A Review of Health Effects and NIOSH Evaluations of Select Hazards in the Oil and Gas and Construction Industries

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Disclaimer

• The findings and conclusions in this presentation/report are those of the author(s) and do not necessarily represent the views of the National institute for Occupational Safety and Health.
Origin of NIOSH

- Occupational Safety and Health Act of 1970 created OSHA and NIOSH
- U.S. federal agency that conducts research and makes recommendations to prevent worker injury and illness.
- **NIOSH Mission**: To provide leadership in research to prevent work-related illness, injury, disability, and death.
NIOSH Activities - Research

- Surveillance/Epidemiology
- Field Studies
- Laboratory Studies
- Exposure Measurement
- Control Technology
- Protective Equipment
- Emergency Response
- Training
- Information Dissemination

Photo by Aaron Sussell
Hydrocarbon Gases and Vapors: Occupational Exposure and Health Effects

Modern NSPS 0000 Compliant Battery

- Separator
- Pressure relief valve
- Emission control piping
- Liquid drop out
- To combustor, VRU, flare
Hydrocarbon Gases and Vapors: Occupational Exposure and Health Effects

Opening Production Tanks
Hydrocarbon Gases and Vapors: Occupational Exposure and Health Effects
Asphyxiation

- Displacement of oxygen
  - Normal: ~21%
  - Deficient: <19.5%

- Even if oxygen concentrations remain sufficiently high to support life, self-rescue may be impaired.
Hydrocarbon Gases and Vapors: Occupational Exposure and Health Effects

Narcosis
(reversible depression of the central nervous system marked by stupor or insensibility)

• At high concentrations, onset can be very rapid

• It may only take a few breaths:
  – light headedness
  – feeling dizzy
  – unconsciousness if the concentration in the air is high enough

• The difference between concentrations producing narcosis and those leading to death may be small
Hydrocarbon Gases and Vapors: Occupational Exposure and Health Effects

Cardiac arrest

• High concentrations can lead to abnormal heart rhythm and cardiac arrest
  – particularly where exposure is accompanied by stress and exercise

• Certain pre-existing cardiac conditions may lead to increased sensitivity from exposure
### Results of Personal Breathing Zone Grab Samples when Hatch Opened

<table>
<thead>
<tr>
<th>Gas or Vapor</th>
<th>Concentration Range (IDLH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>ND–5979 ppm (5000)</td>
</tr>
<tr>
<td>Ethane</td>
<td>ND–24,818 ppm (3000)</td>
</tr>
<tr>
<td>Propane</td>
<td>ND–41,435 ppm (2100)</td>
</tr>
<tr>
<td>i-Butane</td>
<td>ND–3793 ppm (1800)</td>
</tr>
<tr>
<td>n-Butane</td>
<td>ND–19,336 ppm (1860)</td>
</tr>
<tr>
<td>i-Petane</td>
<td>ND–2990 ppm (1400)</td>
</tr>
<tr>
<td>n-Pentane</td>
<td>ND–3385 ppm (1500)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vapor</th>
<th>Concentration Range (IDLH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td>ND–280 ppm (500)</td>
</tr>
<tr>
<td>Toluene</td>
<td>ND–129 ppm (800)</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>ND–55 ppm (500)</td>
</tr>
<tr>
<td>Xylenes</td>
<td>ND–84 ppm (900)</td>
</tr>
</tbody>
</table>

*ND = not detected
Diesel Particulate Matter (DPM): Occupational Exposure and Health Effects

- Complex aerosol: gases, respirable particulates, > 40 potentially toxic compounds
- Solid elemental carbon (EC) core with hydrocarbons, S, NO_x adsorbed onto core
Everywhere...

- Earth-moving equipment
- Drilling rigs
- Wireline crews
- Blender trucks and pumps
- Sand movers
- Transport (T) belts
- Water transport systems
- Fuel Delivery Trucks
- Diesel-driven generators
- Specialty crew: equipment for rig moving, coiled tubing, etc.
Diesel Particulate Matter (DPM): Occupational Exposure and Health Effects

- Dose, duration of exposure
  - Eye, nose, throat irritation
  - Cough
  - Exacerbation of pre-existing conditions: bronchitis, asthma,
  - Headaches, dizziness
  - Cardiovascular disease
  - Cancer

- International Agency for the Research of Cancer considers DPM to be a human carcinogen (Group 1)

- NIOSH considers DPM to be a potential occupational carcinogen
Diesel Particulate Matter (DPM): Occupational Exposure and Health Effects

- No OELs: NIOSH, OSHA, ACGIH*

- California Department of Health Services:
  - 20 µg/m$^3$ as time-weighted average (TWA) for elemental carbon (EC)

- U.S. MSHA:
  - 160 micrograms per cubic meter ($\mu$g/m$^3$), total carbon (TC), 8-hour TWA (not health based)

*American Conference of Governmental Industrial Hygienists
Silica: Occupational Exposure and Health Effects

- Exposure to respirable crystalline silica a **serious but preventable** health hazard

- Health effects:
  - **Silicosis**: a nodular pulmonary fibrosis

- Important considerations:
  - Dose of respirable silica-containing dust
  - Particle size
  - Crystalline/non-crystalline nature of the silica
  - Duration of the exposure
  - Varying time period from first exposure to diagnosis
Silica: Occupational Exposure and Health Effects
Silica: Occupational Exposure and Health Effects

- **Silicosis**: a nodular pulmonary fibrosis
  - Three types:
    - **Chronic**: after 10 or more years of low exposure
    - **Accelerated**: 5-10 years after first exposure
    - **Acute**: after exposure to high concentrations and results in symptoms within a few weeks to 5 years after exposure
      - Resembles alveolar proteinosis; pulmonary fibrosis may not be present
Silica: Occupational Exposure and Health Effects

• Other Health Impacts:
  • Tuberculosis (TB)
    • As silicosis progresses, may be complicated by severe infections; TB most common
  • Cancer
  • Decreased pulmonary function
  • Wheezing/coughing
  • Eye irritation
Silica: Occupational Exposure and Health Effects

• 2.2 million workers exposed to respirable crystalline silica
  – Construction Industry (1.85 million)
    • Cutting, grinding, crushing, drilling, etc., silica containing materials such as concrete, masonry, tile, rock
  – General Industry occupations (320,000)
    • Brick, concrete, and pottery manufacturing
    • Foundry work
  – Maritime Industry
    • Sandblasting
Silica: 
Occupational Exposure and Health Effects

Construction Industry:
Silica: Occupational Exposure and Health Effects

• General Industry:
  – Hydraulic Fracturing during Oil and Gas Exploration
New OSHA PEL for Construction

- New limit: 50 µg respirable crystalline silica/m³ of air, averaged over an 8-hour day
- New action level (AL): 25 µg/m³, over an 8-hour day
  - Employers required to measure the amount of silica that workers are exposed to if it may be at or above the AL
- Limit workers’ access to areas above PEL
- Provide respirators
- Offer medial exams including X-rays and lung function tests every 3 years for workers above the PEL for 30 or more days/yr
Noise:
Occupational Exposure and Health Effects

Impacts of Noise Exposures

• Permanent hearing loss limits ability to:
  • Hear high frequencies
  • Understand speech
  • Communicate

• Reduction in work productivity

• Contribute to workplace accidents

• Affects quality of life

• Hearing damage can be prevented...but permanent noise-induced hearing loss can’t be cured or reversed!
How does noise damage hearing?

• **One-time exposure** to a sudden powerful noise
  – Can result in instant hearing damage

• **Prolonged exposures** to moderately loud noise
  – Can lead to gradual loss of hearing
  – Loss of hearing slowly over time becomes permanent

• Tinnitus (ringing in ears) can occur without other apparent hearing loss
Noise OELs

- OSHA PEL:
  - 90 decibels (A)
  - 5 dB exchange rate

- NIOSH REL:
  - 85 dB (A)
  - 3 dB exchange rate
What is an HHE?

- An evaluation of possible health hazards at a workplace
- Evaluations to determine whether particular workplace exposures, processes or conditions pose a hazard to workers
- Agents NIOSH has studied include:
  - Chemicals: lead, silica
  - Biological: anthrax, mold
  - Physical: heat stress, noise, radiation, ergonomic stressors
Who can request an HHE?

- Management
- Employees
- Unions
- Gov’t agencies

http://www.cdc.gov/niosh/hhe/
Benefits of an HHE

- Provide current health hazard data to employers and employees
- Identify problems and offer workplace solutions
- Generate exposure and human toxicity data
- Precipitate research and development
NIOSH Health Hazard Evaluations (HHE)

Physicians/Epidemiologists, Veterinarian, Nurse, Statistician, Behavioral scientist

Industrial hygienists, Engineers, Toxicologist, Communications
Category I & II HHE Requests

- No site visit performed
- Contact by telephone (to validate request or obtain additional information)
- Office-based response/consultation to resolve problem
- Requestor (and facility management) receive letter with enclosed information
NIO SH Health Hazard Evaluations (HHE)

Category III & IV HHE Requests

• Site visit(s) performed

• May involve:
  • Complex medical/epidemiologic and industrial hygiene/exposure assessment investigations

  • Descriptive
  • Problem solving
  • Hypothesis generating

• Development of new sampling and analytical methods

• Feasibility studies
NIOSH Health Hazard Evaluations (HHE)

Evaluation of the Workplace

- Observe processes and practices
- Collect samples
- Interview employees
- Conduct medical tests or physical examinations
- Review reports
  - injury and illness
  - exposure records
- Evaluate controls
NIOSH Health Hazard Evaluations (HHE)

When an HHE Can Help

• New hazards, exposures, or processes
• Illnesses from an unknown cause
• Exposure to unregulated agents
• Adverse health effects at exposures less than current standards
What Final Product Do We Provide?

- A Final Report:
  - Technical
  - Methods
  - Evaluation criteria
  - Results, discussion
  - Recommendations

- Plain language summary
  - What NIOSH did
  - What NIOSH found
  - What management can do
  - What employees can do
NIOSH Health Hazard Evaluations (HHE)

Final Report Distribution

- Sent to:
  - Employees/reps
  - Employer
  - OSHA
  - Health department
1 of Series of 4 HHEs in AZ:
Noise and Silica Exposures during Housing Construction

• Local union request

• Residential roofing worksite

• Evaluate potential exposures to silica dust and noise during saw cutting of cement tile
What NIOSH did:

- Measured exposures to dust and respirable crystalline silica
- Evaluated noise exposures
- Observed work practices, fall protection, and PPE use
- Medically screened employees for silicosis
What NIOSH found:

- Most workers were overexposed
- Employees not fully aware of hazard
- Most had normal lung function
  - Of those with abnormal lung function, none had moderate or severe impairments
- Lung function decreased with increasing years of dry-cutting cement tiles
- No chest x-rays showed silicosis
What NIOSH recommended to management:

• Establish engineering and work practice controls

• Implement mandatory respiratory protection until effective controls in place

• Conduct periodic monitoring for silica to ensure controls are working

• Develop and enforce a hearing conservation program

• Implement silica medical surveillance

• Ensure compliance with fall protection standards
What NIOSH recommended to employees:

- Use dust control measures
- Use respirators and hearing protection properly
- Tell management about health and safety concerns
- Attend training programs provided by company
- Tell doctor about potential silica exposures and contact them if develop symptoms such as shortness of breath and cough
Questions/Discussions

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Alice Hamilton, M.D.
Mother of U.S. Occupational Medicine
1869–1970