NIOSH Field Studies: Exposure Assessment, Silica Controls and Gauging and Thiefing

Disclaimer: The findings and conclusions in this presentation have not been formally disseminated by NIOSH and should not be construed to represent any agency determination or policy.
Worker Exposure Assessment

Based on worksite operations and chemicals in the industry, workers have potential risks for exposures to multiple chemical hazards.
Field Studies- identify and characterize workplace exposures and evaluate their significance.

- Become familiar with process operations
- Perform the preliminary, qualitative survey
- Perform workplace monitoring (quantitative evaluation)
- Interpret the sampling results and communicate with stakeholders
- Develop controls if needed
- Re-evaluate to determine effectiveness of controls
Exposure Hazards

- Silica
- Diesel particulate matter
- Oil mists
- Acids & Bases
- Metals
- Volatile Organic Compounds (BTEX)
- Hydrogen sulfide (H₂S)
- NORM and T-NORM
- Biocides (aldehydes, quaternary, others)
- Alcohols (Methanol)
- Polyaromatic Hydrocarbons

Not an all-inclusive list
NIOSH FIELD STUDY STRATEGIES

• Focus on process or activity
  • Drilling, Completions, Production, Service

• Focus on exposure hazard
  • Chemical: Silica, Hydrocarbons, Diesel Exhaust etc
  • Physical: Noise, Heat/Cold, NORM

• Focus on emerging issue identified by surveillance

• Focus on worker exposures by production area

• Development and evaluations of controls
NIOSH Field Laboratories

2015 and 2016 Bravo Star Trailer (DART and WSD)

• 7 x 12 interior space
• Weatherized
• Heating/AC
• Can operate with generator power or supplied shoreline power

Finally, after 2 years!
Methods Used

• Standard Industrial Hygiene Methods
  • NMAM and OSHA Numbered Methods
  • Personal and Area Samples

• Direct Reading Methods
  • Real Time Instruments, Meters and Monitors
  • Video Exposure Monitoring

• Biological Monitoring
  • Measure Internal Exposures/Effects by Breath, Urine
Focus on Process-Completions
Health Hazard- Exposure to Respirable Silica during Hydraulic Fracturing
NIOSH researchers were the first to systematically evaluate occupational exposures to workers at hydraulic fracturing sites\(^1\)

- Personal breathing zone air samples were collected for workers at 11 sites in 2010 and 2011
- Silica exposures for sand mover operators/T-belt operators can be 10-50 times greater than occupational exposure limits

Exposure comparisons by job title
Point Sources of Respirable Crystalline Silica Release

Eight (8) primary points of dust release or generation from completion equipment or workplace operations:

1) Dusts ejected from thief hatches on top of the sand movers during refilling operations
2) Dust ejected and pulsed through side fill ports on the sand movers during refilling operations
3) Dust generated by on-site truck vehicle traffic including sand trucks and crew trucks, the release of air brakes on sand trucks, and by winds
4) Dust released from the transfer belt under the sand movers
5) Dusts created as sand drops into, or is agitated in the blender hopper and on transfer belts
6) Dust released from operations of transfer belts between the sand mover and the blender
7) Dust released from the top of the dragon’s tail on sand movers
8) Dust deposited on and released from workers coveralls
Respirable Silica Exposure Zones

- Maximum respiratory protection
- Moderate respiratory protection
- Avoid area during sand transfers and pumping
First study to identify RCS hazard during hydraulic fracturing

OSHA-NIOSH Hazard Alert

Industry formed RCS Workgroup

JOEH article most downloaded of 2013

Wide array of new, improved controls implemented
Stimulate the Well (frac’) Without Silica Proppant

• Complete elimination of proppant is not possible in all formations

• Manufactured proppants such as ceramic beads/ sintered bauxite limit generation of respirable silica
Engineering Controls

- Chemical treatment of silica sand reduces dust generation
- Elimination of pneumatic sand transfer from transport trucks
  - Silos, Containerized sand, Elevators
- Vacuum collection of dust from emission sources
- Equipment designed to prevent dust generation
- Retrofit existing equipment with controls
Incorporate Engineering Controls Where Possible

Focus on the Source!

- Thief hatches on sandmovers are a large contributor of dust emissions.
- An engineered control was needed to limit worker exposure
NIOSH Mini baghouse retrofit assembly

Features
- Highly effective
- Inexpensive
- “bolt-on”
- Uses pneumatic energy
- In-field retrofit
Develop Effective Training Programs

Hazard Communication

**OSH-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 the Hazard Alert) during hydraulic fracturing.

This Hazard Alert discusses the health hazards associated with hydraulic fracturing and focuses on worker exposure 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.

Cryotite silica is a common mineral found in the earth's crust. It occurs primarily as a major component of the sand, clay and stone materials used to make everyday products such as concrete, brick and glass.

Respirable crystalline silica is the portion of crystalline silica that is small enough to enter the gas exchange region of the lungs if inhaled; it includes particles less than 10 micrometers (µm) in diameter.

NIOSH and OSHA have been investigating worker safety and health hazards in oil and gas industries, including chemical exposures during hydraulic fracturing operations.

OSHA has jurisdiction over the safety and health of workers, including workers involved in hydraulic fracturing and gas operations. The General Duty Clause of the Occupational Safety and Health Act (OSHA Act) and OSHA General Industry Standards (29 CFR 1910) apply to the operations cited. As part of the enforcement of these standards, OSHA has identified high-risk activities as well as those that may have ongoing hydraulic fracturing operations.

NIOSH aims to reduce the hazards in the oil and gas extraction industry, especially those traveling to work by creating the National Occupational Research Agenda (NORA) Oil and Gas Extraction Council, which provides recommendations to NIOSH for the assessment of occupational safety and health issues. To address an existing lack of information on occupational dust and chemical exposures associated with hydraulic fracturing, NIOSH established the NIOSH Oil and Gas Extraction Council, which includes representatives from the oil and gas industry, labor, environmental and health organizations and other stakeholders.

Exposure to silica during hydraulic fracturing has been the focus of the NIOSH study for data.
Fatalities Associated with Manual Gauging, Thieving, Fluid Handling

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

- All occurred at production tanks.
- 5 fatalities occurred during thieving (collecting a sample) by fluid haulers.
- One employee was wearing 4-gas monitor, reported 6.5% O2.
- One had sought medical evaluation for dizziness, etc. a few weeks prior.

For more information: www.cdc.gov/niosh/topics/fog/data.html
Evaluating Rapid Releases of Hydrocarbon

• Exposure assessments designed to measure gas and vapors released in plumes and during very short worker tasks
  • Non-traditional IH assessment methods
  • Grab Samples
  • PEAK, STEL, IDLH assessments
  • Real-time GC as well as GC/MS analysis
Tank is continuously vented to the atmosphere. Gases and vapors in tank are in equilibrium with outside air. No significant pressure on the tank.
Behavior of Production Fluid Storage Vessels with NSPS 0000 Controls (post-2012)

Hatch is closed. No visible emissions, greater than 95% VOCs produced are controlled. Gases and vapors in tank are in equilibrium with gas and vapors in the liquid hydrocarbon. The different gases and vapors are exerting pressure on the container.
Hatch is opened. A large volume of gases (mostly propane and butane) rush out of the hatch very quickly. The “cloud” can displace oxygen in the immediate work area and presents an immediate asphyxiation hazard.
As hatch remains open, heavier hydrocarbons in the tank (pentane, hexane, heptane, BTEX) will evaporate and leave the tank and enter the workspace. Rate of flow is still high and these gases and vapors may be present at toxic and flammable concentrations.
Hatch remains open. Gases and vapors in tank are approaching equilibrium with the environment and the rate of emission slows down significantly. Heavy gas and vapors drop toward the ground.
Determinants of Released Gas and Vapors

• Production rate of the well
• Composition of fluid and inherent vapor pressure – higher vapor pressure more gas and vapors in headspace
• Pressure setting on emission controls- gas and vapor equilibrium changes with pressure,
• Number of tanks in the battery-more tanks greater volume of release
• Proper operation of vapor controls
Direct Reading Instruments
Qualitative Characterization of Tank Release
Train Workers to Limit Exposures

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

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Apply Effective Controls

- Remote tank gauging and sensing
- Closed tank gauging systems
- LACT units
- Reduce quantity of times workers must manually gauge tanks
Develop Effective Training Programs

Hazard Communication

API Recommended Practices

Multi-gas meters
OSHA/NIOSH/NSTEPS Alliance Hazard Alert

http://www.nationalstepsnetwork.org/docs_tank_gauging/TankHazardInfographicFinal04_22_15.pdf
Future Directions for NIOSH Exposure Assessment Research in the Oil and Gas Extraction Industry

• Acute Exposure Hazards (VOC exposures, flammability hazards) During Handling of Crude, Produced Water, etc.
• Flowback (VOCs, aldehydes, alcohols, BTEX)
• Long term evaluation: NIOSH Mini Baghouse Retrofit Assembly  Long term goal: licensing, adoption
• Drilling (VOCs, diesel particulate [DPM], silica)
• Servicing Operations (NORM, VOCs, DPM)
Focus on Worker Exposures by Production Area
What Operations Did We Study?

• Flow Back Operation - Oil wells, Wet and Dry Gas Wells
• Lease Operators
  • Legacy wells
  • Newer Wells
• Drill Out
• Production Operators
• Pigging Operations
What Areas or Basins

• Fayetteville Shale - Dry Gas
• Marcellus - Wet and Dry Gas
• Utica Shale - Wet Gas
• DJ - Oil and Gas
• Piceance - Oil and Gas
• San Juan - Oil and Gas
• Jonah - Oil and Gas
• Bakken - Oil
2013-2016 Field Sites

- 2013 Field Sites
- 2015 Field Sites
Comparison of PBZ Gas and Vapor Profile by Basin

- DJ Flowback Tech 1
- Piceance Flowback Tech 1
- Marcellus Wet Gas Guager
- Marcellus Dry Gas Guager
- Niobrara Tank Gauging
- San Juan Gauging
- Haynesville Production Operator
- Bakken Service Technician
Previous Graphs on the Same Scale
Variation in composition and concentration in PBZ samples collected in the Niobrara (CO) Basin Different Wells.
Variation composition and concentration in PBZ samples collected on a flowback worker over 4 days at the same well in the Marcellus (PA) basin.
JOINT US/EU
CONFERENSE ON HEALTH AND SAFETY AT WORK

HYDRAULIC FRACTURING

BAKKEN SAFETY TOUR
AUGUST 31 - SEPTEMBER 2 2016

2016