



# Nanotechnology

## Risk Evaluation & Control

### Best Practices

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**NHSF-Insurance Industry Perspective**

**Loss Control**  
SERVICES



## Please Note the fine print

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# Nano Encounters of the 1<sup>st</sup> Kind

## Business Models

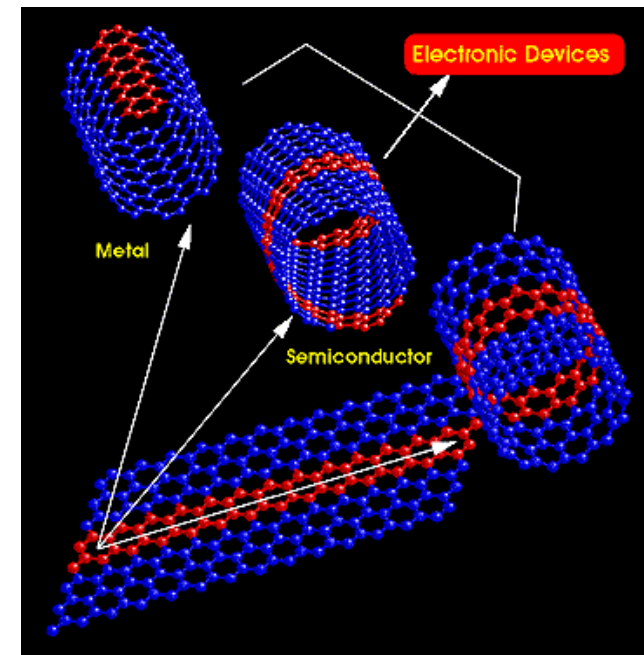
- R & D Startups
- Pilot
- Bulk manufacturing

## Types of industry

- Horizontal markets
- Electronics/Life Sciences
- Green/Solar
- Accidental?

## Types of nano materials

- Organic & Inorganic



# Manufacturing Methods

- Wet chemistry
- Dry labs
  - AFM microscopes, HPLCs
- Arc furnaces
- Semiconductor process toxic gases
  - CVD
  - Photolithography
- Containment hoods
- Glove boxes



# Manufacturing Methods

- Cleanrooms
- Liquid suspension containment
- Spray on deposition
- Dry powder transfer equipment
- Packaging equipment





# Health & Safety Exposures

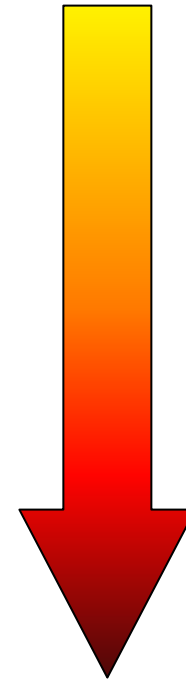
- Knowns versus unknowns
- Constant change!
- Identifying hazards
  - hard to quantify exposures
  - unquantifiable exposures
- Familiar routes of entry
- Many familiar controls
- Go with what you know!
- Be overly conservative!



# Ranking Nano Exposure Risk

- **Wet Process**
  - Fewer modes of entry
  - Absorption, ingestion, injection
- **Dry Process**
  - Same modes of entry
  - Add Inhalation
- **Particle Toxicity?**

**Less Risk**



**More Risk**



# E H & S Best Practices

- **Map** processes to identify potentially hazardous scenarios
- **Prioritize scenarios** that pose the greatest threat
- **Devise strategies:**
  - **modify** hazardous procedures and emissions
- **Measure** to validate performance of engineering controls and PPE
- **Test** to determine risks and management options
- **Re-validate** protective strategies



# Hierarchy of Controls

- **Change** design, hazard no longer exists
  - Substitution
  - Replace high hazard for lower hazard
- **Engineer**
  - Isolation
  - Ventilation
- **Administrate**
  - Procedures, policies, shift design, training
  - Personal Protective Equipment
    - Respirators/masks
    - Gloves & Goggles



# Control Options

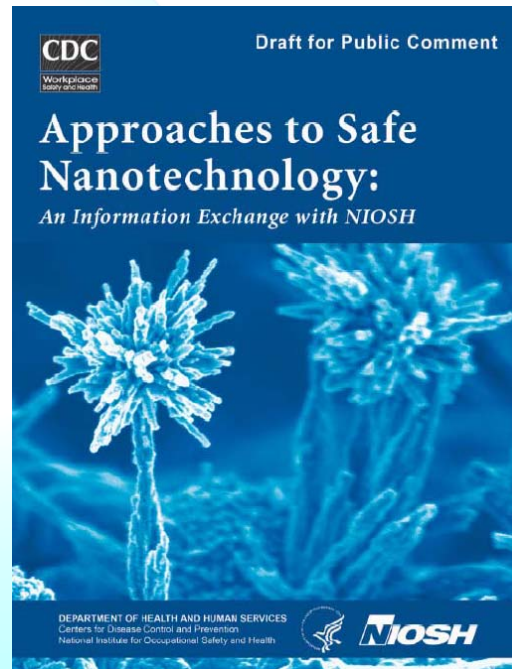
- Total enclosure
- Partial enclosure with local exhaust ventilation
- Ventilation
  - HEPA & ULPA filters
  - Good general dilution ventilation
  - Avoid explosive atmosphere concentrations
- Control access - limit # of workers & time exposed
- Suitable PPE
- Good work practices
  - Regular cleaning to avoid re-suspension
  - Personal hygiene practices
- Don't forget Maintenance!



# Regulation & Best Practices

NIOSH - March 2009

## Approaches to Safe Nanotechnology



<http://www.cdc.gov/niosh/docs/2009-125/>



# Favorable Risk Characteristics

- Informed and involved management
- Pervasive risk management philosophy
- Strong E H & S interaction at all levels
- Adherence to NIOSH best practices
- Strong engineering controls
- Strong emphasis on the employee education for administrative controls
- Enforced policies and procedures
- Thorough incident investigation