A Condensed Environmental Health & Safety Reference For Nanotechnology Startups (CERNS)

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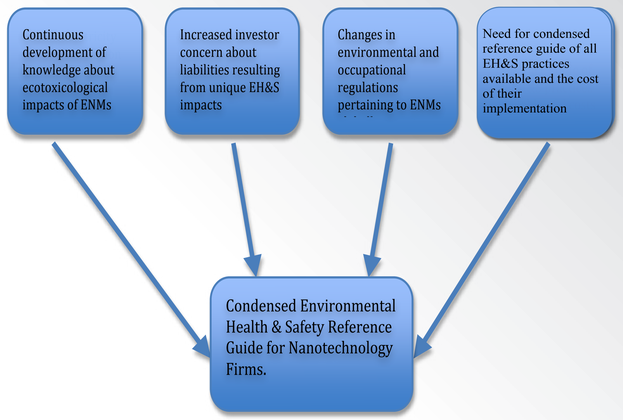
Introduction

The nanotechnology industry has grown dramatically in the past several decades and provided unique applications for a variety of industries. Applications of nanomaterials have improved the performance of electronic components, pharmaceuticals and many other products, as they exibit novel properties due to their billionths of a meter dimensions.However, these novel properties have been observed to interact with human health and the environment in unique ways, posing a wide variety of environmental health & safety (EH&S) risks. Because of these risks, our project seeks to condense all available safe handling/storage practices for engineered nanomaterials (ENM) from available guidance documents and provide references for any nanotechnology startup that may not have the resources or expertise to formulate an adequate EH&S program independantly.

Factors Driving Need for Comprehensive Nano-specific Environmental Health and Safety Guidelines



Methodology

Our clients at the University of California Center for the Environmental Implications of Nanotechnology (UC-CEIN) compiled 27 of the most commonly cited nanotechnology- specific guidance documents. These documents come primarily from North American and the European Union sources. The documents include 14 from academic institutions, 11 from government agencies (US and EU), 1 from the nanotechnology industry, and 1 from a non-profit. Individual recommendations were extracted from each guidance document and assembled in a spreadsheet matrix. The resulting spreadsheet encompassed 93 specific recommendations and quickly shows which guidance documents can be referenced for each of those recommendations.

Two versions of CERNS were created. “Abbreviated CERNS” is a short document containing a comprehensive summary of recommendations based upon data gathered in the spreadsheet matrix and “Full CERNS” is a longer document including both a recommendations section and a background section outlining the important factors driving nano-specific EH&S.

An economic implications section was created for CERNS by assembling a comprehensive list of equipment and materials recommended within the reviewed guidance documents. Pricing information was obtained from specific suppliers and used to categorize the cost of implementing a nano-specific EH&S program.

Data

While developing CERNS, an analysis on the consistency of recommendations across various guidance documents was performed. Of the 903 unique recommendations encountered, we found 64.2% of recommendations were contained in only between 1 to 10% of guidance documents (Fig. 1). Also, only 2.3% of the recommendations occurred in 40% or more of the reviewed documents (Fig. 1). These findings indicate that there is little overlap of recommendations across guidance.

When evaluating beween the different sources of guidance (academic institutions, nanotechnology industry, government agencies), the pattern of lack of overlap in recommendations across guidance remained. (Figure 2). Note that the 0% frequency overlap represents the instances when one of the compiled recommendations is not specifically mentioned in any guidance document from a particular source group, such as government agencies. Of the compiled recommendations, 65.4% were not specifically mentioned in any guidance from academic institutions, followed by 26.3% for government agencies.

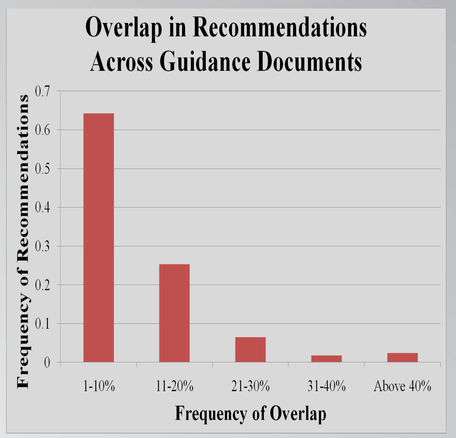


Figure 1: Overlap of recommendations across all reviewed guidance documents

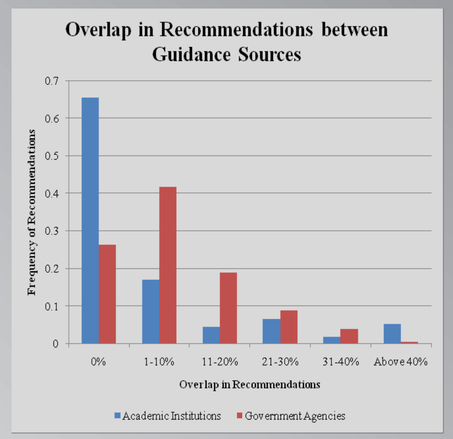
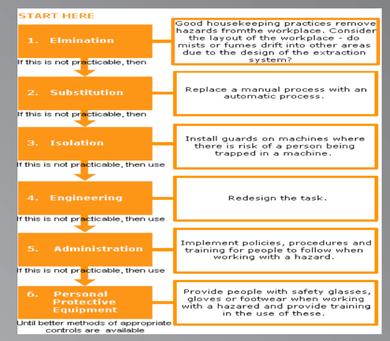


Figure 2: Overlap of recommendations broken down between the two of the main sources of guidance documents: academic institutions and government agencies

List of the 27 Guidance Documents Reviewed

Academic Institutions	Government Agencies	Nanotechnology Industry	Non-Profit
Duke University	British Standards Institute - Nano Labeling	DuPont Nano Risk Framework	IRSST (2010)
Ellenbecker & Tsai (2009)	British Standards Institute - Safe Handling/Disposal		
Harvard University	EU - Workplace Exposure to Nanoparticles		
Journal of Occupational and Environmental Hygiene	EU - Assessment Methods		
Lawrence Berkeley National Laboratory	EU - Nanomaterials Regulatory Aspects		
Massachusetts Institute of Technology	NIOSH - Medical Screening and Hazard Surveillance		
Stanford University	NIOSH (2009)		
UC Irvine	Stanford Linear Accelerator Laboratory		
UC Nanotechnology	US Department of Energy - Nanomaterial ES&H		
UC Los Angeles	US Department of Energy N 456.1		
UC Santa Barbara	US Department of Energy P 456.1		
University of North Carolina			
University of New Hampshire			
University of Washington			

Hierarchy of Control for Reducing Nanomaterials Exposure Risks



Source: http://www.safework.sa.gov.au/contentPages/images/HierarchyControls2.gif

This diagram illustrates the general method that most guidance documents categorize and prioritize nanomaterials safe handling practices.

Discussion

The observed low level of overlap between guidance documents for the vast majority of recommendations does not necessarily correlate to the recommendations’ effectiveness or importance in managing vnanomaterials exposure risks. The consistently low level of overlap in recommendations though does further highlight the importance for a comprehensive compilation of available and current guidance, since even the best individual guidance documents fail to provide a comprehensive overview of best practices for nano-specific EH&S. Such a complete summay of recommendations to our knowledge does not exist already, in spite of the growing number of guidance documents in recent years.

A Bren Masters Group Project in 2010 surveyd the nanotechnology industry and found that small (1-19 employees) and young (0-9 years old) nanotechnology firms were more willing to implement nano-specific EH&S but often lacked the time and resources (Baumgartner et al, 2010). The development of CERNS is intended to respond directly to the need for easily accessible and comprehensible EH&S information among nanotechnology startups. Although CERNS seeks to be a comprehensive document, firms should recognize that since procedures and production processes vary widely across industry, safety practices need to be tailored to each company. In the future firms need to be continuously vigilant as the standard for best practices for nanomaterials safe handling will continue to evolve.

Acknowledgements

We would like to thank our advisor, Patricia Holden, for patience, expertise, and diligence in helping to make this group project a success. We would also like to thank our clients at the University of California Center for the Environmental Implications of Nanotechnology, Hilary Godwin and Tim Malloy, for their continued support throughout the development of the project. We would also like to thank Barbara Herr Harthorne and Arturo Keller for their valuable advice. We also sincerely thank the Environ Corporation for their generous financial support of this project.

References

Baumgartner, L., Carr, B., Fish, B., and J. Meyerhofer. 2010. Current Practices and Perceived Risks for Environmental Health, Safety, and Product Stewardship in the Nanomaterials Industry (Masters Group Project Thesis). University of California, Santa Barbara, Santa Barbara, CA.