

Survey of Current Practices in the Nanotechnology Workplace

December 5, 2006

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ON NANOTECHNOLOGY
A partnership for nanotechnology stewardship and sustainability

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Overall Project Objectives

- To address the lack of consolidated understanding of current health, environmental, and stewardship practices in the nanomaterials workplace
- Complete in 7 months: Apr-Oct 2006

Project in Two Phases

- Phase I: Catalogue existing and currently planned efforts to delineate EHS practices and product stewardship approaches worldwide in the nanomaterials workplace
- Phase II: Survey nanotechnology organizations worldwide regarding their *current* EHS practices and product stewardship approaches
- Both reports available at: <http://icon.rice.edu/>

Main Findings of Phase I

- While some compiling of practices has occurred, existing or ongoing studies:
 - Do not make information freely available to the public, or
 - Have gathered data only in a limited geographical area, or
 - Results will not be available for some time

- These findings reinforced the need for the Phase II survey to identify current practices

Phase II Research Approach

- Design and pretest a questionnaire for the survey
- Solicit participation in the study
- Administer the questionnaire to a minimum of 45 participant organizations
- Analyze survey responses
- Compile a report by October 2006

All steps designed to protect the identity of participants.

What's distinctive about the study?

- Looks at the Environmental, Health and Safety (EHS) practices in the workplace and product stewardship of nanomaterials
- Global in scope
- Publicly available
- Includes all sectors—industry, university and research labs

Questionnaire Design

- Identify areas of interest based upon Phase I results
- Systematic pairing of question and response variables
- Combination of open-ended and close-ended questions
- An extensive process of revisions, collecting expert opinions, and pre-testing
- Translation into Japanese and Chinese languages

Questionnaire Categories

- Interview subject
- Organization information
- Nanomaterial information
- General OEHS and Nano-OEHS
- Containment and exposure controls
- Waste management
- Employee and area exposure monitoring
- Risk characterization
- Product stewardship

Participant Development and Interview Arrangement

- Contact list comprised of some ICON referrals; most from resource mining
- Initial email of invitation with precontact package
 - Letter of endorsement from ICON
 - Letter of invitation from PI Holden
 - Invitation to Interview
- Consent form: send and receive completed
- Schedule interview
 - Questionnaire sent out in advance

Questionnaire Administration

■ Pre-testing

- With 2 nanotech companies
- Reviewed by NIOSH, ICON
- Each interviewer

■ Interviews

- Conducted primarily by one researcher at a time; others participating as needed
- Recorded when permitted by interviewee
- 3rd party involvement for some participants
 - Japanese
 - Chinese (PRC)

Data Analysis

- Review / index interview transcripts
- Response coding
- Descriptive analyses
 - within question category
 - across categories
 - between direct and 3rd party data
- Distillation into baseline understanding

Sample Description

- 337 organizations contacted out of more than 1600 worldwide
- 19% overall response rate
 - 216 non-responses
 - 68 declinations
- Reasons organizations declined to participate

Region of Origin	# Contacted	# Respondents	Response Rate (%)
North America	178	25	14%
Asia	82	25	30%
Europe	69	11	16%
Australia	8	3	38%
Total Contacts	337	64	19%

Characteristics of participating organizations

- Types of respondent organizations
 - 80% private sector
 - 9% research labs
 - 9% university labs
 - 1 consulting firm
- Job titles of respondents
 - 46% executive administration/management
 - 17% scientists
 - 16% EHS personnel
 - 21% other
- Customers of participating organizations included R&D, electronics, energy, coatings, plastics, automotive, and medical industries

Organization Characteristics (cont.)

- Located in 14 different countries on four continents
- 56% were less than 10 years old
- 86% reported working with nanomaterials 10 years or less
- Majority had fewer than 50 employees handling nanomaterials – only 4 had more than 250

Limitations of this Study

- Relatively small sample size
- Based on self-report data
 - What actually occurs is unknown
 - Why information is reported is unknown
- Sample bias
 - Don't know anything about non-participants

Categories of Findings

- I. Nanomaterials
- II. Reported Beliefs on Nanomaterial Risk
- III. EHS Programs
- IV. Engineering Controls
- V. Personal Protective Equipment (PPE) and Clothing
- VI. Monitoring
- VII. Waste Management
- VIII. Product Stewardship
- IX. Reported Impediments

I. Nanomaterials

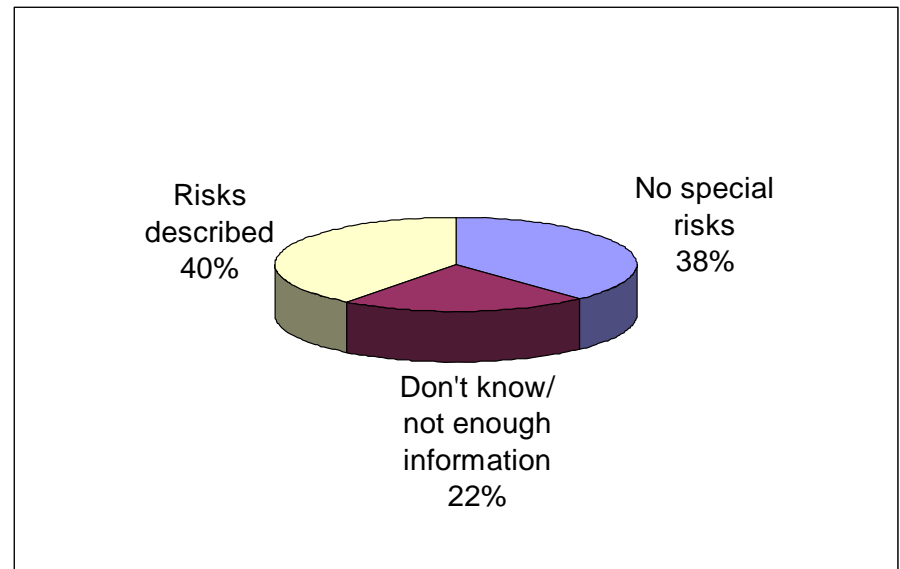
- Nomenclature an issue – but four most commonly handled nanomaterials (of 14+)
 - Nanopowders
 - Carbon nanotubes
 - Colloidal dispersions
 - Fullerenes (Buckyballs)

- Forms in which materials were handled
 - Dry powder
 - In solution
 - Embedded in or fixed to a surface

- 41% reported handling or producing nanomaterials on a small scale, but some producing at pilot and commercial scale

II. Reported Beliefs on Nanomaterial Risk

- Leading concerns included inhalation exposure and potential for flammability
- Top ranked sources used for determining risks of nanomaterials
 - scientific literature
 - government regulations and guidelines
 - expert consultation
- Most (66%) do not perform or fund toxicological testing of their nanomaterials

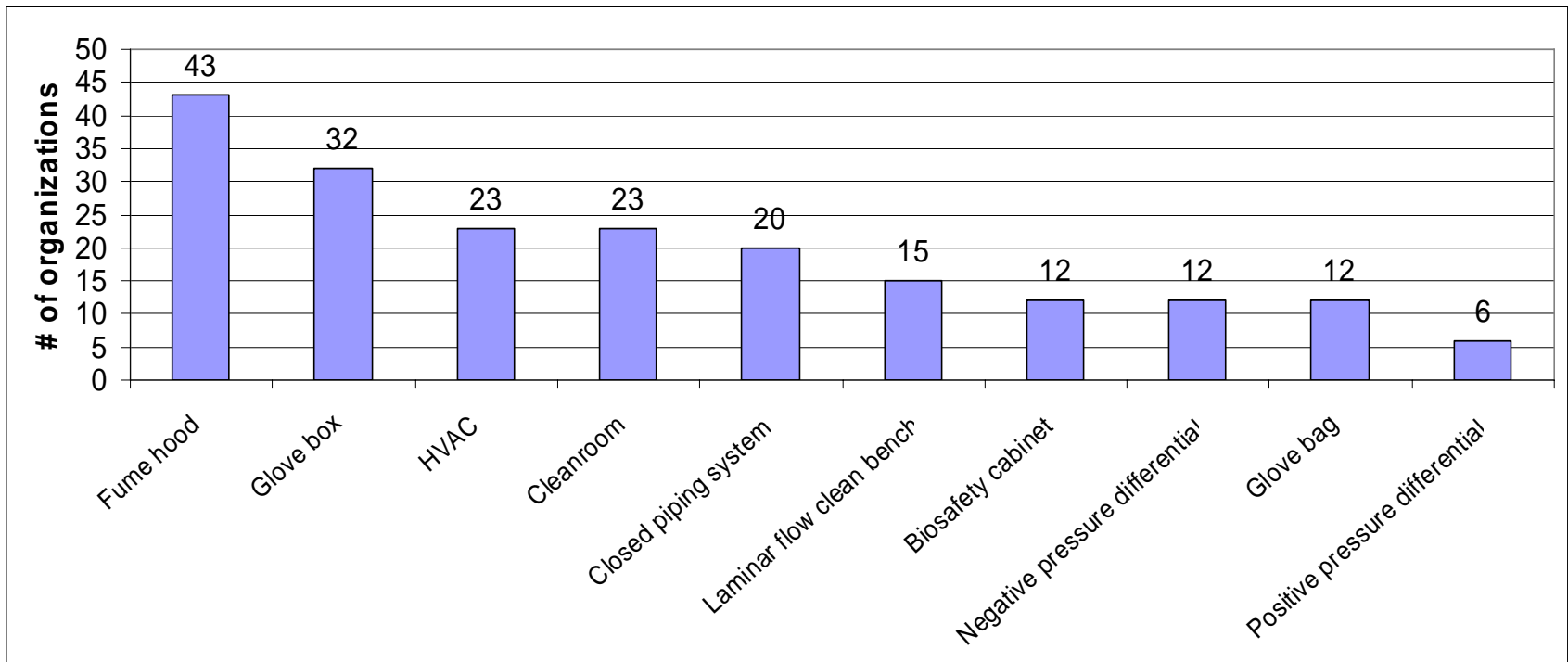


III. EHS Programs

- 92% of respondents reported implementing a general EHS program
- 58% described a nano-specific EHS program
- Nano-specific EHS programs were more prevalent in organizations that:
 - Had worked with nanomaterials for a longer time
 - Had more employees handling nanomaterials
 - Believed there are special risks associated with their nanomaterials

IV. Engineering Controls

- Primarily reported using conventional engineering controls
- Subset reported using specialized approaches



IV. Engineering Controls (cont.)

- Higher number of conventional controls reported by organizations that are:
 - Larger, or
 - Handling a number of different nanomaterials, or
 - Handling nanomaterials in a variety of phases
- North American organizations more often than others reported using high capital cost engineering controls such as cleanrooms and separate HVAC systems
- Fume hoods were less frequently reported for use with nanopowders
 - Some reported concern that turbulent air flow may result in a loss of expensive material through ventilation

Specialized Engineering Controls

- Enclosed processes to reduce exposure to inhalation
 - Airlocks
 - Remote control equipment for production
- Explosion-proof enclosure
- Transitional buffer zones of lower pressure to isolate cleanroom outflow
- Oxygen and pressure safety alarms for production equipment shutoff

V. Personal Protective Equipment and Clothing

- 84% recommended PPE and clothing standards for employees working with nanomaterials
- Recommendations did not deviate significantly from conventional practices
 - But questions were mainly prompted by convention
- Some recommendations varied with size of company, type of nanomaterial, and commercial sector

VI. Monitoring the Work Environment for Nanoparticles

- 61% did not monitor
 - Yet companies cleaned up particle spills by vacuuming
- Those that reported monitoring (36%) most frequently measured particle concentration and size
 - Small number used devices outside of nano-scale
- Most common device used was a particle counter

VII. Waste Management

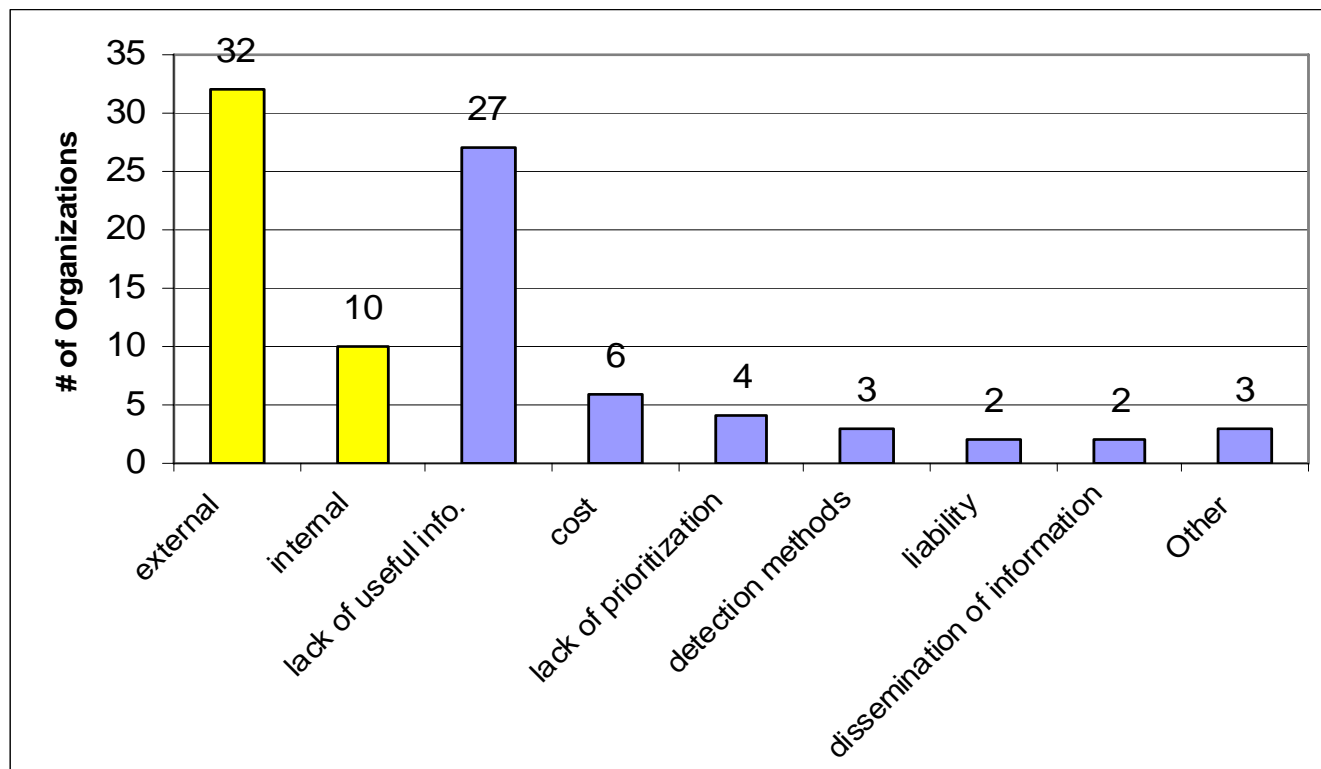
- A majority of respondents (24/47) reported discarding of nanomaterials as hazardous waste
- A few others agglomerate, incinerate, store or recycle nanomaterials
- A majority (35/56) do not separate nano-waste
- Most (34/51) do not label their waste as “nanomaterial”

VIII. Product Stewardship

- Material Safety Data Sheets (MSDS) was the most commonly described method (37/43) for transmitting information on *safe use*
- 29/51 reported having guidance for *safe disposal* of nano-products
- 12/29 recommended hazardous waste disposal, but did not provide formal guidance for their customers

XI. Reported Impediments to Nano-Specific Practices

- 39/53 described impediments
- Primary impediment was lack of information



Main Findings of Phase II

- Nano-specific EHS programs and training were widely reported
- Actual practices did not significantly depart from conventional safety practices for handling chemicals
 - But questions regarding PPE and monitoring were prompted by conventional choices
 - Innovation was volunteered more for engineering controls
- Many organizations displayed active interest in additional information on how best to handle nanomaterials

Overall Implications

- Lack of information and guidance were the main reported impediments to further developing and implementing nano-specific health, safety and product stewardship programs
- Most pressing need is for research on toxicology, hazards and safe handling methods for nanomaterials



Recommendations for Future Research into Current Practices

- Increase sample size
- Verify self-reported information
- Address potential bias created by non-random (volunteered) participation

A researcher's job is never done!

- Still interpretation, and we welcome your viewpoint.
- The team encourages comments:

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Acknowledgements

- ICON, for funding and support
- Tracy Godfrey and Scott Walsh of Environmental Defense
- Questionnaire review and pre-testing:
 - Keith Swain of DuPont Company
 - Matthew Hull of Luna Innovations
 - Chuck Geraci of NIOSH
- 3rd party surveying:
 - Hideo Shindo of NBCI
 - Dianhong Shen at the Chinese Academy of Sciences
 - Tsung-Tsan Su, Ting-Kuo Lee and Tsing-Tang Song at the Office of National Nanoscience and Nanotechnology Program in Taiwan
- David Vandenberg at UCSB EHS
- All the survey participants who took the time to speak with us and share their practices, insights, and concerns. Without their interest and help, this report would not have been possible.