

### Summary of Current Research into Environmental Health and Safety Effects of NanoTechnology

This report presents the findings of an international survey of current environmental health and safety (EHS) and product stewardship practices in the global nanotechnology industry. Of the 337 organizations that were invited to participate, 64 companies, research labs, and university labs from four continents responded, which constitutes a response rate of 19%. The survey was administered between June and September, 2006 through telephone interviews and written and web-based surveys. The questionnaire was designed specifically for the study and inquired about current practices related to research, use and manufacture of nanomaterials (< 100 nm size) in the following areas: environmental health and safety training, use of engineering controls, personal protective equipment (PPE) and clothing recommendations, exposure monitoring, waste disposal, product stewardship practices, and risk characterization. All information was self-reported and no direct verification was performed.

In general, surveyed organizations reported that they believe there are special risks related to the nanomaterials they work with, that they are implementing nano-specific EHS programs and that they are actively seeking additional information on how to best handle nanomaterials. Actual reported EHS practices, however, including selection of engineering controls, PPE, cleanup methods, and waste management, do not significantly depart from conventional safety practices for handling chemicals. This is the primary finding of this report. In fact, practices were occasionally described as based upon the properties of the bulk form or the solvent carrier and not specifically on the properties of the nanomaterial.

Additionally, few organizations reported monitoring the workplace for nanoparticles or providing formal guidance to downstream users on the safe disposal of nanomaterials. When asked, organizations generally recommended disposal of nano-products as hazardous waste, though they did not frequently report conveying this information to their customers. Reported practices in the handling of nanomaterials, with some exceptions, are based on criteria unrelated to any perceived risks stemming specifically from working with nano-scale materials. The “by-default” use of conventional practices for handling nanomaterials appears to stem from a lack of information on the toxicological properties of nanomaterials and nascent regulatory guidance on EHS practices. Indeed, most organizations reported that the biggest impediment to improving their nano-specific EHS program is a lack of information and nearly half of the organizations that reported implementing a nano-specific EHS program described it as a precaution against unknown hazards. Organizations reported seeking new information from scientific literature and governmental guidelines for help in assessing the risks related to their nanomaterials and the appropriate steps that should be taken to address them. This suggests that there is a strong demand for both more toxicological research on nanomaterials and additional industry and governmental guidance in risk assessment and EHS practices.

The relative dearth of regulatory guidance and uncertain risks associated with nanomaterials may contribute to the significant variance reported in EHS practices amongst organizational type and size. Nano-specific EHS programs and training were more often reported by organizations that have been working with nanomaterials longer, have more employees handling nanomaterials, and who believe there are risks related to their

nanomaterials. Larger organizations that handle a number of different nanomaterials in a variety of phases and engage in a variety of nano-related operations reported the use of all 7 engineering controls in higher numbers, and in particular cleanrooms, separate HVAC systems for lab areas, and closed piping systems. Smaller companies more frequently reported using "disposable" PPE, such as dust masks, disposable body coverings, and lower cost controls such as respirators, as well as glove boxes and glove bags. The organizations that indicated that either part or all of their nanomaterial operations are enclosed to prevent worker exposure were mostly companies rather than academic or purely research labs. While most organizations acknowledged that toxicological data on nanomaterials are needed, university labs specifically reported cost concerns and a lack of prioritization of EHS practices as the most significant impediments.

In addition to organizational type and size, there appear to be geographical variations in reported practices. North American organizations more frequently reported administering nano-specific EHS programs including training, and monitoring the work environment than organizations in other parts of the world. Similarly, North American organizations more often reported using high capital cost engineering controls such as cleanrooms, closed piping systems and separate HVAC systems, compared to organizations from Asia that indicated more widespread use of glove boxes, glove bags and respirators. More than European organizations, North American and Asian organizations reported that a lack of information is the primary impediment to improving nano-specific EHS. On the other hand, a relatively higher percentage of European organizations reported either conducting or funding toxicological research. In addition, respondents in Europe and Australia more frequently reported thinking that there are specific risks related to the nanomaterials they handle. Few reported EHS practices appear to be determined solely by type and amount of nanomaterial handled. However, dust masks are reportedly widely used with nanopowders, while fume hoods are reportedly less frequently used with nanopowders because they can result in a loss of expensive material through ventilation. Very few organizations reported monitoring the workplace for nanoparticles, although those that handle larger volumes of nanomaterials are more likely to do so.

This project identified current practices in the nanotechnology workplace for a subset of nanomaterial organizations worldwide. The findings should be of great value for the continuing development of "best practices" in nanomaterial safety, disposal and product stewardship, as well as a basis for ongoing research. However, independent verification of self-reported practices was not performed, and thus future research to determine actual workplace safety and product stewardship practices in the nanomaterials industry should incorporate additional steps such as site visits. Additionally, this project did not consider practices beyond the research lab or manufacturing facility, such as consumer and waste management practices. To address practices used throughout the full life-cycle of nanomaterials including the products in which they are used, future research should include interviews and site visits with waste management companies and nanomaterials customers. Such approaches will become increasingly important as the volume of products containing nanomaterials reaching consumer markets continues to rise.

For more information, please see...

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