Workforce Health and Safety: NIOSH Update

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San Diego, California

Selected Topics

- Economic and Workforce Trends
- NIOSH Carcinogen Policy
- Nanotechnology and Risk
- Influenza Transmission Research
- Hydraulic Fracturing
Facts About Yuma

- **Agriculture** plays a dominant role in the Yuma County Economy. Value of crops, livestock, fruits and vegetables produced on Yuma County farms and ranches was over $633 million in 1996. Crops accounted for 84%, while livestock products was 16%.

- **Military** bases contribute substantially to the local economy with the Marine Corps Air Station and Yuma Proving Grounds located in the county.

- **Tourism** to Yuma County generates an estimated gross revenue of over $380 million per year. New and exciting light industry increases Yuma's diversification.

- **Unemployment** rate in Yuma is 23.70 percent (U.S. avg. is 8.60%).

Pace of the Recovery

- [Graph showing cumulative change over quarters from start of recession with 2007 Recession and Other Recessions lines]

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Employment Picture Varies by State

Non-Farm Employment
Unemployment High and Persistent

Industrial Structure is Changing
Health Care Growth Unabated
NIOSH Statutory Mandate Relative to Chemical Carcinogens

“... develop criteria dealing with toxic materials and harmful physical agents and substances which will describe exposure levels that are safe for various periods of employment, including but not limited to exposure levels at which no employee will suffer impaired health or functional capacities or diminished life expectancy as a result of his work experience.”

OSH Act, Section 20 (a)(3)

NIOSH and Carcinogens

NIOSH conducts toxicological and epidemiological research on occupational carcinogens

NIOSH assesses workplace exposures to carcinogens

NIOSH sets recommended exposure limits (RELs)

NIOSH pocket guide lists 135 substances as carcinogens
Current NIOSH Carcinogen Policy

NIOSH reviews data on cancer as part of setting a REL for a substance

NIOSH makes a determination whether a substance is a potential occupational carcinogen

Peer review of this decision occurs as part of the peer review of the Criteria Document or Current Intelligence Bulletin

Serves as the basis for risk management AND risk communication decisions

Reasons for Review

- “potential occupational carcinogen” conveys uncertainty not warranted with many known human carcinogens (e.g. asbestos, benzene, and cadmium)
- How to incorporate uncertainty from incomplete data and understanding of the mode of action in the policy
- How to incorporate advances in cancer science
Cancer Policy Revision Timeline

Federal Register Notice: August 23, 2011

Public Meeting: December 12, 2011

Constructing Draft Policy: 2012

Public Draft: Anticipated Early 2013 (?)

Federal Register Questions

Should there explicitly be a carcinogen policy as opposed to a broader policy on toxicant identification and classification (e.g. carcinogens, reproductive hazards, neurotoxic agents)?

What evidence should form the basis for determining that substances are carcinogens? How should these criteria correspond to nomenclature and categorizations (e.g., known, reasonably anticipated, etc.)?

Should 1 in 1000 working lifetime risk (for persons occupationally exposed) be the target level for a recommended exposure limit (REL) for carcinogens or should lower targets be considered?

In establishing NIOSH RELs, how should the phrase “to the extent feasible” (defined in the 1995 NIOSH Recommended Exposure Limit Policy) be interpreted and applied?

In the absence of data, what uncertainties or assumptions are appropriate for use in the development of RELs? What is the utility of a standard “action level” (i.e., an exposure limit set below the REL typically used to trigger risk management actions) and how should it be set? How should NIOSH address worker exposure to complex mixtures?
Approach?
Use of a Tiered Decision Logic

- **NTP**
  - If substance is listed on the NTP Report on Carcinogens, adopt cancer classification

- **EPA**
  - If substance is listed by EPA as carcinogen, adopt cancer classification

- **IARC**
  - If substance is listed by IARC as carcinogen, adopt cancer classification

- **None?**
  - Nominate to NTP for cancer classification
Benefits of Draft Policy Approach

- Avoids duplication of effort
- Preserves scarce government resources
- Allows NIOSH to focus on the occupational aspects of exposures
- Streamlines the RELs process

Disadvantages of Draft Policy Approach

- NIOSH no longer conducts separate in-depth carcinogenesis review
- Some inconsistency with past practice
- More reliance on other agencies with different agendas and different cancer criteria
Issues Under Discussion

1/1000 Risk Level
Meaning of to the extent feasible
Action level: purpose and criteria
Incorporating uncertainty into cancer classifications
How to deal with complex mixtures

1/1000 Risk Level
Risk level NIOSH historically has used
Selected to be supportive of OSHA needs (Benzene decision)
Determined by quantitative risk assessment
Meaning of “to the extent feasible”

Stated in 1996 NIOSH Cancer/RELs Policy revision

1996 Policy stated NIOSH would project a range of risks and select a level where there might be residual risk

Action Level

Historically meant to address the variability in exposure measurements

Also triggered preventive action

Should it continue to be used?
Incorporating Uncertainty into Cancer Classification

What to do when there are limited data?

How to determine occupational relevance?

The Complexities of Complex Mixtures

Cumulative risk considerations from multiple chemical exposures

How to set RELs that make sense for components of complex mixtures
Nanotechnology and Risk

• Nanotechnology - The Motivation
  
  Purposely engineered nanomaterials and devices demonstrate novel size-dependent properties and behavior that hold great promise in many areas of benefit to man.

• Nanotechnology - The Challenge
  
  Does the nature of engineered nanomaterials and devices present new occupational safety and health risks?

  How can the benefits of nanomaterials be realized while proactively minimizing or eliminating the potential risks?
### What’s So Unique About Nano?

<table>
<thead>
<tr>
<th>Natural</th>
<th>Anthropogenic</th>
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<tbody>
<tr>
<td></td>
<td>Incidental</td>
</tr>
<tr>
<td>Forest Fires</td>
<td>Combustion engines</td>
</tr>
<tr>
<td>Volcanoes</td>
<td>Incinerators</td>
</tr>
<tr>
<td>Ocean Spray</td>
<td>Jet engines</td>
</tr>
<tr>
<td>Viruses, macromolecules</td>
<td>Welding fumes</td>
</tr>
</tbody>
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### Inhalational Hazard?

- Alveolar type II
- Alveolar type I
- ROS Cytokines
- Macrophages
- Blood-air barrier ~200 nm thick
- Caveolae
- Alveolar air space
- EN
- surfactant
- EN
- surfactant
Whole body inhalation exposure to SWCNT elicited acute inflammation combined with early progressive fibrosis and granulomas in mice.

Granuloma Formation from SWCNTs


- Multiwall CNTs aspirated by laboratory mice can migrate from the alveoli in the lung, through the lung, to the pleura
Two dividing control cells with normal centrosome morphology

Four polar mitosis, nanotube association 24 hours following exposure to 0.024 μg/cm² SWCNT
Monopolar mitotic spindle 24-hr following exposure to MWCNT – nanotube association with centrosomes*

* Resulting errors in chromosome number (aneuploidy) is a key event in the progression of cancer.

[Adapted from: Sargent L, SOT 2011 presentation, with permission]

Occupational Exposure Limits for CNTs

- Summary of the hazard
- Dose-response risk assessment
- **Draft** NIOSH proposed REL:
  - 7 ug/m³ for CNT and CNF
  - Measured as elemental carbon
  - Set as LOQ for NIOSH Method 5040
  - 8-hr TWA concentration, respirable fraction
- **“Probable”** proposed REL:
  - Since 2010 draft, NIOSH Method 5040 LOQ improved
  - LOQ is now 1 ug/m³

http://www.cdc.gov/niosh/docket/review/docket161A/
Can CNTs Initiate and/or Promote Cancer?

- Focus of NIOSH toxicology research
- NIOSH has performed several subchronic inhalation studies in rats
- Results?
- Attend the Society of Toxicology 2013 Meeting
  - San Antonio, March 10-13

Influenza Issues

- Is the word “pandemic” counterproductive?
  - Yes
- H5N1 Influenza – Is it coming?
  - Yes
- What is the relative contribution of droplets vs. aerosols in influenza transmission?
  - NIOSH research goal
- Should CDC Guidance become an OSHA standard?
  - OSHA thinks so
- Should vaccination be mandatory for healthcare providers?
  - Many think so; others do not.
Avian Influenza (H$_5$N$_1$)

- In 1997, influenza A viruses of H$_5$N$_1$ subtype first isolated from a patient in Hong Kong
- Highly contagious and deadly pathogen in poultry and has reached epizootic levels in Asian domestic fowl
- Spread to wild bird populations across Europe and Africa, but no cases yet in US birds
- Human spread has been limited (2003-2012):
  - WHO reports 610 confirmed cases
  - 192 Indonesia, 123 Viet Nam, 169 Egypt, 43 China
  - 360 deaths for a 59% case fatality rate!

As of 13 January 2013, World Health Organization

Science Research: Influenza

- **Influenza Transmissibility Study**
  - Respirable aerosol sampler
  - Live virus analysis
  - Evaluate Exposures for High Risk Procedures

- **N95 vs. Surgical Masks Effectiveness**
  - Large-scale clinical trial
  - Veterans Hospital Clinics
Particles inhaled while wearing no mask, surgical mask & N95 respirator

- Coughing and breathing systems were 6 feet apart and facing each other.
- Plot shows concentration of aerosol particles at mouth of breathing mannequin.
- Surgical mask admitted ~20% of particles.
- N95 respirator blocked virtually all particles.
- Similar results are seen for other masks and respirators and for all positions of the breathing simulator.

Spread of particles in room after cough

- Coughing and breathing systems were 6 feet apart and facing each other.
- Breathing machine wearing N95 respirator and operating at 32 liters/minute.
- Plot shows concentration of 0.3 to 0.4 \( \mu \)m KCl aerosol particles at different locations after a single cough.
The Energy Workforce

- America’s Energy Hotspots
  - Deeping Sea Drilling
  - Hydraulic Fracturing

One in many upstream operations in an industry with a high fatality rate (2006-2010)

Source:
- Private Sector Fatality Rates - Bureau of Labor Statistics Census of Fatal Occupational Injuries (CFOI)
- O&G Fatality Rates - OSHA calculated using CFOI fatality counts and employment data from the BLS Quarterly Census of Employment and Wages.
United States of Shale

Hydraulic Fracturing Process
Potential Chemical Exposures

- Silica
- Diesel particulate
- Volatile organic compounds (NBTEX)
- Hydrogen sulfide (H₂S)
- Acid gases (HCL)
- Aldehydes (biocides)
- Metals (Pb)

Not an inclusive list

HF Needs Many Truckloads of Sand
Where Does Exposure Occur? During All Sand Moving Operations

NIOSH Field Studies

- 11 site visits in five states
- 116 samples for silica

Findings:
- 54 / 116 (47%) > OSHA Permissible Exposure Limit
- 92 / 116 (79%) > NIOSH Recommended Exposure Limit
- 36 / 116 (31%) > 10 X NIOSH REL

http://blogs.cdc.gov/niosh-science-blog/2012/05/silica-fracking/
Protecting Workers

- Use a less hazardous non-silica proppant (e.g., ceramic) where feasible.
- Use local exhaust ventilation for capture and collection.
- Use passive enclosures at points of dust generation.
- Minimize distances between the dragon tail and T-belts and blender hoppers.
- Replace transfer belts with screw augers on sand movers.
- Use amended water (e.g., containing chloride and magnesium salts) to reduce dust generation on roads into and at the well site.
- Mandate use of cam-lock caps for fill ports on sand movers.
- Use administrative controls.
- Provide worker training.
- Monitor workers to determine their exposure to crystalline silica.
- Use appropriate respiratory protection as an interim measure until engineering controls are implemented.

Proposed Controls

NIOSH Mini-baghouse retrofit assembly
Proposed Controls

NIOSH screw augur retrofit assembly

Legislation Passed by Congress on 23 December 2010
Signed by President Obama on 2 January 2011
Effective 1 July 2011