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

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

U.S. Oil and Gas Industry, 2014

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

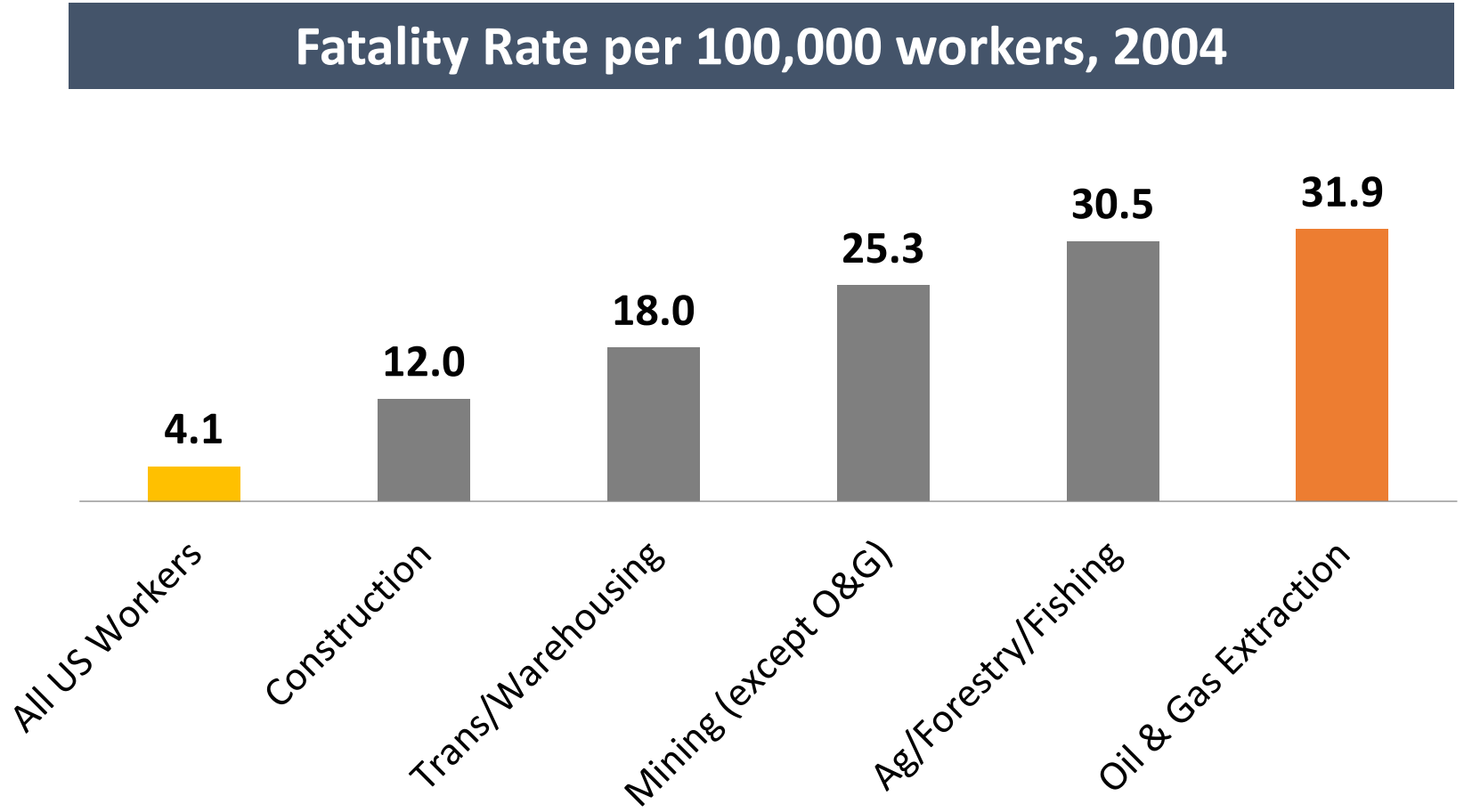
50% of workers

Fatality rate 27.9

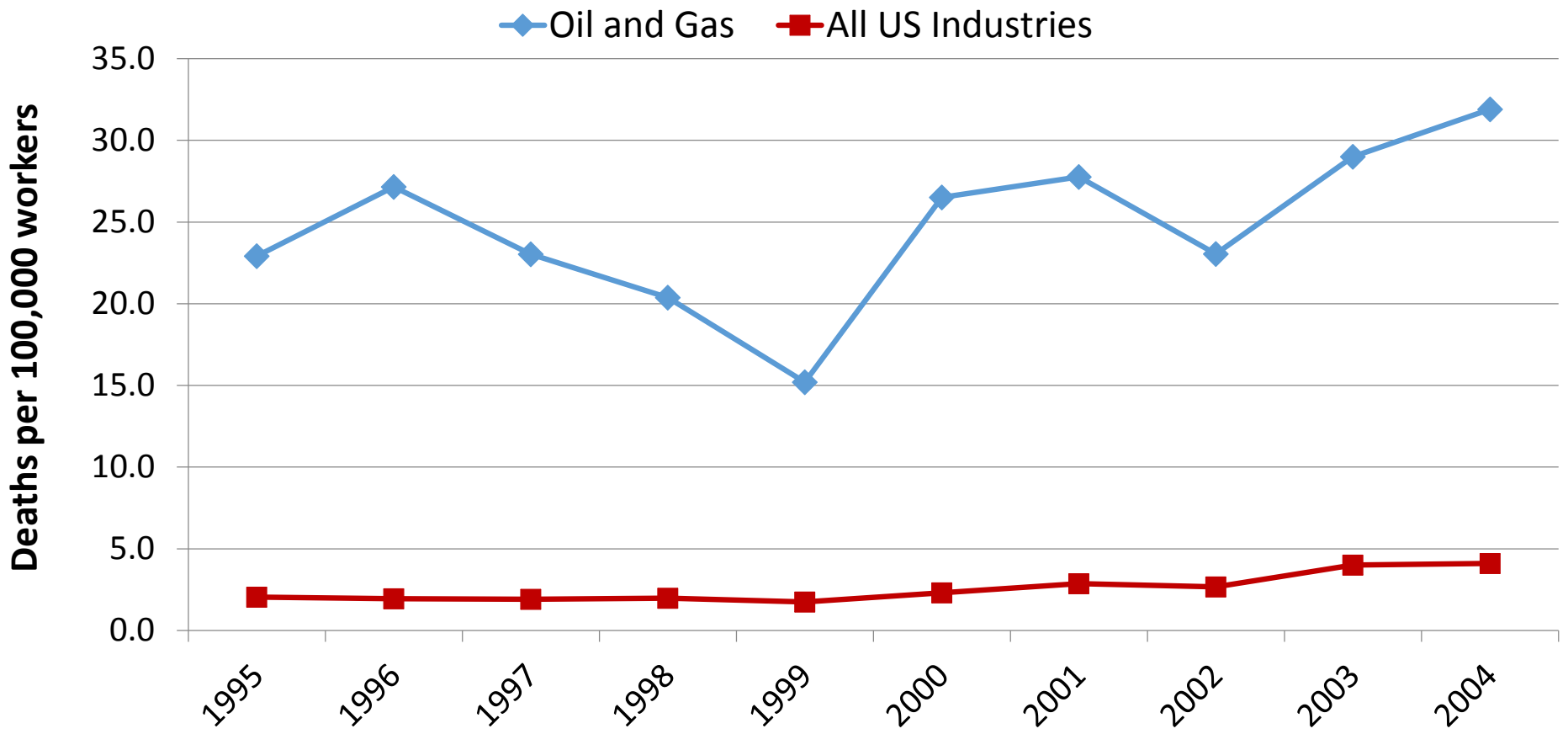
Why the NIOSH Oil and Gas Extraction Program Began

8x

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

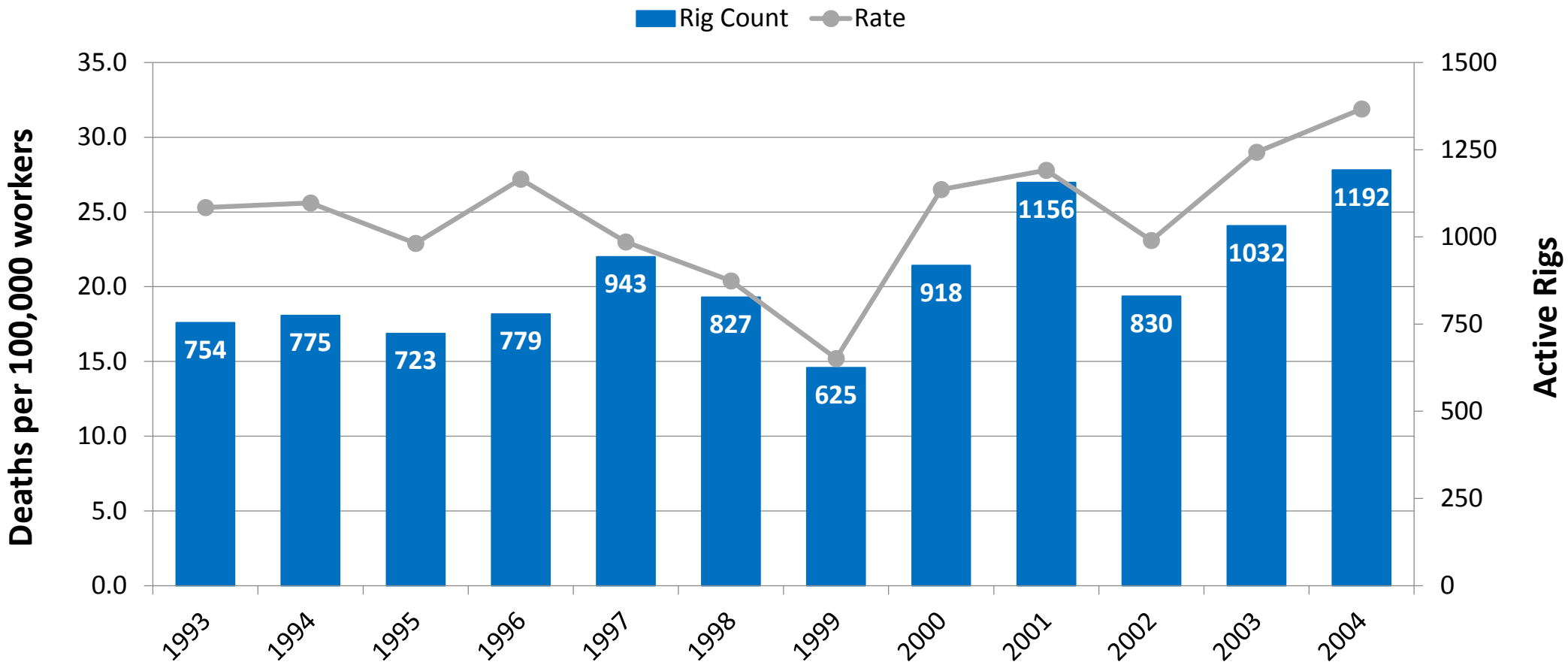


Occupational Fatality Rate, U.S. Oil and Gas Extraction and all U.S. Industries, 1993-2004



Note: Fatality counts from BLS Census of Fatal Occupational Injuries. Worker Estimates from BLS Quarterly Census of Employment and Wages. Oil and gas extraction includes NAICS 211, 213111, 213112. Rate per 100,000 workers per year.

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



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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

CDC

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 nonfatal 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

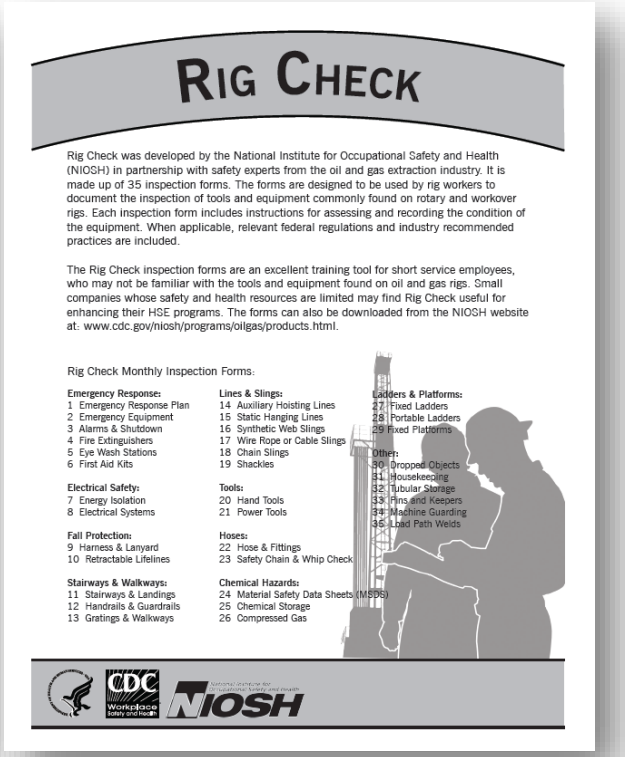
1. US Department of Labor, Bureau of Labor Statistics. National Census of Fatal Occupational Injuries in 2006. Washington, DC: US Department of Labor; 2007. Available at http://www.bls.gov/news.release/pdf/cfoi.pdf.
2. Steenland K, Burnett C, Lalich N, Ward E, Hurrell J. Dying for work: the magnitude of U.S. mortality from selected causes of death associated with occupation. Am J Ind Med 2003;43:461–82.
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/usr_doc/nasi_workers_comp_2005_full_report.pdf.

Fatalities Among Oil and Gas Extraction Workers — United States, 2003–2006

Oil and gas extraction (i.e., removing oil and natural gas from the ground) is a growing industry in the United States, employing approximately 380,000 workers in 2006 (*1*). In recent years, activity in this industry has increased substantially, from an average of 800 actively drilling rigs in the United States during the 1990s to approximately 1,300 during 2003–2006 (*2*). In August 2005, the U.S. Department of Labor's Bureau of Labor Statistics (BLS) asked CDC to investigate a 15% increase in fatalities among oil and gas extraction workers (from 85 fatalities in 2003 to 98 in 2004) (*3*). CDC analyzed data from the BLS Census of Fatal Occupational Injuries (CFOI) for the period 2003–2006. This report describes the results of that analysis, which indicated that increases in oil and gas extraction activity were correlated with an increase in the rate of fatal occupational injuries in this industry, with an annual fatality rate of 30.5 per 100,000 workers (404 fatalities) during 2003–2006, approximately seven times the rate for all workers (4.0 per 100,000 workers) (*4*). Nearly half of all fatal injuries among these workers were attributed to highway motor-vehicle crashes and workers being struck by

INSIDE

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 Response:
1 Emergency Response Plan
2 Emergency Equipment
3 Alarms & Shutdown
4 Fire Extinguishers
5 Eye Wash Stations
6 First Aid Kits

Electrical Safety:
7 Energy Isolation
8 Electrical Systems

Fall Protection:
9 Harness & Lanyard
10 Retractable Lifelines

Stairways & Walkways:
11 Stairways & Landings
12 Handrails & Guardrails
13 Gratings & Walkways

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

Tools:
20 Hand Tools
21 Power Tools

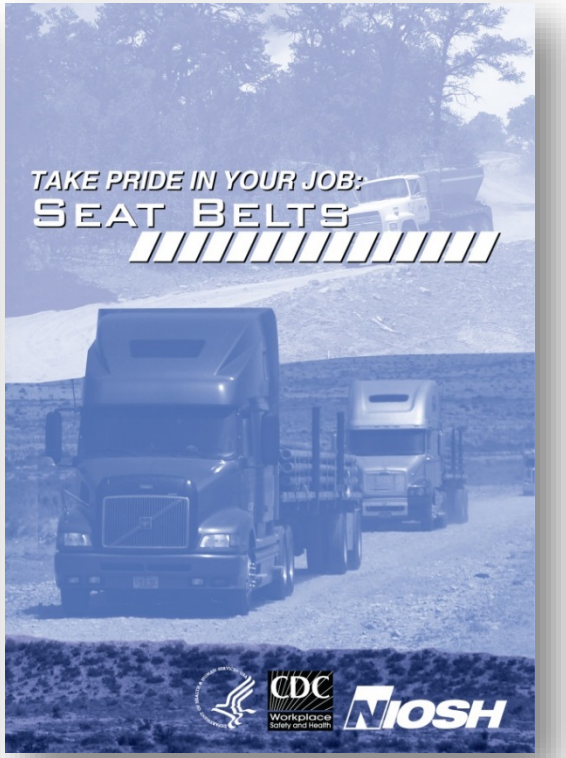
Hoses:
22 Hose & Fittings
23 Safety Chain & Whip Check

Chemical Hazards:
24 Material Safety Data Sheets (MSDS)
25 Chemical Storage
26 Compressed Gas

Ladders & Platforms:
27 Fixed Ladders
28 Portable Ladders
29 Fixed Platforms

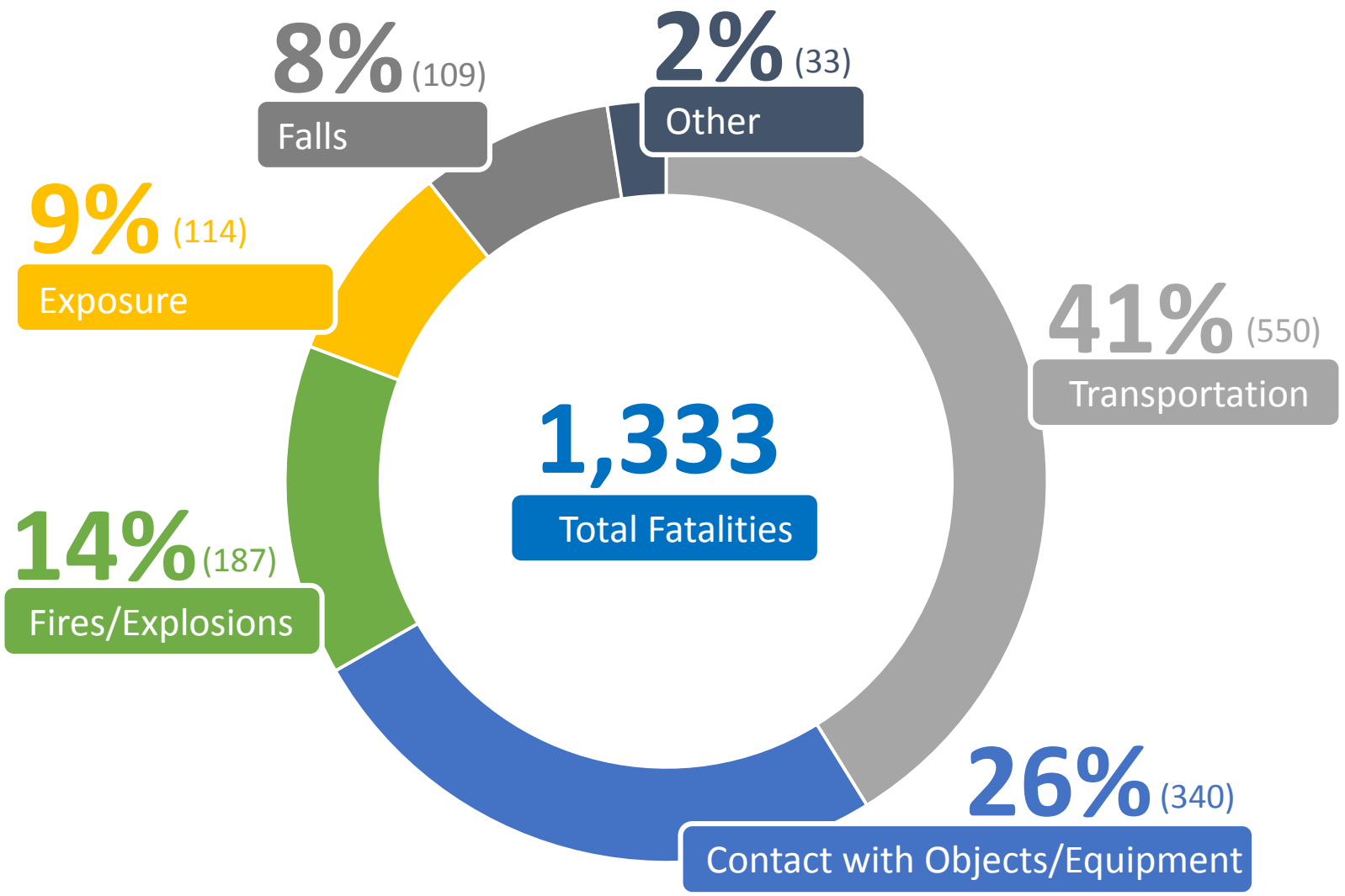
Other:
30 Dropped Objects
31 Housekeeping
32 Tubular Storage
33 Pins and Keepers
34 Machine Guarding
35 Load Path Welds

CDC Workplace Safety and Health NIOSH



Injury Surveillance and Prevention

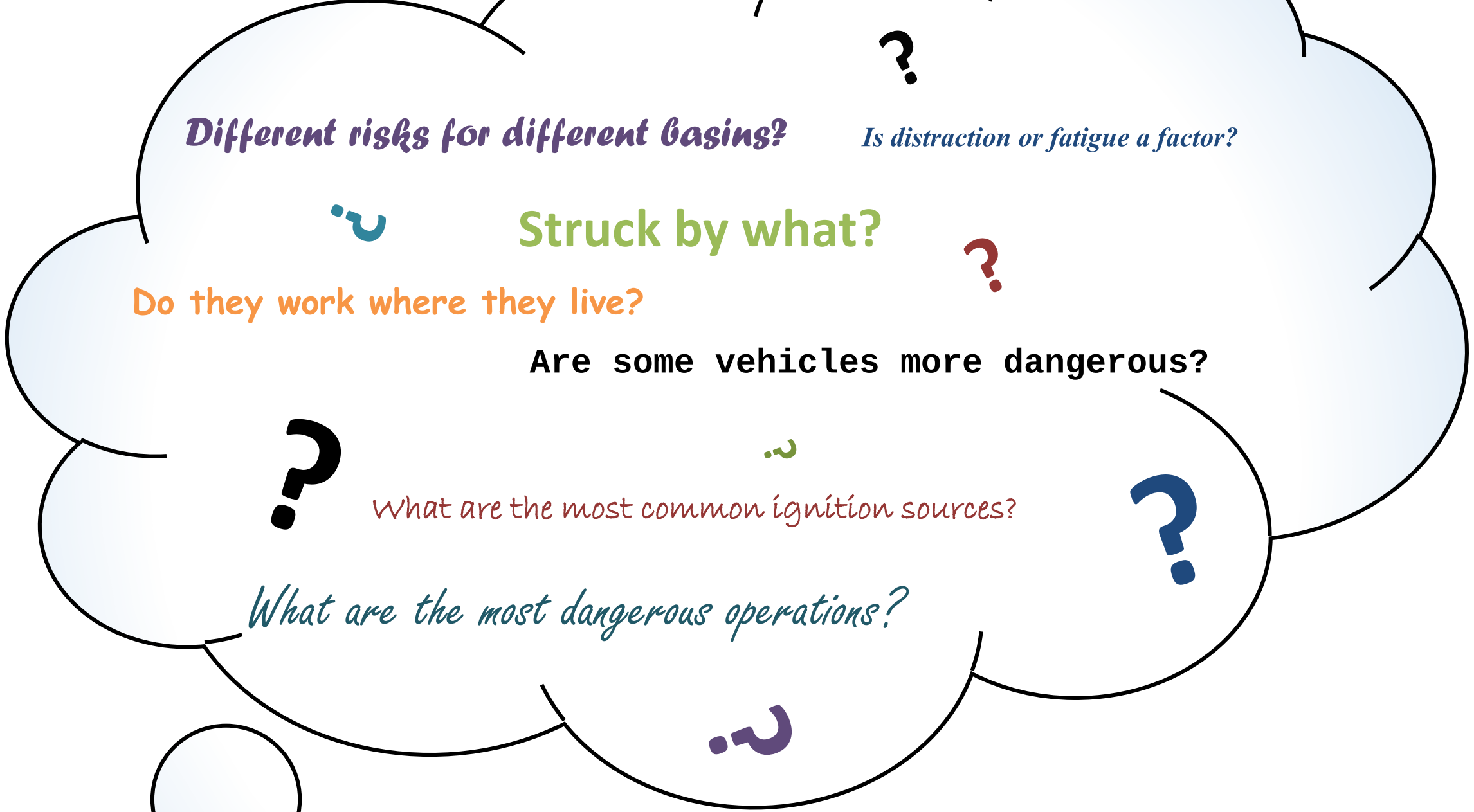
Most Frequent Fatal Events, U.S. Oil & Gas Extraction Industry, 2003-2014



Note: Fatality counts from BLS Census of Fatal Occupational Injuries. Includes NAICS 211, 213111, 213112.

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?

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

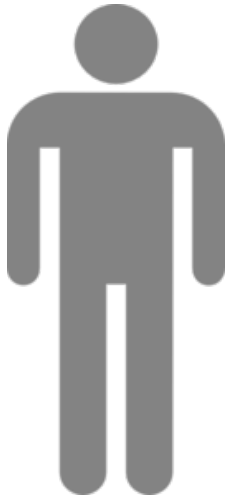
Data Sources

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 [Esswein et al. 2014; Jordan 2015]. These risks are in addition to the risk of exposure to hydrogen sulfide (H_2S), 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 2015]. 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].

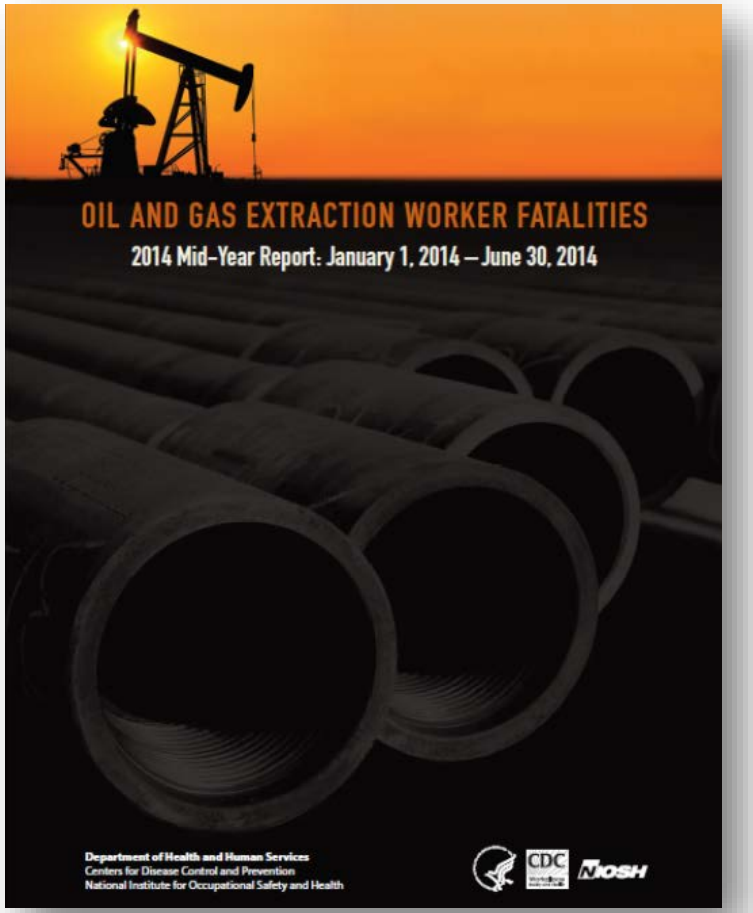
Working on or near oil and gas production tanks is of particular concern because these tanks may contain concentrated hydrocarbon gases and vapors that are under pressure. When the thief hatch is opened, the release of these pressurized gases and vapors can expose workers. Second, the gases and vapors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

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



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, MD[1]; Kyla Retzer, MPH[2]; Michael J. Kunnett, MD[3,4]; Michael Hodgson, MD[5]; Todd Jordan, MSPH[6]; Sophia Ridl[2]; Max Kiefer, MS[2]

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 (O_2)-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 O_2 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 O_2 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 (H_2S) 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; H_2S 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 H_2S, 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 2105, 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 O_2 deficiency. The exposure assessment conducted by OSHA following the 2010 case found O_2 concentrations as low as 11% at 1 foot above the open thief hatch (O_2 concentrations

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

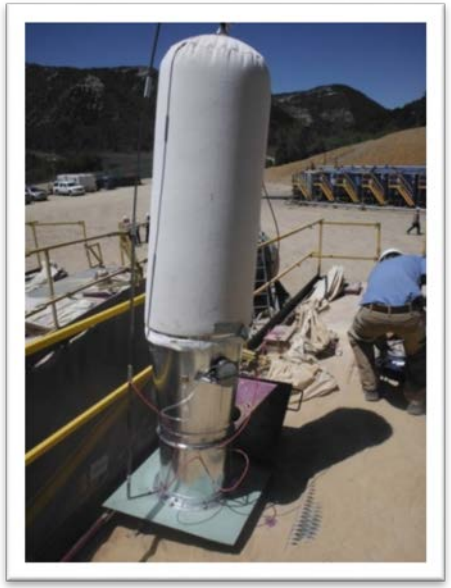
NIOSH researchers were the first to systematically evaluate occupational exposures to workers at hydraulic fracturing sites[1]

- 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

[1] Esswein, Breitenstein, Snawder, et.al,. *Occupational Exposures to Respirable Crystalline Silica in Hydraulic Fracturing* Jour. Occ. Env. Hyg. Vol. 10, Issue 7, May, 2013

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
26August, 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

designed by: PEC SAFETY

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 (H_2S)

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:

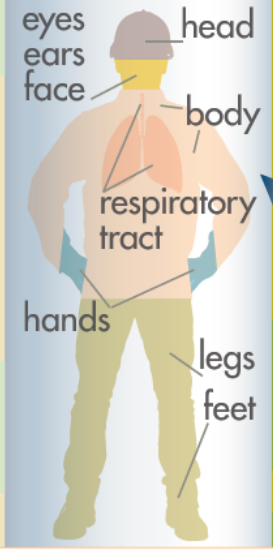
- Hazard Communication
- Lone Worker Policy
- Proper use of PPE and respiratory protection
- Types, use, and limits of respiratory protection equipment as appropriate
- Recognizing ignition sources
- Tank Gauging work practices/procedures
- Emergency Response Plan
  - ▸ Procedures for alarm response and site re-entry
- Use and limits of toxic- or multi-gas meter for O_2, H_2S, 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

PPE protect your



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.

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

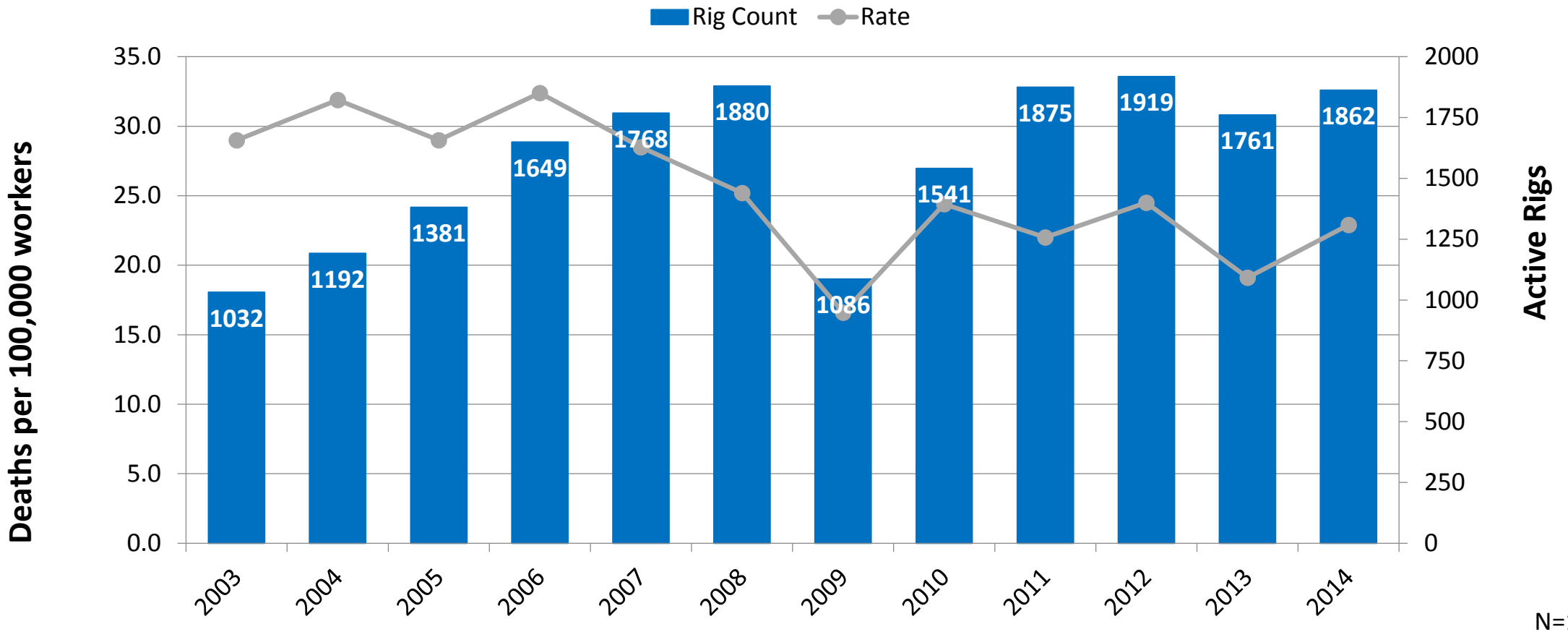
Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute of Occupational Safety and Health

CDC Workplace Safety and Health
NIOSH

Recent NIOSH Publications

Occupational Fatality Rate is Improving

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



N=1,333

Department of Health and Human Services
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CDC Workplace Safety and Health

NIOSH

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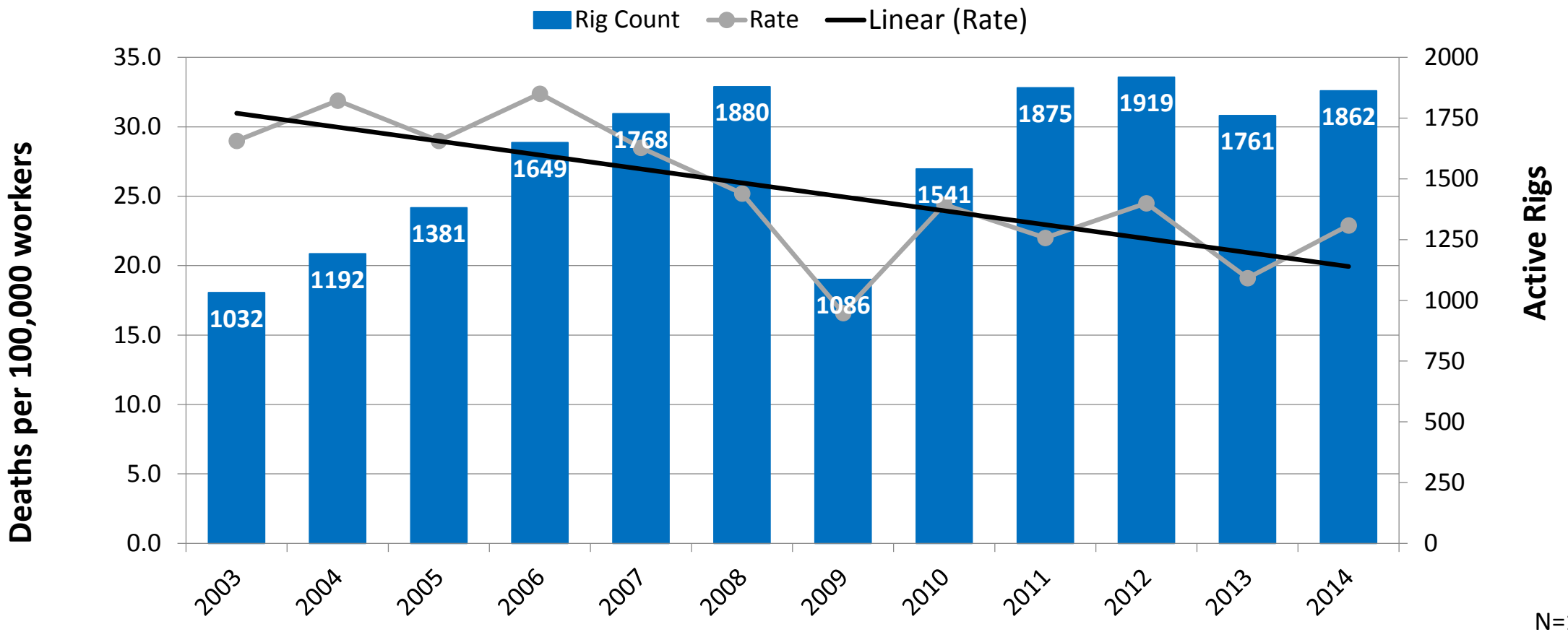

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CDC Workplace Safety and Health

NIOSH

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

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