.
- 2) Provide hazard awareness training so that workers understand the potential hazards for volatile chemical exposures from open tanks.
- 3) Monitor workers for their exposure to volatile hydrocarbons.
- 4) Ensure that workers do not work alone.
- 5) Use appropriate respiratory protection.

FIGURE 3
Average Number of U.S. Rotary Rigs & Fatalities, January to June 2014



Note: Baker Hughes, Rig Counts; NIOSH Fatalities in Oil and Gas Extraction Database

FIGURE 4
Site of Fatalities in Oil & Gas Extraction Industry, January to June 2014



6) Wear calibrated, real-time personnel monitors that can detect oxygen deficiency and explosive limits.

7) Establish emergency procedures.

The use of FOG to explore these fatalities has highlighted the importance of such a system in targeting specific hazards in the oil and gas extraction industry.

Conclusion

The oil and gas extraction industry has made progress in reducing the fatality rate among its workforce. Still, oil and gas extraction workers continue to die in large numbers and remain more at risk of dying on the job than most other American workers. Efforts to reduce hazards will need to focus on implementing effective interventions that target high-risk operations and groups of workers within the industry. The systematic collection of detailed information about worker fatalities will help guide these efforts.

NIOSH continues to develop relationships with state agencies and OSHA regional and area offices to enhance the collection and dissemination of information on oilfield fatalities. Increased access to state source documents will allow for validation of existing information, identification of additional motor vehicle fatalities, and provision of more robust information overall. Partnerships with states may also allow for joint reports to be produced containing specific information on an individual state's oilfield fatalities. ■

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of NIOSH. Mention of any company or product does not constitute endorsement by NIOSH.



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