



## Reported Practices and Perceived Risks for Environmental Health, Safety, and Product Stewardship in the Nanomaterials Industry

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### Introduction

Motivated by the tremendous growth of the engineered nanomaterials (ENMs) industry, the safety of nanotechnology is garnering significant attention worldwide. Government agencies, industries, and nonprofit groups are in the process of determining which environmental health and safety (EHS) practices will best protect workers, consumers, and the environment. Without sufficient information or regulation, ENM industries may act independently to avoid risk, creating inconsistent methods for protecting worker safety and environmental health.

This project surveyed nanomaterials firms, including industrial producers and users of ENMs, to discover what steps these firms are taking to ensure the safety of workers, customers, the public, and the environment, and to reduce potential risks associated with ENMs. Participants also reported on their company's risk management practices and personal risk perceptions.

**Risk Management:** The steps producers and users are taking (e.g., protective equipment, use restrictions, etc.) to reduce the potential hazards or exposure associated with ENMs.

**Risk Perceptions:** the views industry leaders maintain regarding the hazards associated with nanomaterials. These views are expected to profoundly influence the types and magnitudes of actions that companies voluntarily take to protect workers, consumers and the environment.

**On the Web:** <http://www.bren.ucsb.edu/~nano>

### Background

Nanotechnology is defined as the manipulation and manifestation of materials at dimensions between 1 to 100 nanometers (i.e., at the "nanoscale").<sup>1</sup> At the nanoscale, familiar substances can exhibit different physical, chemical, and optical behaviors. Consequently, nanotechnology has the potential to make significant contributions to many fields, ranging from biotechnology to energy, and transportation to agriculture. Nanotechnology also presents new opportunities to improve how we measure, monitor, manage, and minimize emerging contaminants in the environment.

However, ENMs have largely unknown toxicological profiles and have many uncharacterized properties. Consequently, producers and users of nanomaterials may face unknown environmental health and safety risks. Therefore, EHS and product stewardship practices specific to ENMs are under development. This results in a variety of perceptions of ENM risks, and practices addressing these risks have emerged.

Chemical manufacturing provides a useful historical example of an industry that may pose risks to the environment as well as to workers. Cases of worker safety violations within the chemical manufacturing industry have been discussed in the health and safety literature, as well as through the public media. As such, the workplace is a point of first contact with ENMs.

Furthermore, how industry approaches risk management in their in the workplace reportedly affects how they manage their environmental performance. Specifically, firm practices implemented internally for protecting worker safety and health could predispose a nanomaterials manufacturing company to improve its environmental performance. These performance measures include emission controls and waste disposal.

<sup>1</sup> National Institute of Occupational Health and Safety. (2009) *Approaches to Safe Nanotechnology: Managing the Health and Safety Concerns Associated with Engineered Nanomaterials*. Retrieved from: <http://www.cdc.gov/niosh/docs/2009-125/>.

**Project Purpose**

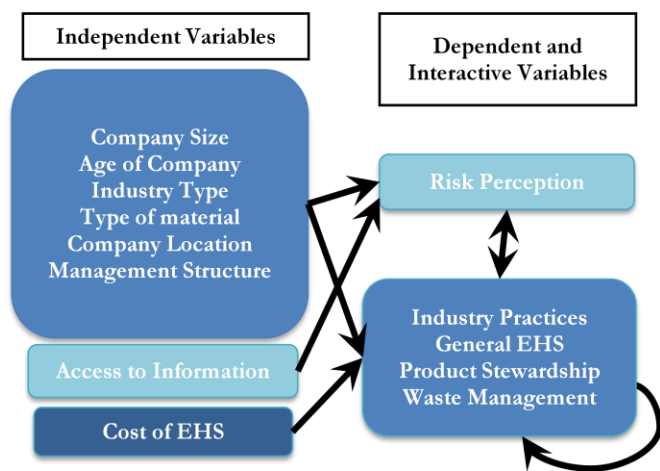
The purpose of this project is to reveal how industries reportedly manage environmental health, safety and product stewardship in the nanomaterials workplace, to determine industries’ views on nanomaterial risks, and to evaluate relationships between reported practices and views on risk that may drive practices. This project aims to inform ENM industries, governments, and other stakeholders who are concerned with balancing the need to protect workers and the environment with the benefits of continued ENM industry growth.

**Survey Approach**

- Solicited companies that manufacture, handle, and/or produce ENMs
- Targeted 500 companies for participation
- Aimed for 20% response rate
- Sampled worldwide
  - Over-sampled (50%) North America

**Research Design**

The survey instrument was revised from a previous study.<sup>2</sup> The questionnaire was intended to evaluate the consistency of reported practices with current guidance documents, evaluate risk perceptions, and test hypotheses related to sets of independent and dependent variables delineated in this project (see below).



<sup>2</sup> Conti, J, Killpack, K., Gerritzen, G., Huang, L., Mircheva, M., Delmas, M., Holden, P. (2008) Health and safety practices in the nanomaterials workplace: results from an international survey. *Environmental Science & Technology*, 42, 3155-62.

**Research Questions**

In the context of absent regulation and indeterminate standards, industry may be adapting their conventional practices for the safe handling of nanomaterials.

- How do reported practices compare to the nano-specific recommendations in guidance documents?
- What does nanotechnology industry believe to be the roles of government and private industry in ensuring the safe development of nanotechnology?
- How do industry’s EHS practices and management views on risk vary by company characteristics?
- What are the unmet knowledge and guidance needs of industry?
- How do industry views on risk relate to industry’s apparent use of publicly available guidance documents on nano-specific health and safety practices?

**Data Collection**

A rigorous solicitation of participants began September 2009 and continued until January 2010. Structured interviews were conducted by telephone. A web-based survey was also used to collect responses.

Responses to unstructured or semi-structured questions were coded for statistical analysis based on prevalent themes. Frequency response data for each individual question of the survey was analyzed. A depth analysis of variable independence and linear relationships between questions was performed by executing Fisher’s exact chi-square testing.

**Results**

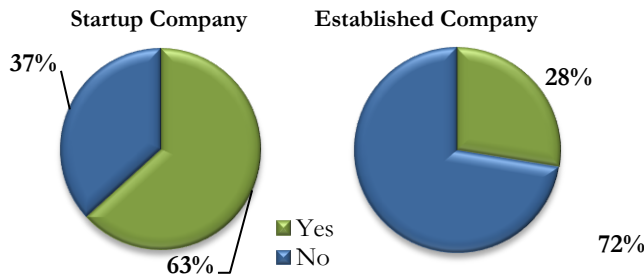
Of the 449 companies contacted, 60 companies completed the survey for an overall response rate of 13.4%. Twenty-six respondents participated in telephone interviews and thirty-four respondents participated through the online version of the survey.

Company characteristics, n=60		
Location	North America	44
	Europe	11
	Asia	5
Age	0-9 years	31
	10+ years	29
Number of years handling ENMs	0-9 years	40
	10+ years	20
Number of employees	1-19	24
	20-249	20
	250+	16
Number of employees that work directly with ENMs	1-6	21
	7-30	30
	31+	9

**Top three handled nanomaterials:**  
 Silica  
 Nano-silver  
 Titanium dioxide

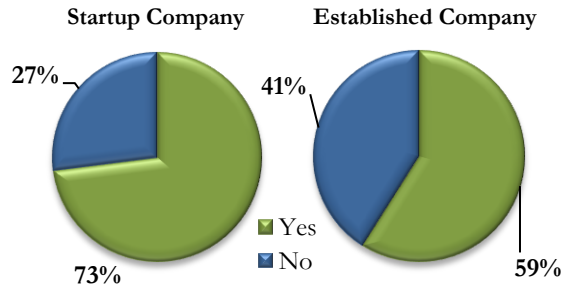
- Startup companies are more likely to report having a nano-specific EHS program (n=19, 63%, p=0.006).

**Nano-specific EHS Program**



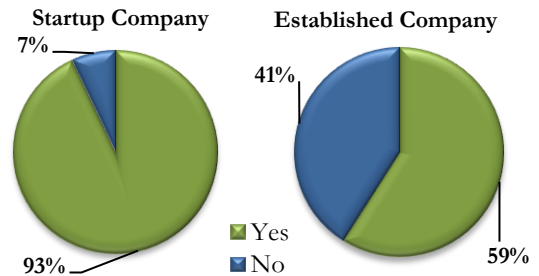
- Startup companies more frequently report using respiratory protection (n=22, 73%, p=0.035).

**Use of Respiratory Protection**



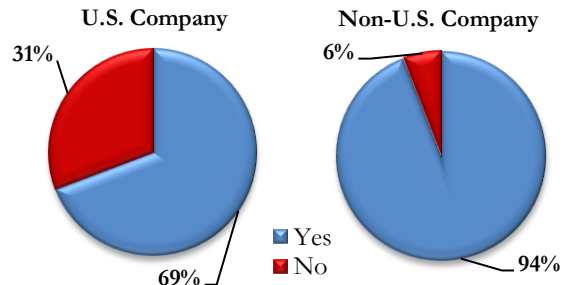
- Startup companies are more likely to report that they advertise or otherwise disclose that their products contain nanomaterials (n=27, 93%, p=0.003).

**Nanomaterials Disclosed in Products**

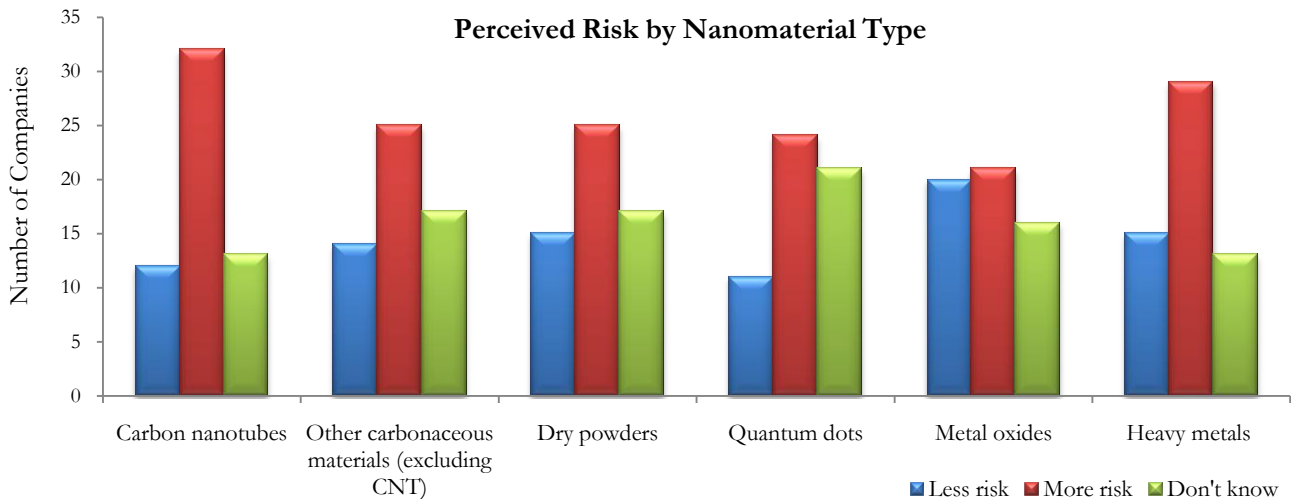
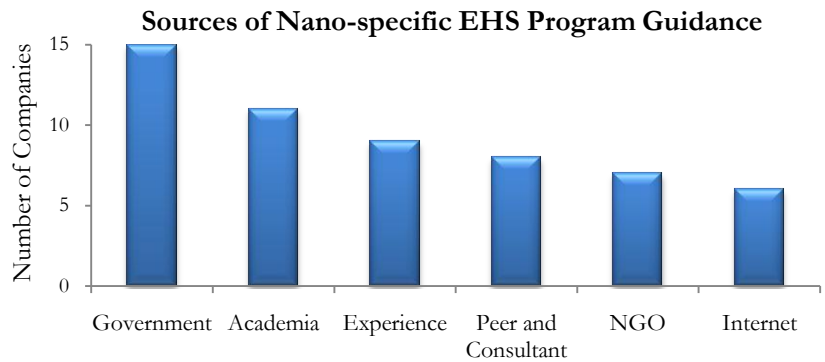


- Companies with headquarters located in the United States were less likely to advertise or otherwise disclose that their products contained nanomaterials (n=27, 69%, p=0.039)

**Regional Differences in nanomaterials Disclosed in Products**



- Most companies reported obtaining guidance for their nano-specific EHS program from government, academia, or their company experience
- Participants reported perceiving higher risk for carbon nanotubes; many reported not knowing the risk associated with a nanomaterial type



**Conclusions**

Conti *et al.* (2008) found that 58% of companies reported implementing a nano-specific EHS program.<sup>2</sup> Of the respondents to this survey, only 45% reported a nano-specific EHS program, a decrease of 13%. It is possible that this decrease is due to the difference in companies surveyed. Research laboratories made up 28% of Conti *et al.*'s sample, while this survey only interviewed companies.<sup>2</sup> If it is true that fewer companies have nano-specific EHS programs than did three years ago, this has important implications for human health and the environment, as well as regulation. Additionally:

- The smaller, younger companies that responded to this survey appear to be more attentive to risks and risk management associated with nanomaterials;
- U.S. companies reported not being fearful of public backlash but do not advertise their products contain nanomaterials;

- Participants indicated using government and academic guidance for developing nano-specific EHS programs but did not report high trust in government and academia to adequately communicate the benefits of nanotechnology;
- And participants perceived carbon nanotubes as a greater risk to human health and the environment than other nanomaterials.

Individuals in industry have a positive view of nanotechnology, perceiving more benefits than risks. However, industry's risk management techniques and EHS programs are the first defense in the protection of human health and the environment from the risks associated with nanomaterials. These findings will identify knowledge gaps for safe-handling practices in industry, as well as illuminate the views and practices of the nanomaterials industry for the benefit of the public.