

NIOSH Oil and Gas Sector Program: Using Data and Partnerships to Improve Safety and Health

Ryan Hill

Manager, NIOSH Oil & Gas Sector Program



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.

U.S. Oil and Gas Industry, 2014

Upstream

32% of workers
Fatality rate 22.9



Midstream

15% of workers
Fatality rate 4.1



Downstream

54% of workers
Fatality rate 4.2

U.S. Oil and Gas Extraction Industry, 2014



Operators

33% of workers
Fatality rate 11.3

Drilling Contractors

16% of workers
Fatality rate 44.6



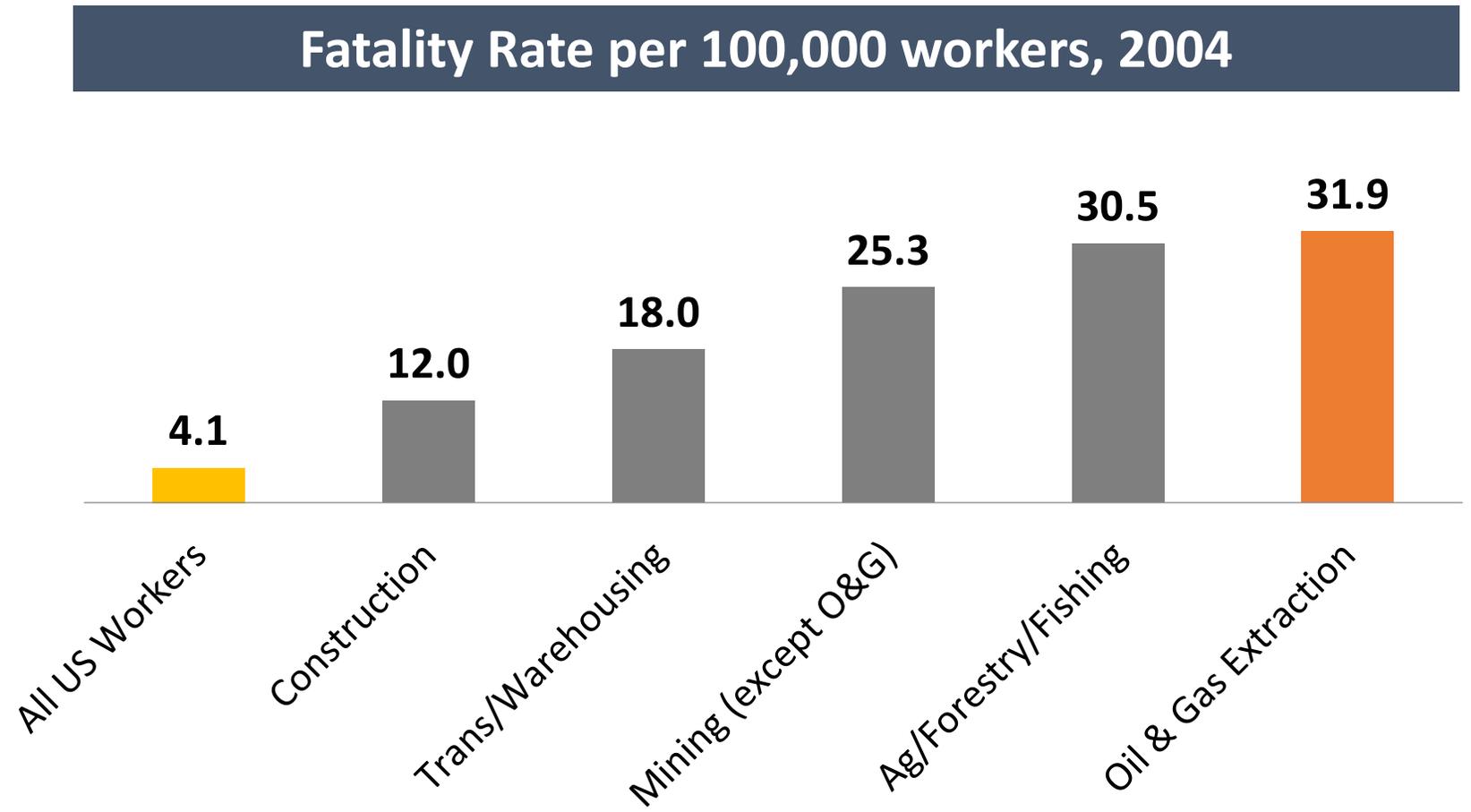
Well Servicing

50% of workers
Fatality rate 27.9

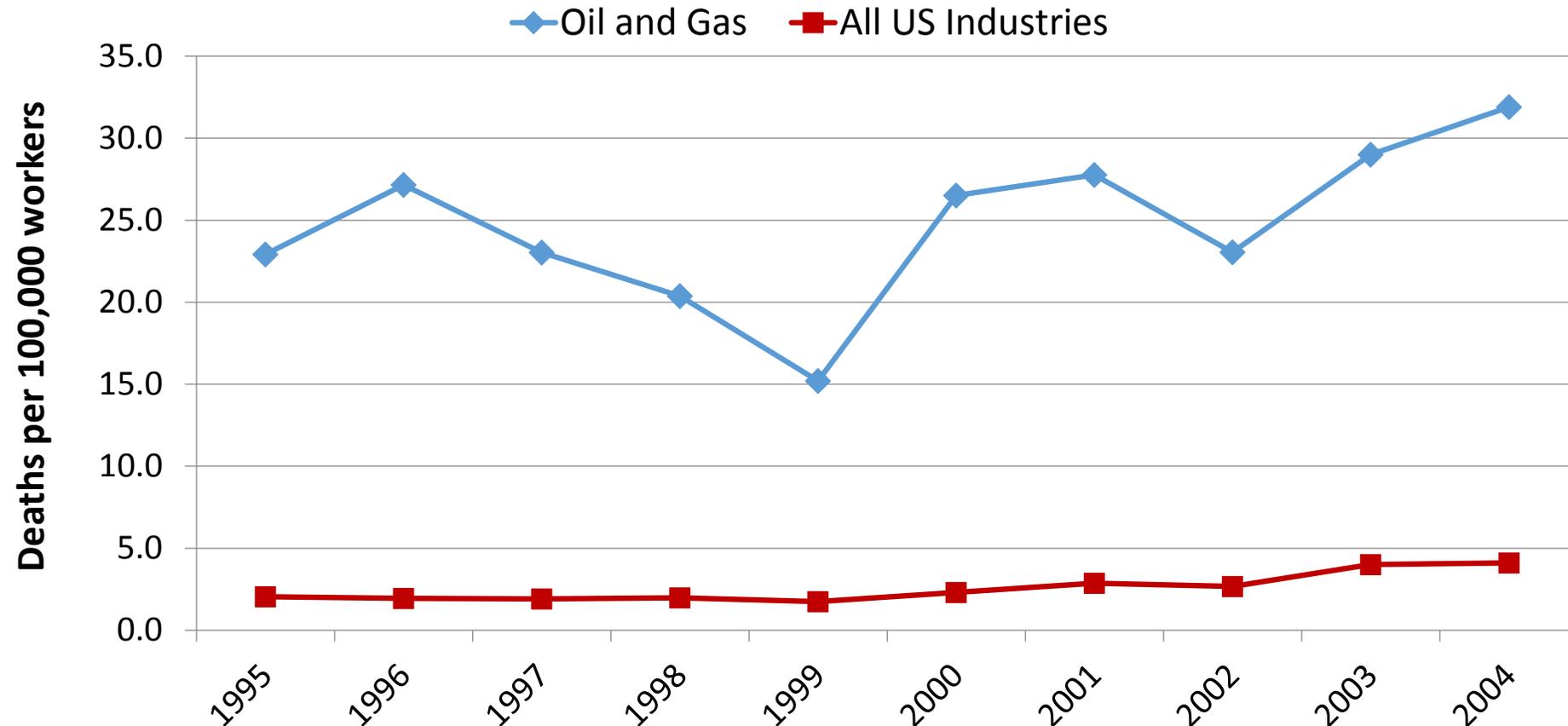
Why the NIOSH Oil and Gas Extraction Program Began

8x

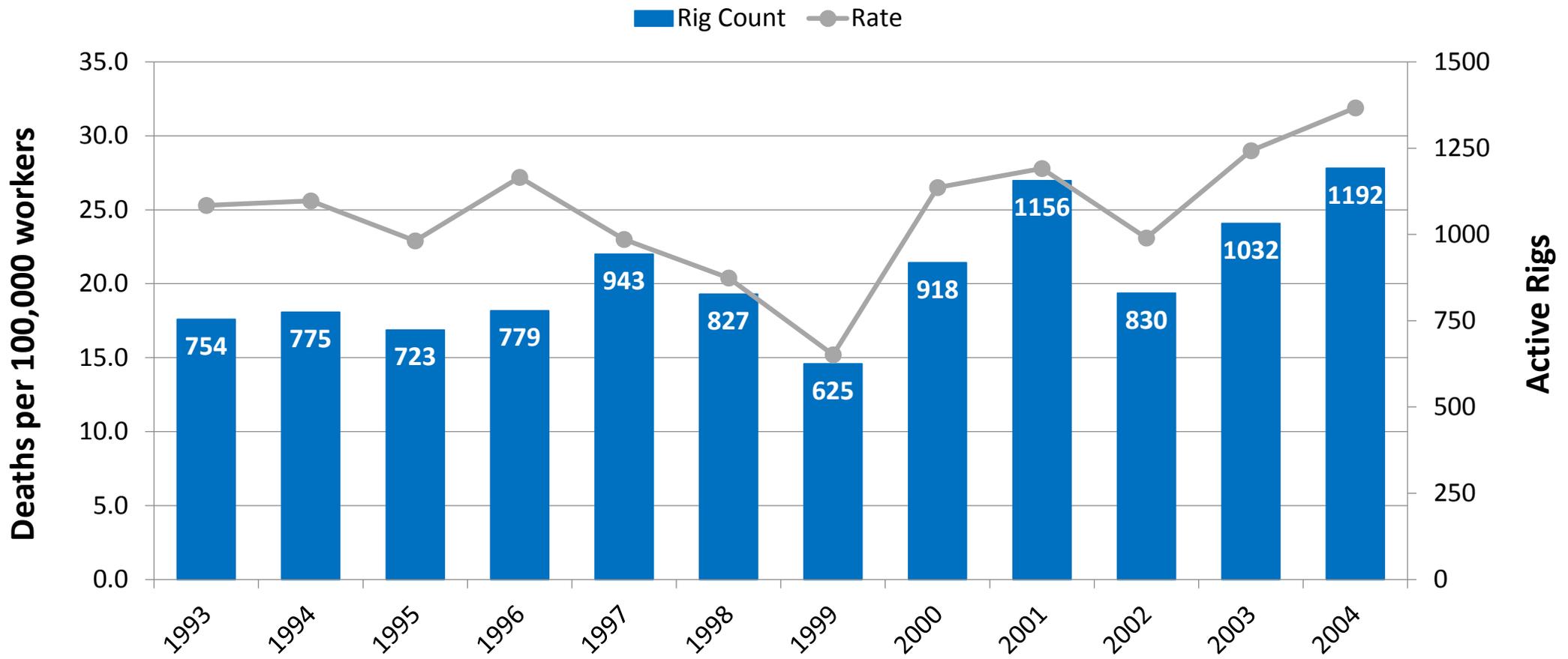
The fatality rate for the O&G industry in 2004 was almost 8 times higher than the rate for all U.S. workers



Occupational Fatality Rate, U.S. Oil and Gas Extraction and all U.S. Industries, 1993-2004



Occupational Fatality Rate and Industry Activity, U.S. Oil and Gas Extraction Industry, 1993-2004



Department of Health and Human Services
 Centers for Disease Control and Prevention
 National Institute of Occupational Safety and Health

Note: Fatality counts from BLS Census of Fatal Occupational Injuries. Worker Estimates from BLS Quarterly Census of Employment and Wages. Rate per 100,000 workers per year. Includes NAICS 211, 213111, 213112. Rig count from Baker Hughes.



Early NIOSH Work in Oil & Gas Extraction

- Identify and describe fatalities and risk factors
- Identify partners
- Well site visits
- Industry conferences and meetings



Establishing Partnerships to Enhance Impact



National Occupational Research Agenda (NORA) Oil & Gas Extraction Sector Council

Early NIOSH Outputs


MMWR
 Morbidity and Mortality Weekly Report
www.cdc.gov/mmwr

Weekly April 25, 2008 / Vol. 57 / No. 16

Workers' Memorial Day — April 28, 2008

Workers' Memorial Day, observed each year on April 28, was established to recognize workers who died or were injured on the job. In 2006, 5,840 workers in the United States died from injuries sustained at work (1); an estimated 49,000 annual deaths have been attributed to work-related diseases (2). In 2006, an estimated 4.1 million private-sector workers had a non-fatal work-related injury or illness; approximately half of these workers required a job transfer, work restrictions, or time away from their jobs (3). An estimated 3.4 million workers were treated in emergency departments in 2004 because of occupational injuries, and approximately 80,000 were hospitalized (4). In 2005, workers' compensation costs for employers totaled an estimated \$89 billion (5).

Additional information on workplace safety and health is available from CDC at <http://www.cdc.gov/niosh>. Information also is available by telephone, 800-CDC-INFO (800-232-4636).

References

1. US Department of Labor, Bureau of Labor Statistics, National Census of Fatal Occupational Injuries in 2006. Washington, DC: US Department of Labor; 2007. Available at <http://www.bls.gov/news.release/pdf/oa.pdf>.
2. Steinfeld K, Burnet C, Lalich N, Wand E, Hurrell J. Dying for work: the magnitude of U.S. mortality from selected causes of death associated with occupation. *Am J Ind Med* 2003;45:661-62.
3. US Department of Labor, Bureau of Labor Statistics. Workplace injuries and illnesses in 2006. Washington, DC: US Department of Labor; 2007. Available at <http://www.bls.gov/news.release/pdf/osh.pdf>.
4. CDC. Nonfatal occupational injuries and illnesses—United States, 2004. *MMWR* 2007;56:393-7.
5. Sengupta I, Reno V, Burton JF Jr. Workers' compensation benefits, coverage, and costs, 2005. Washington, DC: National Academy of Social Insurance; 2007. Available at http://www.nasi.org/usg_dnc/nasi_workers_comp_2005_full_report.pdf.

DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION

RIG CHECK

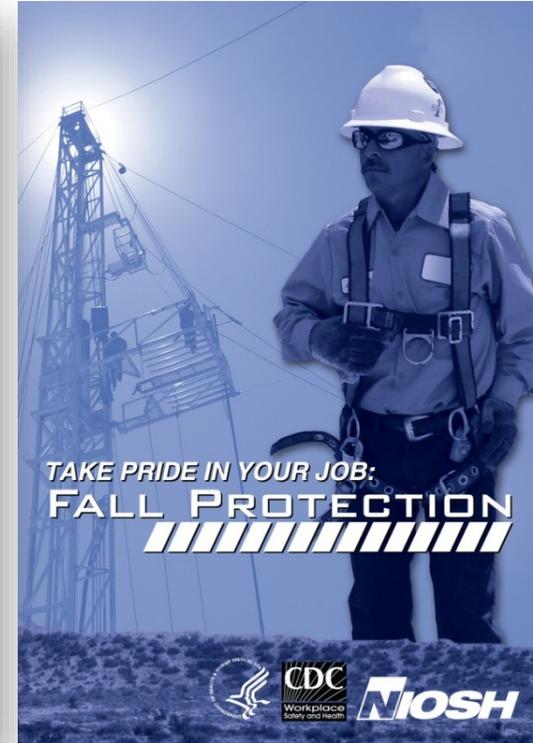
Rig Check was developed by the National Institute for Occupational Safety and Health (NIOSH) in partnership with safety experts from the oil and gas extraction industry. It is made up of 35 inspection forms. The forms are designed to be used by rig workers to document the inspection of tools and equipment commonly found on rotary and workover rigs. Each inspection form includes instructions for assessing and recording the condition of the equipment. When applicable, relevant federal regulations and industry recommended practices are included.

The Rig Check inspection forms are an excellent training tool for short service employees, who may not be familiar with the tools and equipment found on oil and gas rigs. Small companies whose safety and health resources are limited may find Rig Check useful for enhancing their HSE programs. The forms can also be downloaded from the NIOSH website at: www.cdc.gov/niosh/programs/oilgas/products.html.

Rig Check Monthly Inspection Forms:

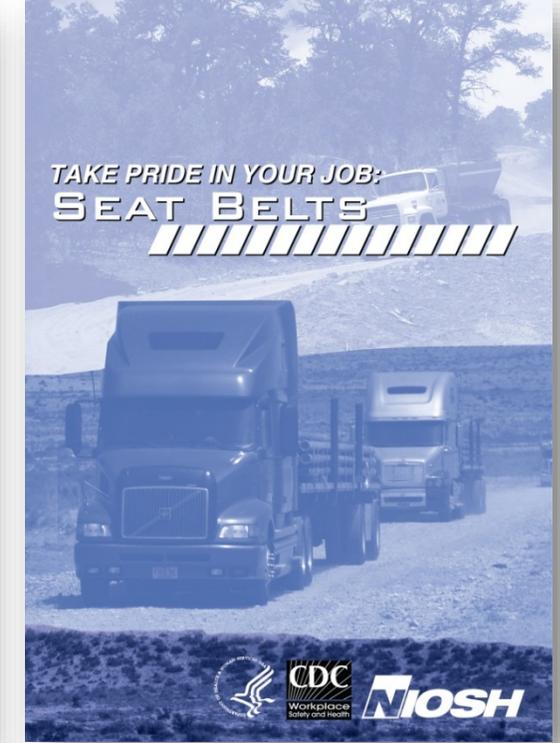
Emergency Responses: 1 Emergency Response Plan 2 Emergency Equipment 3 Alarms & Shutdown 4 Fire Extinguishers 5 Eye Wash Stations 6 First Aid Kits	Lines & Slings: 14 Auxiliary Hoisting Lines 15 Static Hanging Lines 16 Synthetic Web Slings 17 Wire Rope or Cable Slings 18 Chain Slings 19 Shackles	Ladders & Platforms: 27 Fixed Ladders 28 Portable Ladders 29 Fixed Platforms
Fatal Occupational Safety: 7 Energy Isolation 8 Electrical Systems	Tools: 20 Hand Tools 21 Power Tools	Ditches: 30 Dropped Objects 31 Housekeeping 32 Tubular Storage 33 Pins and Keepers 34 Machine Guarding 35 Load Path Welds
Fall Protection: 9 Harness & Lanyard 10 Retractable Lifelines	Hoses: 22 Hose & Fittings 23 Safety Chain & Whip Check	Stairways & Walkways: 11 Stairways & Landings 12 Handrails & Guardrails 13 Gratings & Walkways
Stairways & Walkways: 11 Stairways & Landings 12 Handrails & Guardrails 13 Gratings & Walkways	Chemical Hazards: 24 Material Safety Data Sheets (MSDS) 25 Chemical Storage 26 Compressed Gas	



TAKE PRIDE IN YOUR JOB:
FALL PROTECTION



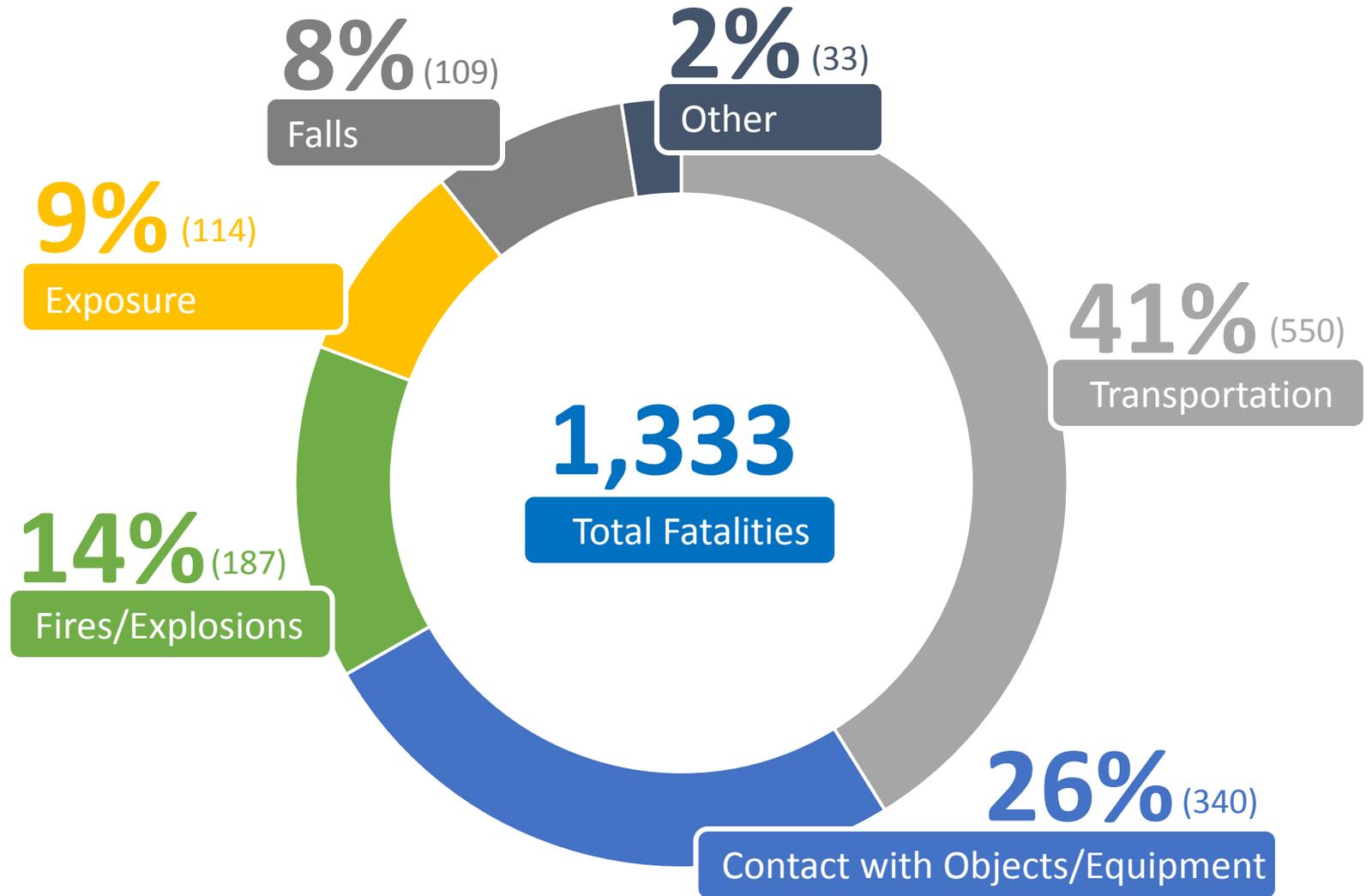



TAKE PRIDE IN YOUR JOB:
SEAT BELTS



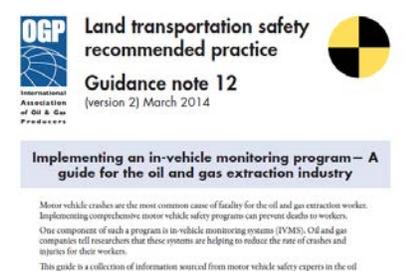

Injury Surveillance and Prevention

Most Frequent Fatal Events, U.S. Oil & Gas Extraction Industry, 2003-2014



Addressing the Leading Cause of Death in the Oil and Gas Extraction Industry: Motor Vehicle Crashes

- Identification of risk factors
- Identification of best practices
- Formation of national workgroup
- Dissemination of guidance documents



Different risks for different basins?

Is distraction or fatigue a factor?

Struck by what?

Do they work where they live?

Are some vehicles more dangerous?



What are the most common ignition sources?

What are the most dangerous operations?

Different risks for different basins? *Is distraction or fatigue a factor?*
Struck by what?
Do they work in any order?
Are some vehicles more dangerous?
What are the most common ignition sources?
What are the most dangerous operations?

The details needed to answer these questions are not available in existing data sources.

Fatalities in Oil and Gas (FOG) Database

Internal database that collects [detailed information](#) about oil and gas worker fatalities in the U.S.

Includes

Fatal events to U.S. oil and gas extraction workers:

- Onshore
- Offshore
- **O&G-related NAICS**
- Motor vehicle incidents
- **Non-traditional commuting**
- Cardiac events

Excludes

Midstream, downstream, non-fatal injuries

Data Sources

OSHA case files, media, crash reports, autopsy reports, industry partners

Fatalities in Oil and Gas (FOG) Database



50

Variables per Incident

- ✓ Industry operations (17)
- ✓ Industry activities (45)
- ✓ Geologic “play”
- ✓ Contributing factors (i.e. fatigue, weather)



41

Variables per Worker

- ✓ Industry-specific occupations
- ✓ Years in Oilfield
- ✓ English as a Second Language

Outputs from FOG

NIOSH-OSHA HAZARD ALERT

Health and Safety Risks for Workers Involved in Manual Tank Gauging and Sampling at Oil and Gas Extraction Sites

The National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) have identified health and safety risks to workers who manually gauge or sample fluids on production and flowback tanks from exposure to hydrocarbon gases and vapors, exposure to oxygen-deficient atmospheres, and the potential for fires and explosions.

Introduction

Workers at oil and gas extraction sites could be exposed to hydrocarbon gases and vapors, oxygen-deficient atmospheres, and fires and explosions when they open tank hatches to manually gauge or collect fluid samples on production, flowback, or other tanks (e.g., drip pots) that contain process fluids. Opening tank hatches, often referred to as "thief hatches," can result in the release of high concentrations of hydrocarbon gases and vapors. These exposures can have immediate health effects, including loss of consciousness and death.

Recent NIOSH and OSHA research showed that workers could be exposed to hydrocarbon gases and vapors when they work on or near production and flowback tanks. This means workers can face significant health and safety risks when they manually gauge or sample tanks (Eswein et al. 2014; Jordan 2013). These risks are in addition to the risk of exposure to hydrogen sulfide (H₂S), a well-recognized chemical exposure hazard for those who work in the oil and gas extraction and production industry (OSHA).

NIOSH and OSHA also identified nine worker fatalities that occurred while workers manually gauged or sampled production tanks from 2010–2014 (NIOSH 2013). Exposures to hydrocarbon gases and vapors and/or oxygen-deficient atmospheres are believed to be primary or contributory factors to the workers' deaths (Harrison et al. 2016).

Working on or near oil and gas production tanks is of particular concern because these tanks may contain concentrated hydrocarbon gases and vapors that are under pressure. When the thief hatch is opened, the release of these pressurized gases and vapors can expose workers. Second, the gases and vapors can displace



A worker collecting a sample from the open hatch of a production tank. Image: J.D. Davis, OSHA.

oxygen, creating an oxygen-deficient environment. Third, the hydrocarbon gas and vapor concentrations can exceed 10% of the lower explosive limit (LEL), creating a chance for fires and explosions. Exposure to hazardous atmospheres and fire/explosion risks will vary depending on tank contents and operating conditions, the presence of ignition sources, and other factors (Box 1, page 3).

What's in this Alert?

This Hazard Alert describes the safety and health hazards when workers manually gauge or sample fluids from production, flowback, or other tanks. It recommends ways to protect workers by eliminating or reducing exposures to hazardous atmospheres, and actions employers should take to ensure that workers are properly aware of the hazards and protected from exposure to hydrocarbon gases and vapors. This alert is a supplement to the OSHA Alliance Tank Hazard Alert released in 2015 [National STEPS Network 2015].

1-800-321-OSHA (6742) • www.osha.gov

1

1-800-CDC-INFO (1-800-232-4636) • www.cdc.gov/niosh

OIL AND GAS EXTRACTION WORKER FATALITIES

2014 Mid-Year Report: January 1, 2014 – June 30, 2014

Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

Morbidity and Mortality Weekly Report

Sudden Deaths Among Oil and Gas Extraction Workers Resulting from Oxygen Deficiency and Inhalation of Hydrocarbon Gases and Vapors — United States, January 2010–March 2015

Robert J. Harrison, MD¹; Kyla Renter, MPH²; Michael J. Konett, MD^{3,4}; Michael Hodgson, MD⁵; Todd Jordan, MSPH⁶; Sophia Rot⁷; Max Kiefer, MS⁸

In 2013, an occupational medicine physician from the University of California, San Francisco, contacted CDC's National Institute for Occupational Safety and Health (NIOSH), and the Occupational Safety and Health Administration (OSHA) about two oil and gas extraction worker deaths in the western United States. The suspected cause of these deaths was exposure to hydrocarbon gases and vapors (HGVs) and oxygen (O₂)-deficient atmospheres after opening the hatches of hydrocarbon storage tanks. The physician and experts from NIOSH and OSHA reviewed available fatality reports from January 2010 to March 2015, and identified seven additional deaths with similar characteristics (nine total deaths). Recommendations were made to industry and regulators regarding the hazards associated with opening hatches of tanks, and controls to reduce or eliminate the potential for HGV exposure were proposed. Health care professionals who treat or evaluate oil and gas workers need to be aware that workers might report symptoms of exposure to high concentrations of HGVs and possible O₂ deficiency; employers and workers need to be aware of this hazard and know how to limit exposure. Medical examiners investigating the death of oil and gas workers who open tank hatches should consider the contribution of O₂ deficiency and HGV exposure.

Workers at oil and gas well sites often manually gauge the level of fluid or collect a sample from storage tanks containing process fluids. These workers climb to the top of the tanks, open a "thief" hatch (a closable aperture on atmospheric tanks, used to sample the tank contents) (Figure), and either place a device into the hatch to measure the fluid level or lower a "thief" sampler (a hollow tube) into the tank to collect liquid samples. In 2013, an occupational medicine physician from the University of California, San Francisco, received a report of a 2012 oil and gas worker fatality in North Dakota: that state's medical examiner attributed death to the inhalation of petroleum hydrocarbons. The male worker, aged 21 years, was gauging crude oil production tanks on the well site, at night and alone. A coworker found the victim unconscious near the open hatch. Colleagues initiated cardiopulmonary resuscitation, and the worker was transported to the hospital where he was pronounced dead approximately 2 hours later. An autopsy found no obvious signs of traumatic injury. Toxicology testing identified detectable quantities of low-molecular weight

hydrocarbons (propane and butane), and evidence of heavier molecular weight hydrocarbons. No indication of exposure to hydrogen sulfide (H₂S) was identified. Initially, the death was attributed to cardiovascular disease and later to hydrocarbons. The occupational medicine physician subsequently identified a second worker who died from a sudden cardiac event in 2010 while performing tank gauging; H₂S was excluded as a factor. The physician contacted NIOSH and OSHA about these two deaths.

To identify other oil and gas extraction worker fatalities associated with exposure to HGVs, the physician and experts from NIOSH and OSHA reviewed media reports, OSHA case files, and the NIOSH Fatalities in Oil and Gas database. Cases were defined as nontraumatic oil and gas extraction worker deaths occurring during January 2010–March 2015, in which the workers were 1) performing tank gauging, sampling, or fluid transfer activities at oil and gas well sites; 2) working in proximity to a known and concentrated source of HGVs (e.g., an open hatch); 3) not working in a confined space; and 4) not exposed to H₂S, fires, or explosions. All available information on identified fatalities was reviewed, including OSHA investigations, coroner and toxicology reports, gas monitor data, and exposure assessment data.

Nine deaths, occurring from January 2010 to March 2015, were identified (Table); six of the deaths occurred during 2014. Three deaths occurred in Colorado, three in North Dakota, and one each in Montana, Oklahoma, and Texas. The median age of workers was 51 years (range = 20–63 years), and all were male. All of the victims were working alone at the time of the incidents and were found collapsed on a tank or catwalk, or at the base of the catwalk stairs. In at least five cases, the hatch was open when the worker was found. Five of the fatalities occurred during the collection of a fluid sample, and four occurred during tank gauging. Toxicologic data on HGVs were not consistently collected during autopsy, but petroleum hydrocarbon vapors were noted as a cause of death for three workers.

Only one of the nine workers was known to have been provided a respirator, but fit-testing had not occurred, and the air-purifying respirator was not suitable for high concentrations of HGVs or O₂ deficiency. The exposure assessment conducted by OSHA following the 2010 case found O₂ concentrations as low as 11% at 1 foot above the open thief hatch (O₂ concentrations

6

MMWR / January 15, 2016 / Vol. 65 / No. 1

US Department of Health and Human Services/Centers for Disease Control and Prevention



Impact of FOG



Two new American Petroleum Institute Standards:

- **RP 18.2:** Alternative Methods for Gauging/Sampling
- **RP 77:** Risk-based Approach for Managing Hydrocarbon Vapor Exposure during Manual Tank Gauging and Sampling of Onshore Production Facilities



Bureau of Land Management:

Update Onshore Order 4 to allow for alternative methods for gauging/sampling

Identification and Control of Health Hazards



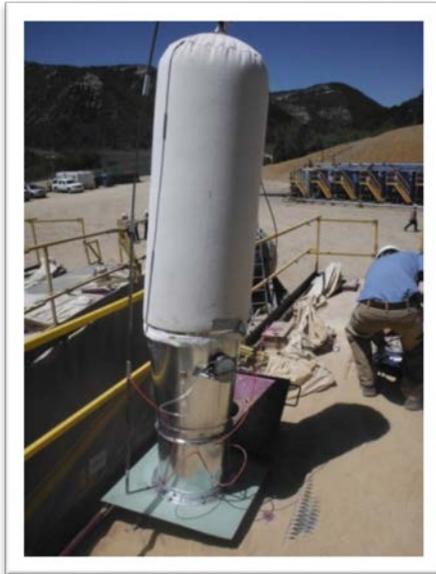
NIOSH researchers were the first to systematically evaluate occupational exposures to workers at hydraulic fracturing sites¹

- Personal breathing zone samples were collected for workers in 2010 and 2011
- Silica exposures for some workers can be 10-50 times greater than occupational exposure limits



NIOSH mini baghouse retrofit assembly

2012



2013



2015



Features

- ✓ Highly effective
- ✓ Inexpensive
- ✓ “Bolt-on”
- ✓ No moving parts
- ✓ In-field retrofit

Oilfield Production Tanks – An Emerging Hazard



Opening Tank Hatches

When hatches on production tanks are opened by a worker, a plume of hydrocarbon gases and vapors can be rapidly released.



MOV 403 Fluttering Hatch Vent
Dickinson, ND
26 August, 2015

Fatalities Associated with Oilfield Production Tanks

Nine (9) worker deaths identified where inhalation of petroleum hydrocarbons was likely factor.

- All occurred at production tanks
- All were working alone
- 5 fatalities occurred to fluid haulers when collecting a sample
- One employee was wearing 4-gas monitor
- One had sought medical evaluation a few weeks prior to death



More information: www.cdc.gov/niosh/topics/fog/data.html

TANK HAZARD ALERT

gauging • thieving • fluid handling
how to recognize and avoid hazards

Opening thief hatches of storage tanks can lead to the rapid release of high concentrations of hydrocarbon gases and vapors. Those may result in very low oxygen levels and toxic and flammable conditions around and over the hatch. Recent reports have documented fires or explosions, and described workers experiencing dizziness, fainting, headache, nausea, and, in some cases, death while gauging tanks, collecting samples, or transferring fluids. Tank gauging, thieving, and fluid handling can be performed safely with proper precautions.



hazards that workers can encounter

- oxygen deficiency
- fires & explosions
- chemical toxicity: hydrocarbon vapors, propane, butane, benzene
- hydrogen sulfide (H₂S)

potential effects of exposure

- death
- chronic illness
- flash fire burns
- dizziness
- irregular heartbeat
- irregular breathing
- respiratory irritation
- fatigue
- nausea
- eye irritation
- headache

EMPLOYERS:

Must Conduct Exposure and Hazard Assessments at Worksites to determine needs for:

- Engineering Controls
- Respiratory Protection
- PPE
- Monitoring Device such as:
 - Multi-gas meter
 - Other direct-reading toxic gas meter (benzene)

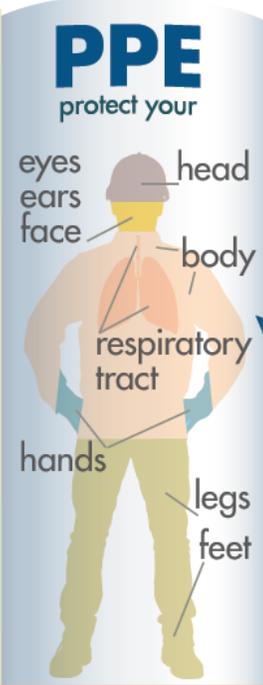
Must Provide Training to Workers:

- Hazard Communication
- Lone Worker Policy
- Proper use of PPE and respiratory protection
- Types, use, and limits of respiratory protection equipment as appropriate
- Recognizing ignition sources
- Tank Gauging work practices/procedures
- Emergency Response Plan
 - Procedures for alarm response and site re-entry
- Use and limits of toxic- or multi-gas meter for O₂, H₂S, LEL, and CO

Should Implement Engineering Controls such as:

- Remote Gauging
- Closed Loop Systems
- Auto Gauging
- Sight Glasses/Gauges
- Remote Venting

Verify sub-contractors are following work practices/procedures



WORKERS:

Your employer has established safety procedures for your protection including a **Hazard Assessment** and **Work Practices/Procedures**

Follow your employer's Hazard Assessment and Established Work Practices/Procedures

- Use toxic- or multi-gas meter provided by your employer as per your training
- Heed all alarms
- Stop flow into tanks prior to gauging, **when possible**
- Minimize leaning over open hatches – stand away/upwind/crosswind when possible
 - Inversion/high humidity/lack of wind could increase danger
- Follow your employer's "lone worker" policy
- Allow tanks to ventilate after opening thief hatches
- Evacuate unsafe work areas and report immediately
- Know the limits of your respiratory protection as provided during employer training
- Immediately report any health symptoms

Wear PPE as required/provided

Attend Hazard Communication Training

Be Aware of Potential Ignition Sources:

- Static
- Cell phones
- Sparks from tools or metal objects
- Open flames
- Non-approved electrical equipment/devices
- Ensure proper grounding/bonding

If you are not sure, **STOP** the job and ask!

Everyone has the right to STOP work that is unsafe.

Through the OSHA National Steps Alliance, this Tank Gauging Hazard Alert is for informational purposes only. It does not necessarily reflect the official views of OSHA or the U.S. Department of Labor. March, 2015

Under the Occupational Safety and Health Act, employers are responsible for providing a safe and healthy workplace and workers have rights. OSHA can help answer questions or concerns from employers and workers. OSHA's On-site Consultation Program (www.osha.gov/consultation) offers free and confidential advice to small and medium-sized businesses, with priority given to high-hazard worksites. For more information, contact your regional or area OSHA office (www.osha.gov/html/RAmap.html), call 1-800-321-OSHA (6742), or visit www.osha.gov.



YOUR LIFE can change in a **SINGLE BREATH** or with **ONE SPARK.**



Recent NIOSH Publications

OSHA-NIOSH HAZARD ALERT

Worker Exposure to Silica during Hydraulic Fracturing

The National Institute for Occupational Safety and Health (NIOSH) identified exposure to airborne silica as a health hazard to workers conducting some hydraulic fracturing operations during recent field studies.

Introduction

Hydraulic fracturing or "fracking" is a process used to "stimulate" well production in the oil and gas industry. It is not a new process, but its use has increased significantly in the last 10 years because of new horizontal drilling and multi-stage fracking (or "completions") technologies that improve access to natural gas and oil deposits. It involves pumping large volumes of water and sand into a well at high pressure to fracture shale and other tight formations, allowing oil and gas to flow into the well.

NIOSH's recent field studies show that workers may be exposed to dust with high levels of respirable crystalline silica (called "silica" in this hazard alert) during hydraulic fracturing.

This hazard alert discusses the health hazards associated with hydraulic fracturing and focuses on worker exposures to silica in the air. It covers the health effects of breathing silica, recommends ways to protect workers, and describes how OSHA and NIOSH can help. Workers and employers need to be aware of the hazard that silica dust poses. Employers must ensure that workers are properly protected from exposure to silica. This hazard alert also provides a brief summary of other health and safety hazards to workers conducting hydraulic fracturing activities.

Crystalline silica is a common mineral found in the earth's crust. It occurs primarily as quartz and is a major component of the sand, clay and stone materials used to make many dry products both as aggregates, brick and glass.

Respirable crystalline silica is the portion of crystalline silica that is small enough to enter the gas-exchange regions of the lungs if inhaled; this includes particles with aerodynamic diameters less than approximately 10 micrometers (µm).

1-800-321-OSHA (6742) • www.osha.gov



Silica dust can cause lung disease.

OSHA and NIOSH are working to reduce the risk of silica exposure to workers, and are providing information on how to protect workers and employers.

OSHA has workers, mid and senior level Occupational Safety and Health (OSHA) and NIOSH can help. Workers and employers need to be aware of the hazard that silica dust poses.

Occupational Exposures to Respirable Crystalline Silica During Hydraulic Fracturing

Eric J. Esswein,¹ Michael Breitenstein,² John Snawder,² Max Kiefer,¹ and W. Karl Sieber¹

¹National Institute for Occupational Safety and Health, Western States Office, Denver, Colorado
²National Institute for Occupational Safety and Health, Division of Applied Research and Technology, Cincinnati, Ohio
³National Institute for Occupational Safety and Health, Division of Surveillance, Hazard Evaluations and Field Studies, Cincinnati, Ohio

This report describes a previously uncharacterized occupational health hazard: work crew exposures to respirable crystalline silica during hydraulic fracturing. Hydraulic fracturing involves high-pressure injection of large volumes of water and sand, and smaller quantities of well treatment chemicals, into a gas or oil well to fracture shale and other rock formations, allowing more efficient recovery of hydrocarbons from a petroleum-bearing reservoir. Crystalline silica ("silica") is commonly used as a proppant to hold open cracks and fractures created by hydraulic pressure. Each stage of the process requires hundreds of thousands of pounds of quartz-containing sand; millions of pounds may be needed for all stages of a well. Mechanical handling of the sand used creates respirable crystalline silica dust, a potential exposure hazard for workers. Researchers at the National Institute for Occupational Safety and Health collected 111 personal breathing zone samples at 11 sites in five states to evaluate worker exposures to respirable crystalline silica during hydraulic fracturing. At each of the 11 sites, field staff sampled occupational health criteria (i.e., the Occupational Safety and Health Administration's recommended exposure limit, or the ACGIH threshold limit value) in some cases, by 10 or more times the occupational health criteria. Based on these evaluations, an occupational health hazard was determined to exist for workers exposed to crystalline silica. Seven points of dust generation were identified, including sand handling machinery and dust generated from the sand and itself. Recommendations to control exposures include product substitution (where feasible), engineering controls or modifications to sand handling machinery, administrative controls, and use of personal protective equipment. To our knowledge, this represents the first systematic study of work crew exposures to crystalline silica during hydraulic fracturing. Companies that conduct hydraulic fracturing using silica sand should evaluate their operations to determine the potential for worker exposure to respirable crystalline silica and implement controls as necessary.

Employment materials are available for this article. Go to the publisher's website at www.cdc.gov/niosh and Environmental Hygiene for the following first supplementary text: a list of consulting contacts and recommendations.

To limit worker exposure to respirable crystalline silica at hydraulic fracturing work sites.

Keywords: completion operations, crystalline silica, hydraulic fracturing, occupational health, quartz

Journal of Occupational and Environmental Hygiene, 11 (10) 516-526
DOI: 10.1080/15247729.2014.933690

Case Study Evaluation of Some Potential Chemical Exposure Risks During Flowback Operations in Unconventional Oil and Gas Extraction: Preliminary Results

Column Editor: James Collier

Reported by: Eric J. Esswein,¹ John Snawder,² Bradley King,³ Michael Breitenstein,² Marissa Alexander-Scoff,³ Max Kiefer¹

¹National Institute for Occupational Safety and Health, Western States Office, Denver, Colorado
²National Institute for Occupational Safety and Health, Division of Applied Research and Technology, Cincinnati, Ohio
³Address correspondence to: Eric J. Esswein, National Institute for Occupational Safety and Health, Western States Office, Denver, CO; e-mail: eric.esswein@cdc.gov

This article is not subject to US copyright law.

Hydrofracture extraction is the primary objective of oil and gas exploration and production (E&P). Nonenhancing formation fluids, the potential for chemical exposures may be encountered during many stages of E&P, including drilling, completion (which includes hydraulic fracturing), and well servicing. Chemicals used in the oil and gas industry, as well as the petroleum product, can present exposure risks to volatile organic compounds (VOCs), including naphthalene, benzene, ethylbenzene and toluene (NAPHTH). Additionally, other aliphatic and aromatic compounds (e.g., gasoline and diesel-range organics and mixtures), alcohols, aldehydes, and combustion products (e.g., circles of nitrogen, oxides, and diesel particulates) can pose occupational exposure risks for workers during E&P operations. Because it is a VOC of major concern because of its carcinogenic potential and because it can be acutely toxic to the nervous system, liver, and kidneys at high concentrations,¹⁻³ other VOCs associated with hydraulic fracturing and flowback operations.

Injury Rates on New and Old Technology Oil and Gas Rigs Operated by the Largest United States Onshore Drilling Contractor

David J. Blackley, ^{1,2} Kyla D. Retzer, ^{3,4} Warren C. Hub and A. Scott Laney, ^{5,6} PhD, MS¹

Background: Occupational fatality rates among oil and gas rigs specifically among oil and gas contractor workers are high compared to other industries. There is a need for research to identify occupational injuries among some of which have involved engineering controls to improve rig safety.

Methods: We compared injury rates on new and old technology in large U.S. drilling contractors during 2003-2012, comparing by job category to injury severity and injury type.

Results: Six hundred seventy-two injuries were recorded over 77.4 million man-hours on new rigs, 60% of them on old rigs. Compared to old rigs, new rigs largely reduced total injury rates. New rigs had less total injury severity category.

Conclusions: For this company, new technology rigs appear to provide for roughly the same number of total injuries from additional man-hours.

KEY WORDS: oil and gas extraction; drilling contractors; occupational injury; engineering controls

INTRODUCTION

The U.S. Energy Information Administration (EIA) projects continued growth in domestic oil and natural gas production (30% by 2035).¹ Drilling contractors are responsible for the majority of new oil and gas wells drilled in the United States. The U.S. Energy Information Administration (EIA) projects continued growth in domestic oil and natural gas production (30% by 2035).¹ Drilling contractors are responsible for the majority of new oil and gas wells drilled in the United States. The U.S. Energy Information Administration (EIA) projects continued growth in domestic oil and natural gas production (30% by 2035).¹ Drilling contractors are responsible for the majority of new oil and gas wells drilled in the United States.

Occupational Fatalities During the Oil and Gas Boom—United States, 2003–2013

Kenneth L. Mann, ^{1,2,3} PhD; Kyle D. Retzer, ^{4,5} PhD; Warren C. Hub, ^{6,7} PhD; A. Scott Laney, ^{8,9} PhD; (Author affiliations are in end text)

During 2003–2013, the U.S. oil and gas extraction industry experienced unprecedented growth, doubling the size of its workforce and increasing the number of drilling rigs by 71% (1.2). To describe fatal events among oil and gas workers during this period, CDC analyzed data from the Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injuries (CFOI), a comprehensive database of fatal work injuries (3). During 2003–2013, the number of work-related fatalities in the oil and gas extraction industry increased 27.6%, with a total of 1,189 deaths; however, the annual occupational fatality rate significantly decreased 36.3% (p<0.05) during this 11-year period. Two-thirds of all worker fatalities were attributed to transportation incidents (479, 40.3%) and contact with objects/equipment (308, 25.9%). More than 50% of persons fatally injured were employed by companies that service wells (65 [51.7%]). It is important for employers to consider measures such as land transportation safety policies and engineering controls (e.g., automated technologies) that would address these leading causes of death and reduce worker exposures to hazards (4–6).

Publicly available data from CFOI were used to determine the number of fatal injuries to workers in the U.S. land-based and offshore oil and gas extraction industry during 2003–2013. CFOI offers information from multiple data sources to identify, verify, and describe fatal work injuries in consistent work-related (1). The event leading to the injury occurred while the employee was working and (2) the event is attributable to at least two independent data sources.⁴ The North American Industry Classification System (NAICS) was used to identify fatal events among the three types of companies in the oil and gas extraction industry: oil and gas operations that control and manage land wells (NAICS 211), oil and gas drilling contractors that drill the wells (NAICS 21311), and well-servicing companies that provide all other types of support operations that prepare a well for production and completion (NAICS 21312). Annual occupational fatality rates were calculated using worker estimates from the Bureau of Economic Analysis (5).⁵ A detailed description of the methodology is available at www.cdc.gov/niosh.



OIL AND GAS EXTRACTION WORKER FATALITIES
2014 Mid-Year Report: January 1, 2014 – June 30, 2014

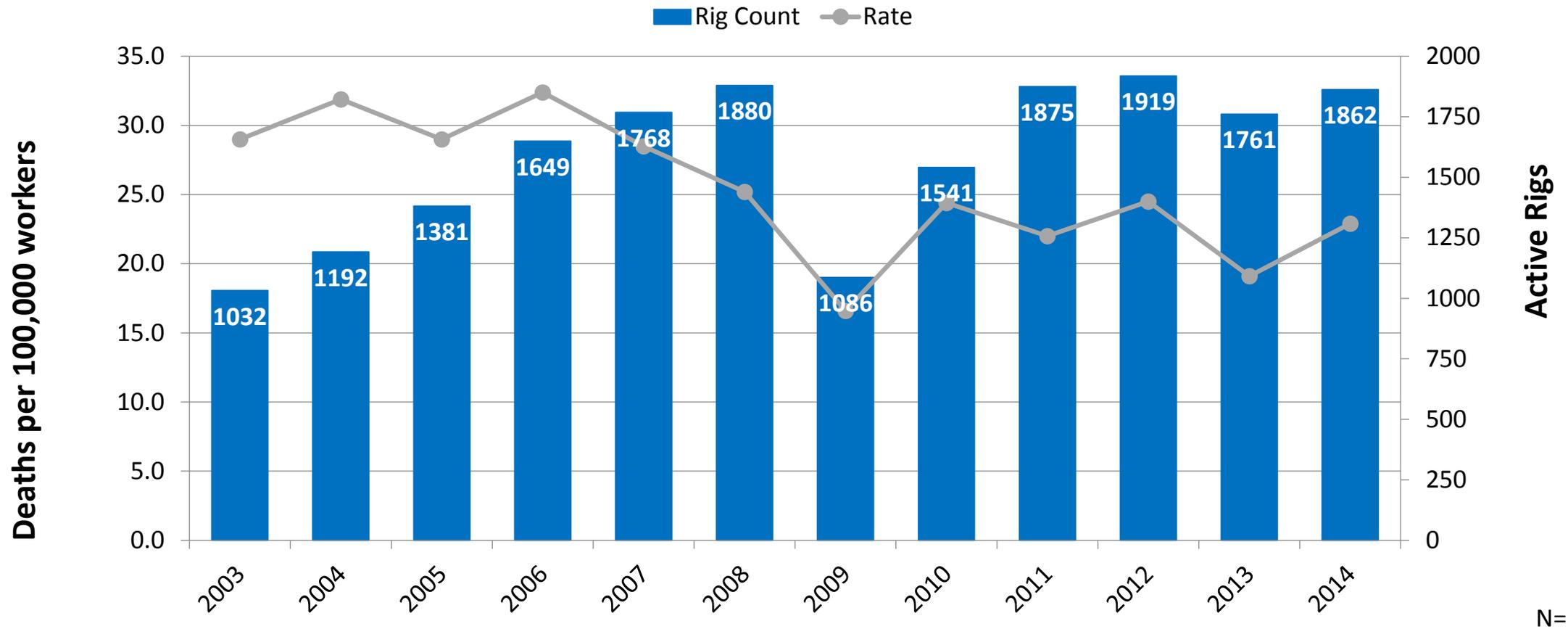


Source: U.S. Department of Labor, Bureau of Labor Statistics, Department of Health and Human Services, National Institute for Occupational Safety and Health. *Fatality rate calculated per 100,000 worker-hours (estimated from Bureau of Economic Analysis, 2013). Data are preliminary.



Occupational Fatality Rate is Improving

U.S. Oil and Gas Extraction Industry, 2003-2014



N=1,333

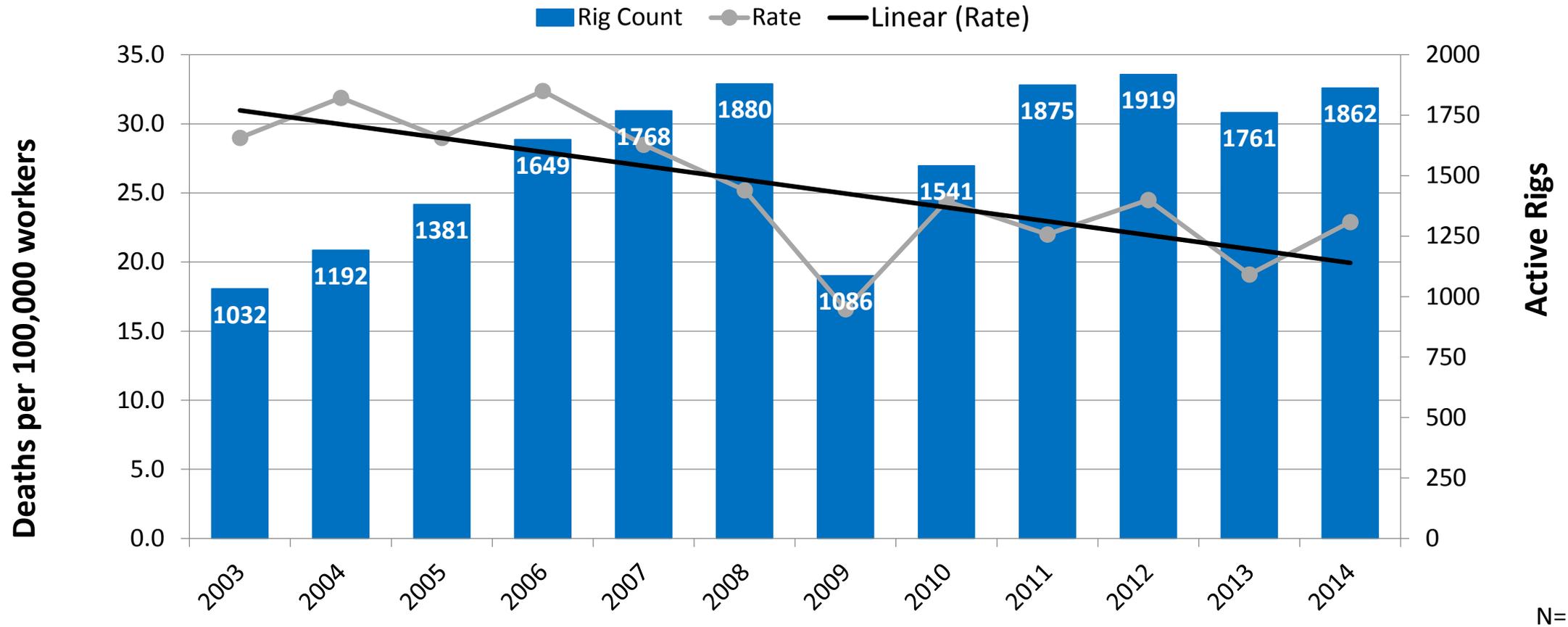
Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute of Occupational Safety and Health

Note: Fatality counts from BLS Census of Fatal Occupational Injuries. Worker Estimates from BLS Quarterly Census of Employment and Wages. Rate per 100,000 workers per year. Includes NAICS 211, 213111, 213112. Rig count from Baker Hughes.



Occupational Fatality Rate is Improving

U.S. Oil and Gas Extraction Industry, 2003-2014



N=1,333

Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute of Occupational Safety and Health

Note: Fatality counts from BLS Census of Fatal Occupational Injuries. Worker Estimates from BLS Quarterly Census of Employment and Wages. Rate per 100,000 workers per year. Includes NAICS 211, 213111, 213112. Rig count from Baker Hughes.



Questions for BSC Members to consider...

- We want to reach small companies/contractors with OSH information. Are there success stories from other industries that we may be able to learn from?
- Given that there are now 4 generations of workers in the U.S. workforce, what strategies have been effective in other industries that might help oil and gas companies develop and deliver effective training to new/young workers?
- We would like to expand FOG to include non-fatal cases. What advice does the BSC have on how to approach and collaborate with states and other partners?

Contact Information

Ryan Hill

rdhill1@cdc.gov, 304.285.6329

NIOSH Oil & Gas Homepage www.cdc.gov/niosh/programs/oilgas

