

Hazardous Waste Worker Panel
NIEHS WETP Fall Meeting, RTP
October 25-26, 2010

Bruce Lippy, Ph.D., CIH, CSP
The Lippy Group, LLC



Lippy Group has again exceeded expectations

2006

Company formed

2010

Company brochure completed

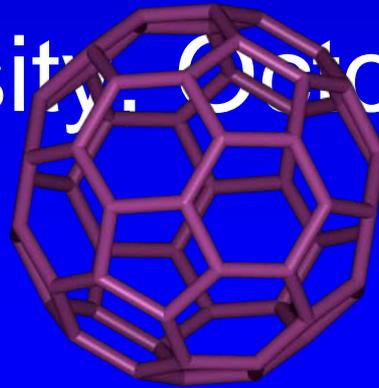
2011

5-yr planned brochure release



**I may have reached
a new peak in geek**

Spoke at the
Buckyball Discovery Conference
Rice University, October 12, 2010



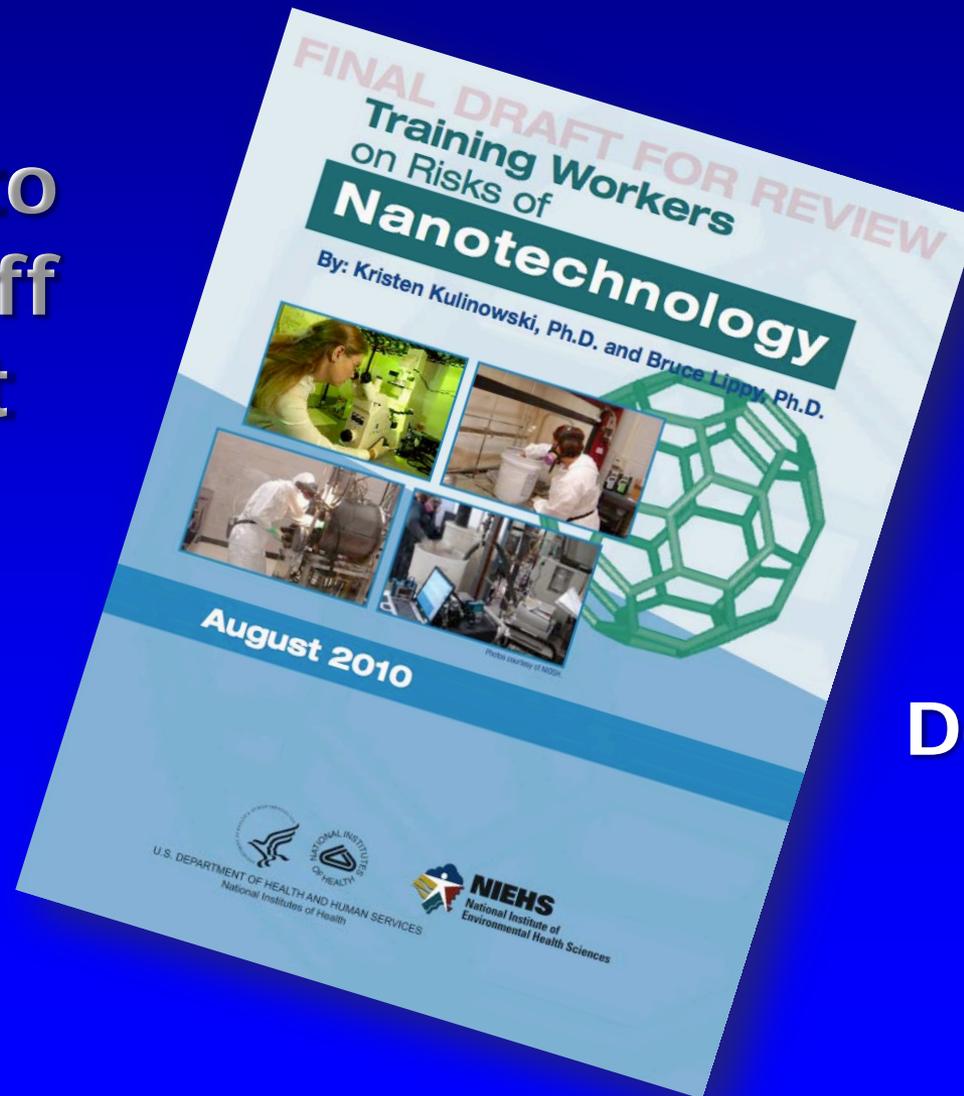
A compliment for the Nanotechnology Environmental and Health Implications (NEHI) subcommittee of NNI



**Good work! An impressive example of
the federal government being proactive
and cooperative on H&S issues. NIOSH
deserves particular praise.**

NIEHS Guidance, “Training Workers on Risks of Nanotechnology” is out!

Thanks to
MDB staff
for great
support



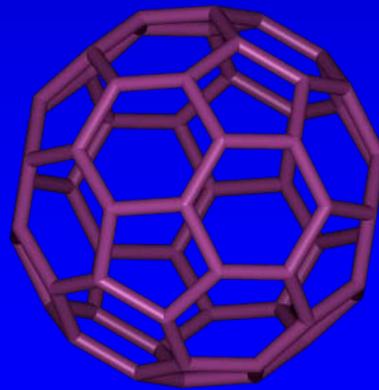
Special
thanks to
Carol Rice,
Don Elisburg
and NIOSH
reviewers



I will cover the main sections of the guidance

- 1. Purpose and overview**
- 2. Introduction to nanotechnology and nanoparticles**
- 3. Application of traditional risk management approaches to protect workers handling nanoparticles**
- 4. Regulatory and voluntary approaches specific to nanoparticles**
- 5. Resources**
- 6. Suggested training program**

Section 1: Purpose and Overview

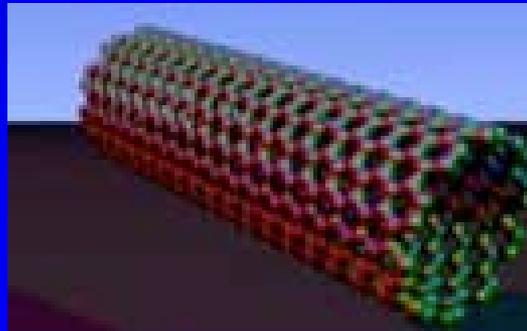




These were our aims:

1. Provide a broad overview of key issues
2. Define current knowledge on worker protection
3. Review applicability of U.S. regulations with a focus on HAZWOPER
4. Provide an outline for an 8-hour awareness course
5. Enable WETP trainers to instruct their constituents

Section 2: Introduction to nanotechnology and nanoparticles



We tried to keep the enormous societal benefits in view while considering the risks to workers

Nanoparticles delivery of "suicide DNA" kills prostate tumors"

Nano.cancer



NATIONAL CANCER INSTITUTE National Cancer Institute U.S. National Institutes of Health | www.cancer.gov

NCI Alliance for **Nanotechnology** in Cancer Transforming the diagnosis, prevention, treatment and clinical outcomes for cancer patients

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Nanotech Highlights

[2nd Annual Nanotechnology & the Life Sciences Workshop 2007](#)
March 30-31, 2007

[2007 NIH Director's New Innovator Award Program \(DP2\)](#)
RFA Number: RFA-RM-07-009
Receipt Date: May 22, 2007

[PAR-07-033](#)
Nanoscience and Nanotechnology in Biology and Medicine (R01)



DELIVERING
today's knowledge in
Nanotech Oncology

Nanotech News [view all] [RSS] [what is RSS?]

[Evaluating Multiple Biomarkers With Quantum Dots](#) May 22

[Nanoparticles Delivery of 'Suicide DNA' Kills Prostate Tumors](#) May 22

[Nanoparticle Self-Assembly Triggered by Tumor-Associated Enzyme](#) May 22

[Analyzing Nanoparticle Levels in Blood](#) May 22

[New Method Weighs Single Living Cells, Nanoparticles, Even Molecules](#) May 22

Spotlight on:
ALLIANCE PROGRAMS

Quick Links

[Nanotechnology Characterization Laboratory](#)

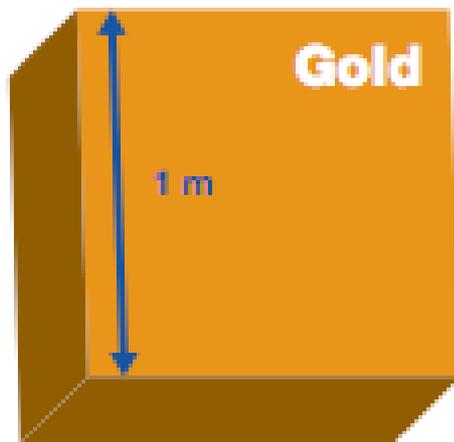
[Nanotechnology Teaming Site](#)

[Funding Opportunities](#)

[Scientific Bibliography](#)

We tried to provide useful analogies for trainers

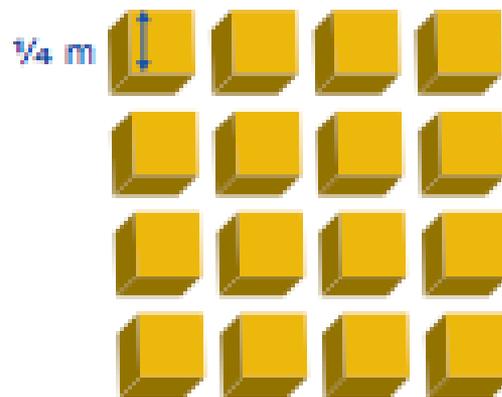
Each side = 1 meter



Mass = 43,000 lb
SA = m^2

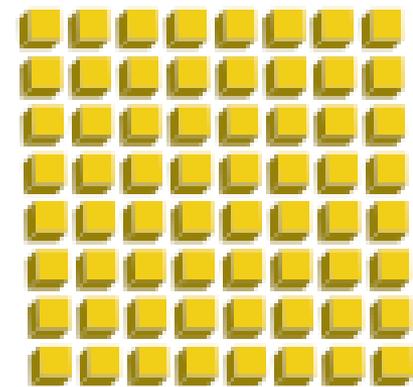
= 8ft x 8 ft room

Each side = $\frac{1}{4}$ meter



Mass = 43,000 lb
SA = $24 m^2$

Each side = 1 nanometer



Mass = 43,000 lb
SA = 6 billion m^2
= 2500 sq miles

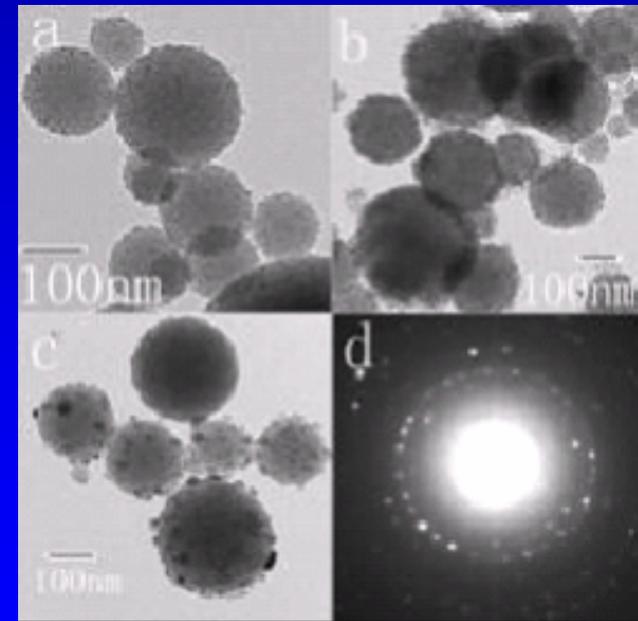
State of Delaware:
< 2000 sq miles



Another analogy that may help

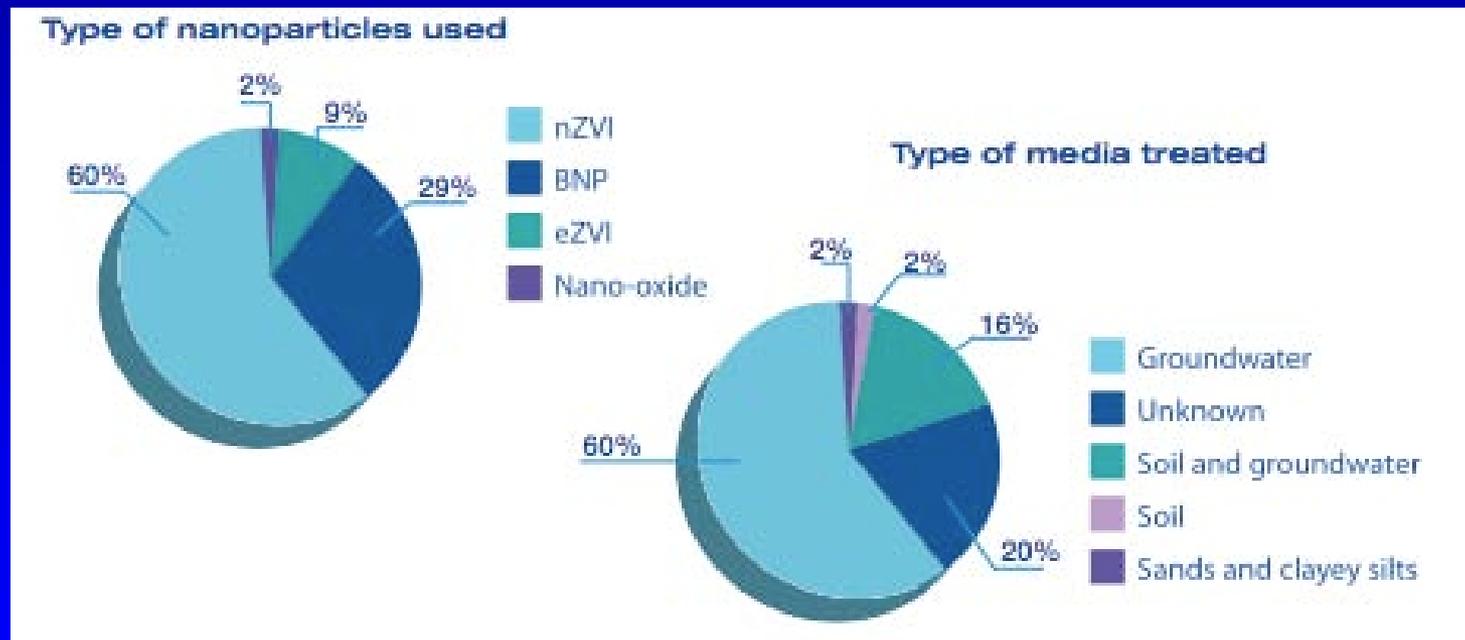
We attempted to keep the document focused on hazardous waste issues

- Iron oxide nanoparticles are 10 times more effective than micro-sized particles for ground water cleanup
- Case study of TCE and PCE groundwater cleanup in N.J. found **costs reduced 80-90%** and time reduced from **18 years for pump-and-treat to days**



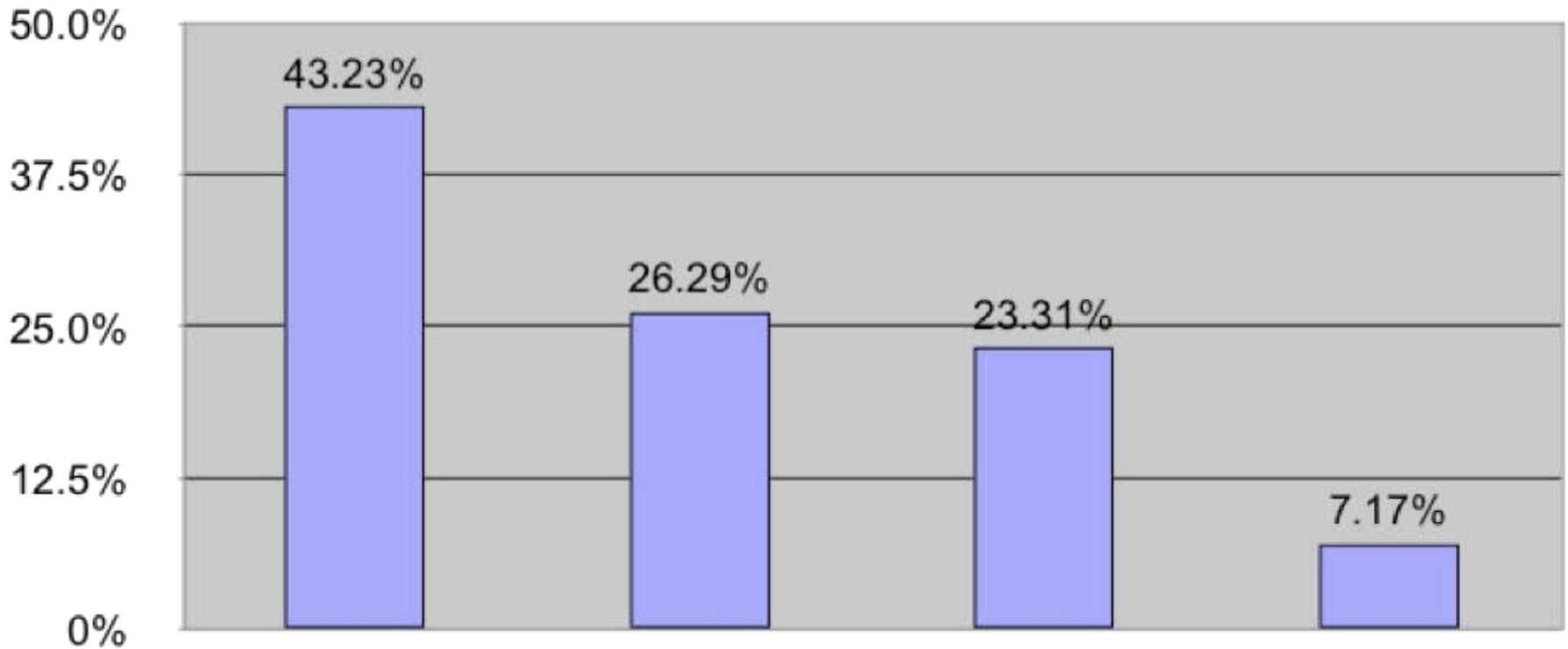
Silica Particles
Containing Zerovalent
Iron, courtesy EPA

WETP students need to know nanoparticles are being used *now* for environmental cleanup



Graphic from NIEHS guide

Nano Products in the Waste Stream (courtesy David Rejeski)



Disposable (Use for Less Than 1 Year)

(Use for 1-5 Years)

(Use for Over 5 Years)

Enter Waste Stream Directly

Less Than 1 Year | **1-5 Years** | **Over 5 Years** | **Indirectly Enters Waste Stream**

Spending on ESH is a small part of the federal research budget

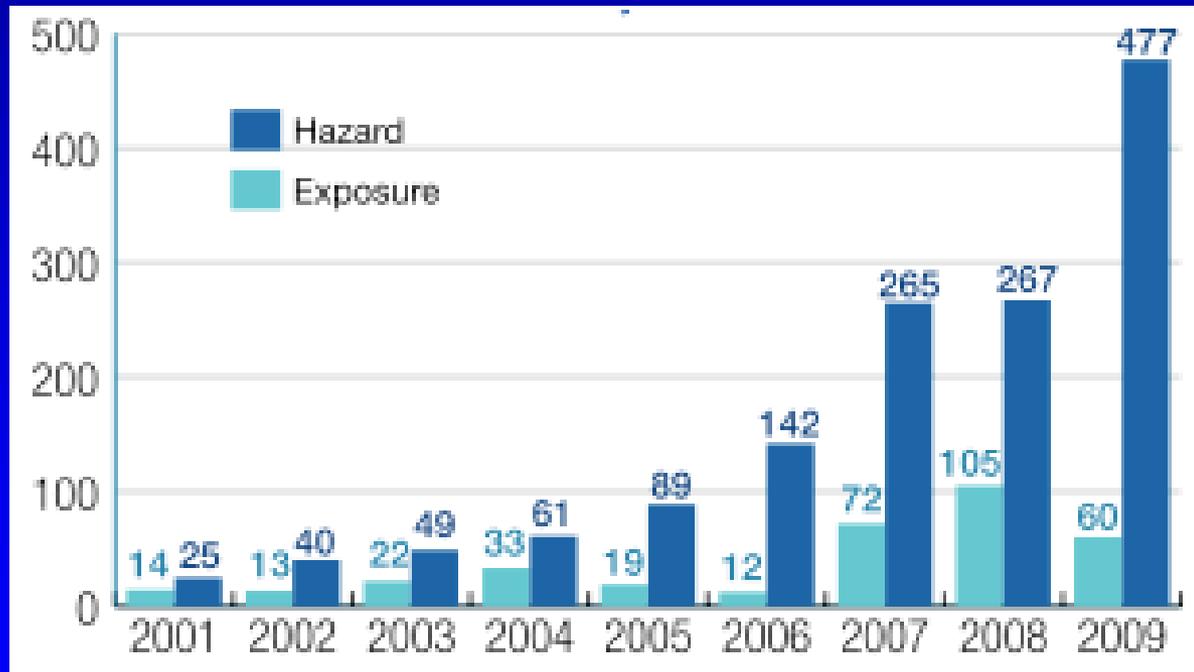
- 2008 budget nearly \$1.5 billion, more than triple the \$464 million spent in 2001
- Approximately 3% directed to ESH (Geiser, 04)
- Only about 0.2% is earmarked to study workplace safety issues

Peer-reviewed journal articles on occupational exposures are a small part of the ESH literature



Source: ICON, Rice University

Articles on hazards far outnumber those on exposures



Europe spends nearly twice as much as U.S. on nanotech risk research

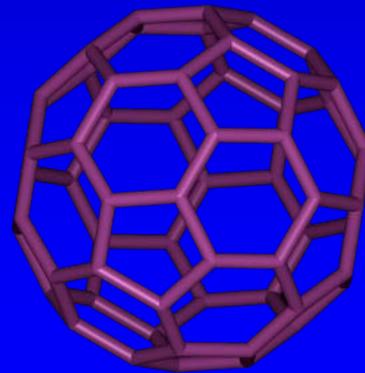


**Nano-Eiffel
Tower Gap?**



<http://www.nanotechproject.org/news/archive/ehs-update/>

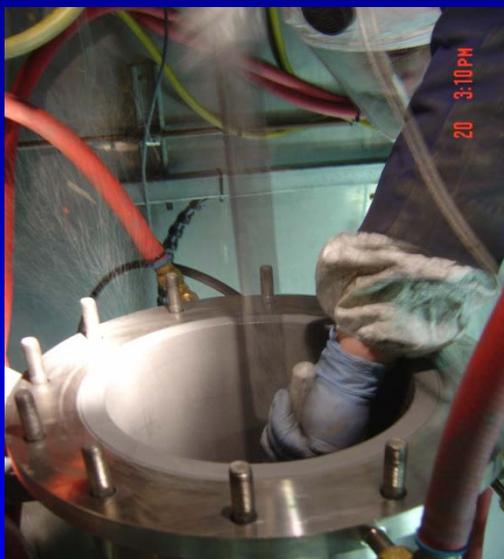
Section 3: Application of traditional risk management approaches to protect workers handling nanoparticles



We focused on the most likely worker exposures to nanoparticles

- **Generating nanoparticles in the gas phase in non-enclosed facilities**
- **Handling nanostructured powders**
- **Working with nanoparticles in liquid media**
- **Conducting maintenance on equipment and processes used to produce or fabricate nanoparticles**
- **Cleaning up spills or waste materials.**

Examples of Potential Exposures



Photos courtesy of M. Methner, NIOSH: with permission.

Harvesting SWCNTs from a carbon arc reactor releases particles



The guide explores possible nano exposures among WETP populations

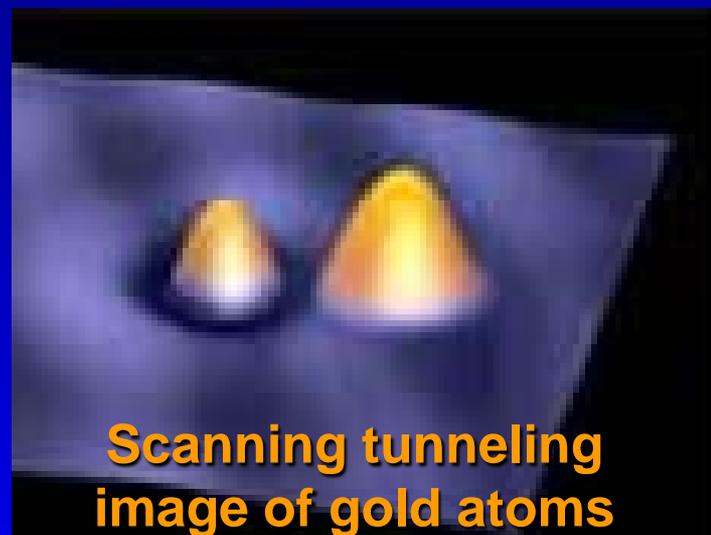
Population	Possible exposures
Firefighters	Combustion products
Stationary engineers	Nanobiocides
Hazardous waste workers	Nanomaterials released into environment or used for cleanup
Chemical workers	Engineered nanoparticles in plants

In assessing exposures (section 3.2), we explored:

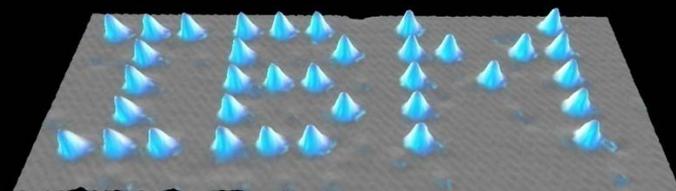
- Difficulties with the standard IH paradigm
- Absence of PEL
- Approaches NIOSH has been using

Students should appreciate the scope of potential nanochemicals

- OSHA has 40 year-old standards for 600 chemicals
- **44,514,121** chemical commercially available CAS (10/25/10)
- 112 known elements
- 10^{200} to 10^{900} distinct nanoscale particle possibilities

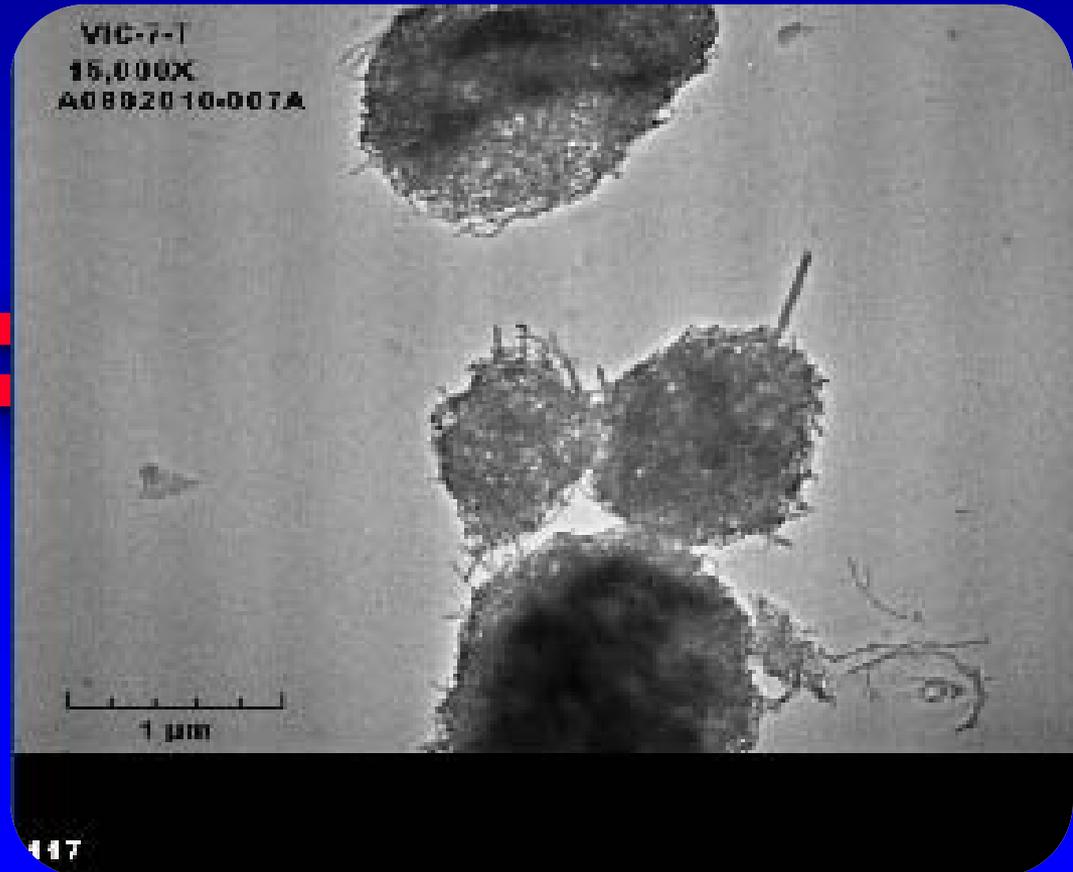


Scanning tunneling image of gold atoms



Writing with atoms (Eigler, 1990)

NIOSH says 10,000 carbon nanotube combinations are possible



“It is likely that no single metric will completely characterize exposure.”

Linda Abbott and Andrew Maynard,
Risk Analysis, 2010

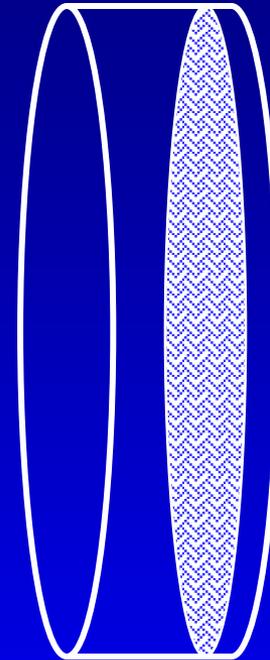
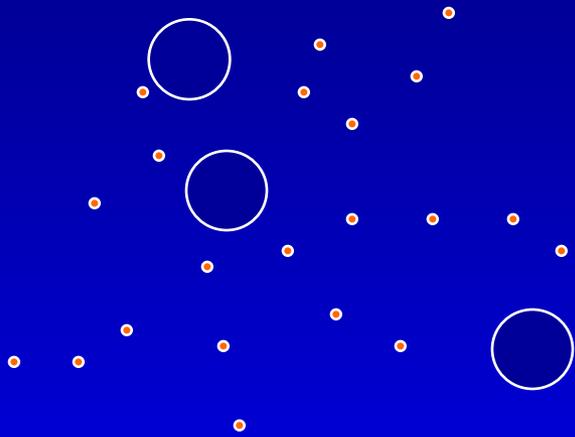


OPC
TSI Aerotrak 9303



CPC
TSI 3700

Large particles bias mass measurements



**Standard
37mm filter
cassette**

If you're carrying a grocery bag full of cantaloupes,
you're not going to notice a handful of grapes

No OSHA Nano PELs, but guidance OELs are being set:

NIOSH draft RELs (to be released within 2 years):

- **1.5 mg/m³ fine TiO₂;**
- **0.2 mg/m³ ultrafine TiO₂**

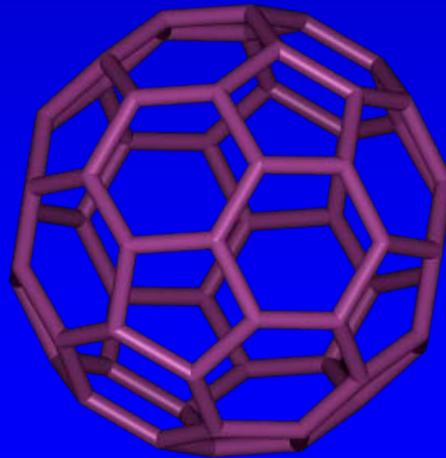
Bayer has set an OEL of 50 ug/m³ for its MWCNTs called Baytubes®

Control methods are reviewed using familiar concepts

- Hierarchy of controls
- Ventilation difficulties
- HEPA filtration
- PPE:
 - “preliminary evidence suggests that N-95 filtering facepiece respirators will be adequate for protecting workers from nanoparticle inhalation.”
- Fire issues



Section 4: Regulatory and voluntary approaches specific to nanoparticles



Nope.

“Is there any way I can tell if the sunscreen I buy for my baby contains nanoparticles?”

Image courtesy Assira and Wikimedia

“Not all nanotechnology-enabled products will lead to exposures and not all exposures will lead to new risks.”

Abbott and Maynard, 2010

Carbon nanotubes are being used in tennis rackets. Is there a risk?

Yes, if your doubles partner is a klutz!



Quiz demonstrating federal regulatory conundrum

For EPA, a washing machine that releases nanosilver particles is a:

- device
- pesticide



We review EPA's strong regulatory lead and local regs, too

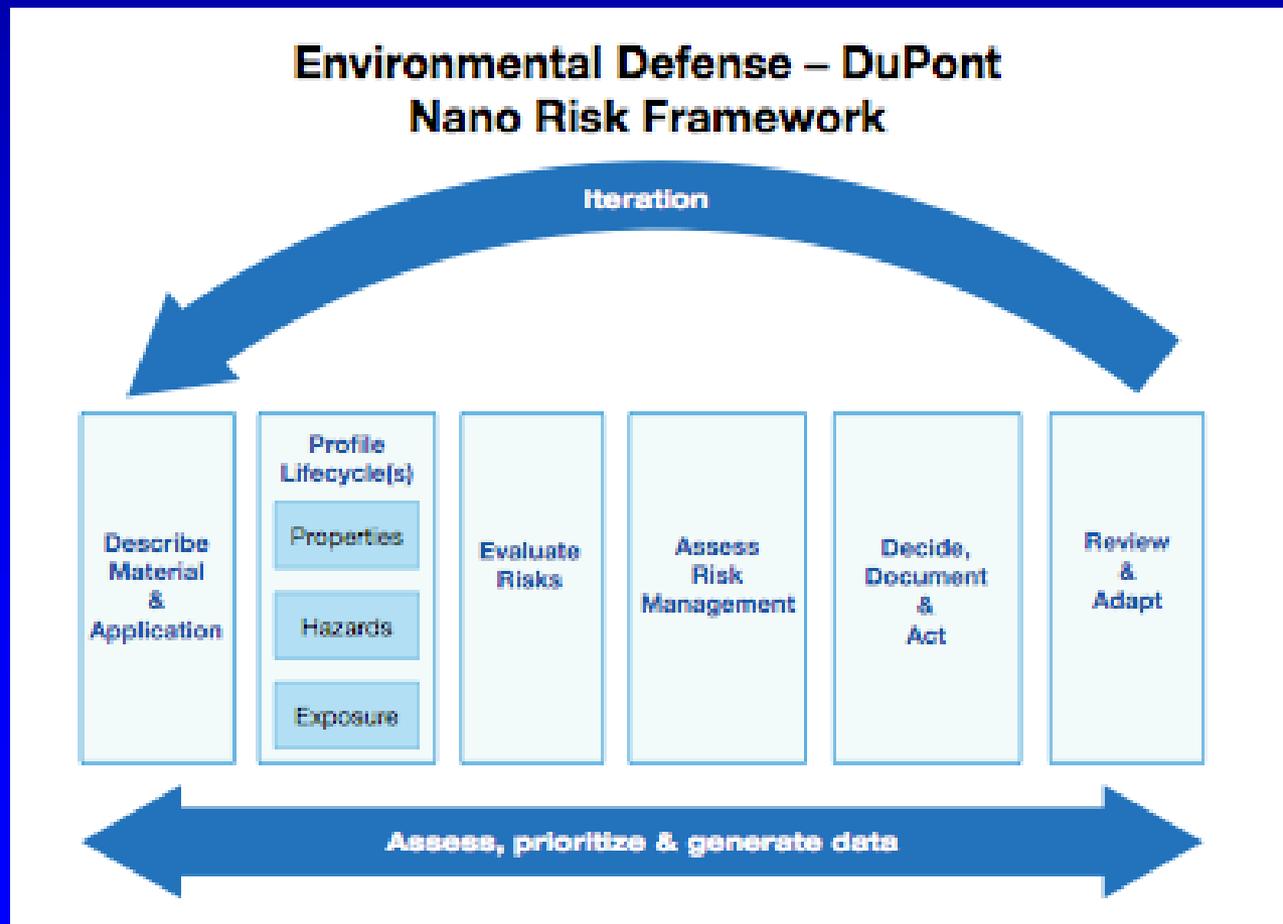
- EPA's Significant New Use Rules
- Berkeley's reporting requirements



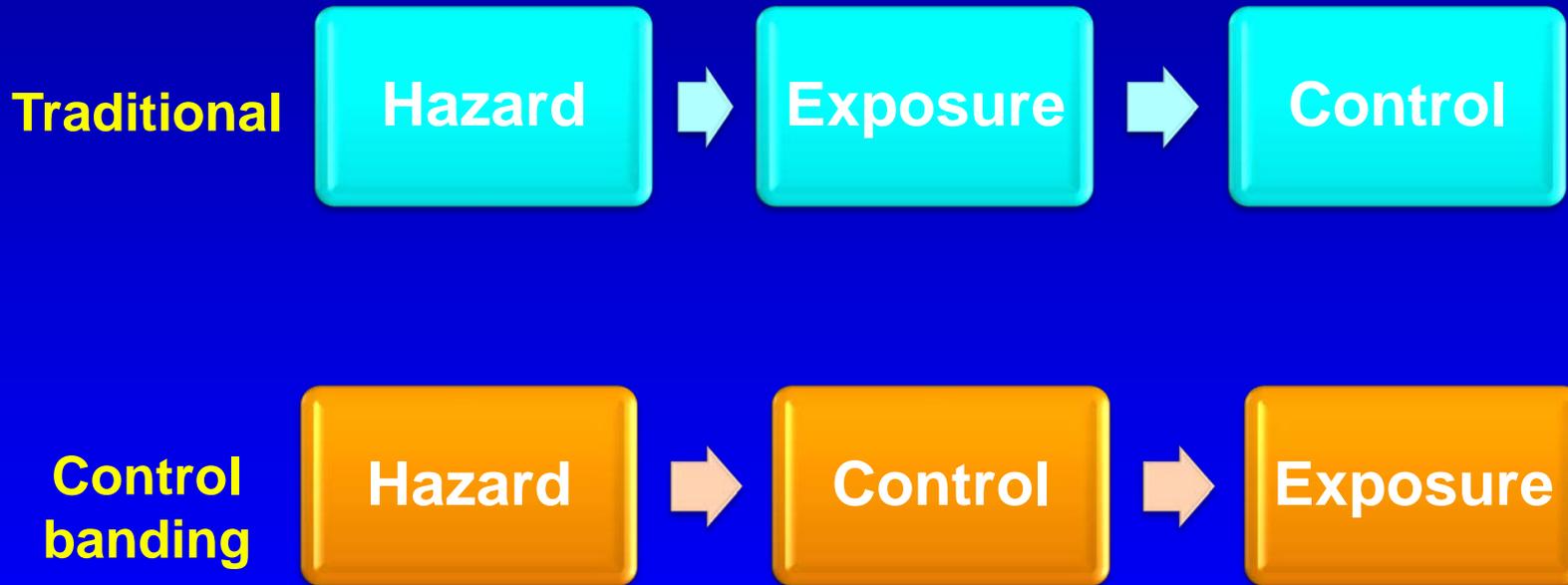
Berkeley Transit Service

There are considerable efforts underway through voluntary organizations

OECD, ISO TC 229, ASTM, EDF-DuPont



Control banding is covered because it provides real possibilities



Livermore's CB Nanotool Risk Level Matrix

		Probability			
		Extremely Unlikely (0-25)	Less Likely (26-50)	Likely (51-75)	Probable (76-100)
Severity	Very High (76-100)	RL 3	RL 3	RL 4	RL 4
	High (51-75)	RL 2	RL 2	RL 3	RL 4
	Medium (26-50)	RL 1	RL 1	RL 2	RL 3
	Low (0-25)	RL 1	RL 1	RL 1	RL 2

RL 1: General Ventilation

RL 2: Fume hoods or local exhaust ventilation

RL 3: Containment

RL 4: Seek specialist advice

**Courtesy: Sam Paik,
LLNL**

“Interpreting the meaning of new exposure metrics will present a challenge for risk communicators.”

Abbott and Maynard, 2010

2010 Award Winner for Understatement





“Is it too soon to talk Hazard Communication for Nano?”

My question to the NEHI
committee



**Wilson Center has 1014 products,
produced by 484 companies, located
in 24 countries (9-29-10)**



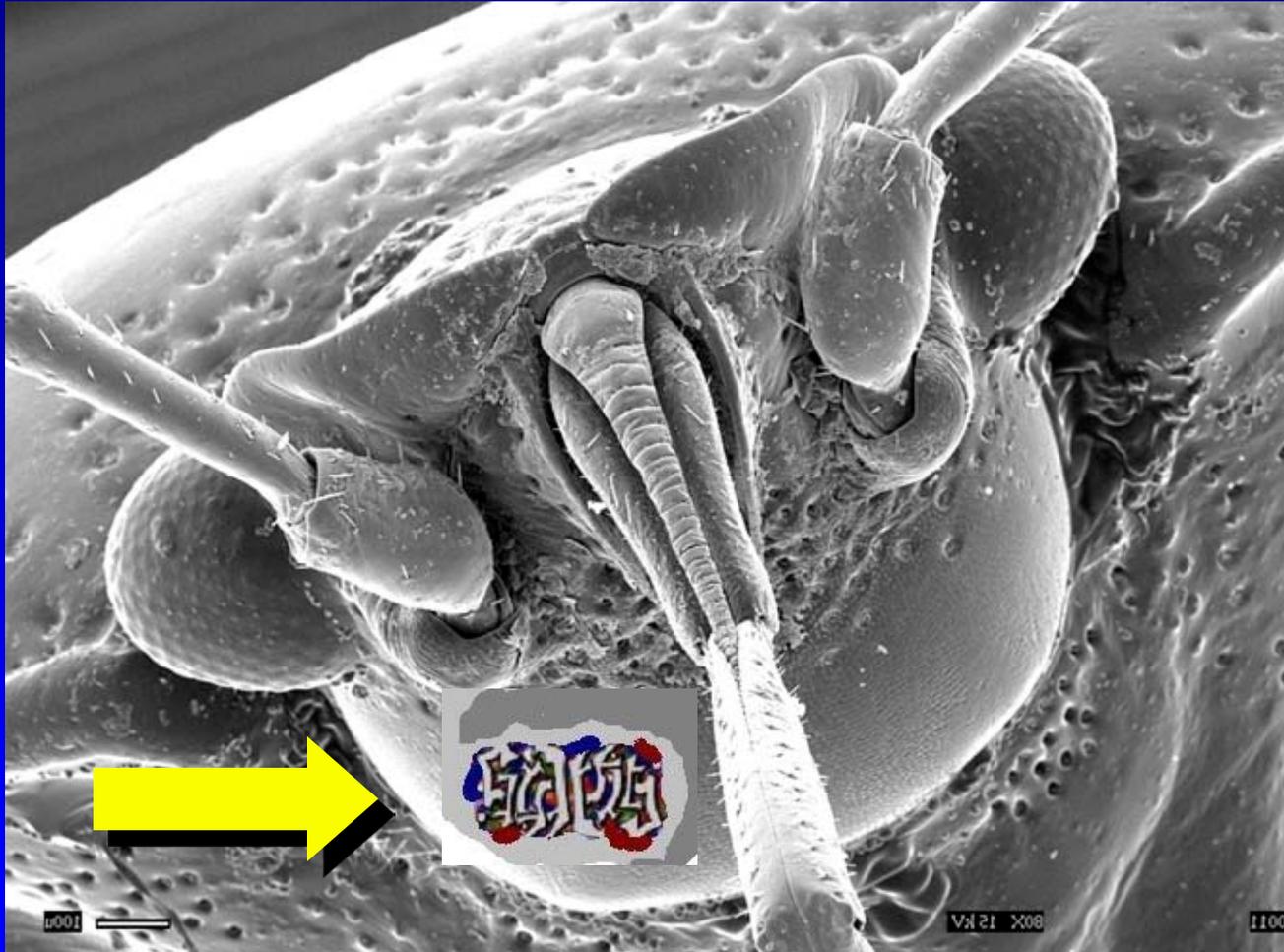
Project on
Emerging Nanotechnologies
at the Woodrow Wilson International Center for Scholars



My favorite nanoproduct: Anti-graffiti Paint Deletum 3000+



My Guess: used to remove nano-graffiti



Lippy Group reviewed NIOSH collection of nano MSDSs

- N = 49 “Improving” MSDSs
- Reviewed all of the MSDSs
- 33% did NOT identify the nano component
- 52% did NOT have any cautionary language

Lippy Group MSDS Review

Use of Occupational Exposure Limits

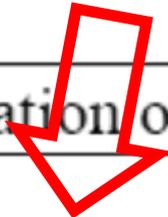
- 62% used OSHA Permissible Exposure Limits or ACGIH TLVs for “macro” sized material
- 32% percent indicated nothing
- Only 6% used conditional language about using PELs/TLVs

MSDS for Carbon Nanotube

Section 1 Product Identification

Chemical Name:	Carbon Fullerene
Formula:	Carbon
Chemical Family:	Synthetic Graphite
Synonyms:	Carbon Nanotube
CAS Number:	7782-42-5 (Graphite)

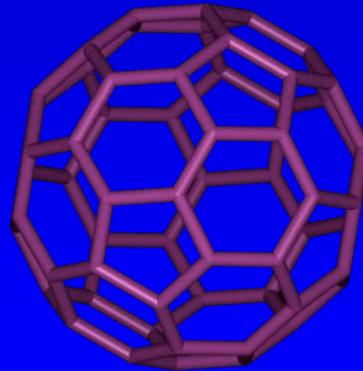
**“Nuisance” dust
standard for
synthetic
graphite:
15 mg/m³**



Section 2 Composition and Information on Ingredients

Component	%	OSHA/PEL	ACGIH/TLV
Synthetic graphite	Up to 100%	15 mg/m ³ (total dust) 5 mg/m ³ (respirable fraction)	2 mg/m ³ TWA

Section 5: Resources



NIOSH has excellent guidance

Approaches to Safe Nanotechnology

Managing the Health and Safety Concerns
Associated with Engineered Nanomaterials



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



www.cdc.gov/niosh/topics/nanotech

The GoodNanoGuide is a tremendous resource

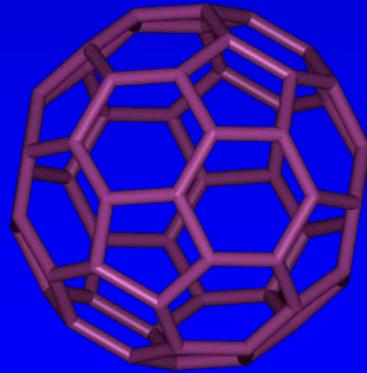
- Protected Internet site on occupational practices for the safe handling of nanomaterials
- Multiple stakeholders contribute, share and discuss information
- Modern, interactive, up-to-date



The screenshot shows the GoodNanoGuide website interface. At the top right is the logo "GoodNanoGuide" with a hexagonal icon. Below the logo are three images: a hand using a pipette, a person in a lab coat working with a microscope, and a person wearing safety glasses. The main content area features a search bar with a "Go" button. Below the search bar is a "Beta Sponsors" section with logos for ICON (International Council on Nanotechnology), NanoTech BC, nanoAlberta (Industry Canada), nano québec, and ifrst. There is also a "My Tools" section with a link to "My Preferences". The central text reads "Welcome to the GoodNanoGuide" and describes the platform as a collaboration tool for experts. Below this text are three columns of content, each with a question and a "Start Here" button: "New to nanotechnology?", "Know about nanotechnology?", and "Expert in workplace practices?".

<http://GoodNanoGuide.org>

Section 6: Suggested Training Program



Kristen Kulinowski and I approached this for WETP audience

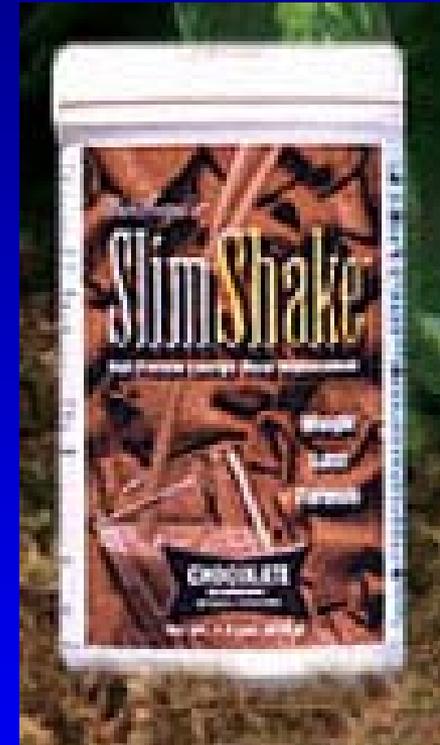
- Learning objectives and outline for awareness course and 8-hour HAZWOPER refresher
- **Only** paper on training: Hsieh, F. M., Tsai P.J., Chen, W. Y. & C. P. Chang (2009). Proceedings of the 2009 IEEE IEEM

Training recommendations are tied to the Minimum Criteria

Module	Topic	Description	Adult learning techniques
1	Introduction to nanotechnology and nanoparticles	An overview of the definition of nanoparticles, classes of nanomaterials with an explanation of engineered versus naturally occurring and a discussion of the benefits, risks and life cycle of nanomaterials.	<ul style="list-style-type: none">» Demonstration of commercially available models of nanoparticles;» Group discussions on whether the benefits exceed the risks and who bears the risks;» Class exercise of handling actual products (some nano and some not) and trying to determine if they contain nanoparticles;» Class discussion of operations in student workplaces where nanoparticles or nanomaterials are handled.

Questions?

**Nanoceuticals™
Slim Shake
Chocolate**



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www.thelippygroup.com

