Occupational Risk Management System Used by NIOSH for NMNs

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The findings and conclusions in this presentation have not been formally disseminated by the National Institute for Occupational Safety and Health and should not be construed to represent any agency determination or policy.
Strategic Plans

• 10 critical areas
• Peer reviewed
• Tightly focused – driven by toxicology
10 Critical Research Areas

1. Toxicity and internal dose
2. Measurement methods
3. Exposure assessment
4. Epidemiology and surveillance
5. Risk assessment
6. Engineering controls and PPE
7. Fire and explosion safety
8. Recommendations and guidance
9. Global collaborations
10. Applications
Gaps in the Protection of Workers

**Hazard Identification**
"Is there reason to believe this could be harmful?"

**Hazard Characterization**
"How and under what conditions could it be harmful?"

**Exposure Assessment**
"Will there be exposure in real-world conditions?"

**Risk Characterization**
"Is substance hazardous and will there be exposure?"

**Risk Management**
"Develop procedures to minimize exposures"

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NIOSH Focus

- Toxicologic research
- Health effects assessment
- Safety research

- Toxicologic research
- Field assessment
- Epidemiologic and hazard surveillance research

- Metrology research
- Field assessment
- Control technology research
- Personal protective equipment (PPE) research

- Risk assessment
- Dose modeling
- Exposure characterization
- Epidemiologic research

- Risk communication
- Guidance development for controls, exposure limits, PPE, and medical surveillance
- Information dissemination
- Adherence investigation
Nanotechnology Research Center (NTRC)

• Virtual Center
• ~ 50 scientists – range of disciplines
• 2004–present
Produced more than 400 peer-reviewed scientific publications

• Resulting > 5,000 primary citations and 82,000 secondary citations
• 650 invited presentations

[NIOSH 2012]
Approaches to Safe Nanotechnology

Managing the Health and Safety Concerns Associated with Engineered Nanomaterials
Utilized realization that there was over 100 years of history of controlling fine dusts, powders and gases

- Nanoparticles followed laws of classical aerosol physics
- Quite controllable
- 2005 First posted on NIOSH website
- 2009 Update and publish

Influenced various agencies and companies world-wide
Nanotechnology Emissions Assessment Technique (NEAT)

• NEAT was developed as an initial step to semi-quantitatively evaluate emissions in nanomaterial workplaces and consists of a combination of field portable, direct reading instrumentation (DRI) and filter-based air sampling with subsequent laboratory analysis.
NEAT Steps

• Develop list of target areas, processes, or tasks
• Identify potential emission sources
• Collect basic particle count
• Collect filter samples
• Use sophisticated equipment
Risk Management and Prevention through Design (PtD)
Prevention through Design using Hierarchy of Controls

Elimination
Eliminate the hazard during design or re-design

Substitution
Substitution of less hazardous materials, processes, operations, or equipment

Engineering Controls
“Design-in” engineering controls to minimize risk

Warnings
Automatic and manual warning systems; signs and labels

Administrative Controls
Training, well-designed work methods & organization

PPE
Available, effective, easy to use

Control Effectiveness

Financial Value

Best

Last Resort
Factors Influencing Control Selection

- **Task Duration:** 8 hours
- **Quantity:** kilograms
- **Task Duration:** 15 minutes
- **Quantity:** milligrams
- **Occupational Health Hazard:**
  - Mild / reversible
  - Severe / irreversible
- **Physical Form:**
  - Slurry/suspension
  - Agglomerated
  - Highly disperse
- **Engineered Local Exhaust Ventilation**
- **Closed Systems**
Conventional controls should work

Exhaust Ventilation

Capture

Diffusion Dominates

About 1 nm

200 to 300 nm

Most Fine Dusts

Micro Scale

Air Stream

No Capture

Inertia Dominants
Available Toxicity Data

Adequate
- Quantitative Risk Assessment
  - Determination of OEL

Suggestive
- Qualitative or Semi-quantitative Hazard or Risk Assessment
  - In-house OELs

Insufficient
- Reason by Analogy or SAR
  - Control Banding
  - Performance-Based Exposure Control Limits

[Schulte et al. 2010; Kuempel et al. 2007, 2012]
Quantitative Risk Assessment in Developing Recommended Exposure Limits for Inhaled Particles

Rodent

- Experimental data of exposure and adverse effect
  - Measure or model
  - Dose-response model (particle surface area dose in lungs)
  - Dose-response modeling
  - Calculate lung tissue benchmark dose*
    - Extrapolate (Adjust for species differences in lung surface area)
    - Assume equal response to equivalent dose

Human

- Recommended exposure limit
  - Technical feasibility of measurement and control
  - Working lifetime exposure concentration
  - Estimated lung deposition fraction
  - Equivalent tissue dose

*Dose associated with specified level of risk.

[Oberdörster 1989; Kuempel 2011; NIOSH 2011]
CURRENT INTELLIGENCE BULLETIN 63

Occupational Exposure to Titanium Dioxide

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

CURRENT INTELLIGENCE BULLETIN 65

Occupational Exposure to Carbon Nanotubes and Nanofibers

http://www.cdc.gov/niosh/docs/2013-145/
Distribution of Potential Nanomaterials

Universe of Potential ENPs

Generalizability

Actual ENPs Studied for Hazard

Studied for Hazard
Issues in Establishing Categorical Occupational Exposure Limits (OELs) for Engineered Nanomaterials (ENMs)

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The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.
Thank you!

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