Applying Basic Risk Management Principles to Nanomaterial Processes

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Abstract

Nanotechnology has the potential to transform many industries, from medicine to manufacturing, and the products they produce. Research in nanoscale technologies continues to expand worldwide. While this emerging technology holds great promise, it also presents unknown risks, especially to the health of workers. Health, safety and environmental issues continue to be high priority areas to be addressed during the commercialization of nanomaterials or the manufacture of nano-enabled products. Facilities engaged in the manufacture or use of engineered nanomaterials, specifically nanoparticles, is concerned if their processes present any potential risk because of worker exposure or release to the environment. Many questions remain about how to best manage and control the potential hazards associated with the safe handling of nanomaterials. Occupational safety and health issues of nanomaterials are complex. The types of nanomaterials and the opportunities for workplace exposure to them continue to grow rapidly. The challenge is to effectively address the safety and health issues of nanotechnology while helping society realize nanotechnology's far-reaching potential benefits. A basic risk management model could be applied to processes making or using nanomaterials to reduce the potential for incidents or occurrences that lead to risk.

1 NIOSH Research

The National Institute for Occupational Safety and Health (NIOSH) is the Federal agency in the U.S. responsible for conducting research and making recommendations to prevent work-related injury, illness, and death. NIOSH has collaborated with stakeholders at home and abroad to fill knowledge gaps related to nanotechnology, to identify and characterize hazards associated with nanomaterials, and to develop guidance for workers exposed to nanomaterials. Protecting the health of workers involved with nanotechnology is a global issue that requires international cooperation, commitment, and collaboration. At a time when materials and commercial applications are being conceived, NIOSH is positioned well to proactively identify, assess, and resolve potential safety and health issues posed by nanotechnology. NIOSH has 38 years of experience in conducting research and formulating recommendations for occupational safety and health. During this period, NIOSH has developed considerable expertise in measuring, characterizing, and evaluating new processes and new materials by conducting quantitative exposure assessments and evaluating health effects. NIOSH also has expertise in developing control systems and prevention strategies for incidental nanoparticles (e.g., diesel exhaust, welding fume, smelter fume, and fire smoke particles). NIOSH will reapply this experience to address similar issues for engineered nanoparticles. Applying the outputs of NIOSH research will support the application of a basic risk management model approach to evaluating and addressing the health safety challenges associated with commercialization of nanomaterials and nano-enabled products.

2 Nanotechnology Research Center

NIOSH established the Nanotechnology Research Center (NTRC) in 2004 to coordinate and promote research in nanotechnology and to develop guidance on the safe handling of nanomaterials in the workplace. The NTRC is a virtual center in which NIOSH scientists and engineers at geographically dispersed locations are linked by shared computer networks and other technologies. This approach surmounts the logistical complications that traditionally arise when scientists and engineers collaborating on common research are not physically in the same location.

2.1 Strategic Goals

The NTRC has four strategic goals:
(1) Determine whether nanoparticles and nanomaterials pose risks of work-related injuries and illnesses
(2) Conduct research to prevent work-related injuries and illnesses by applying nanotechnology products
(3) Promote healthy workplaces through interventions, recommendations, and capacity building
(4) Enhance global workplace safety and health through national and international collaborations on nanotechnology research and guidance.

3 Critical Research Areas

Within the four goals established by the NTRC, NIOSH has identified 10 critical areas of research and communication that serve as the foundation for a strategic plan of action. These 10 critical research areas are:
(1)toxicity and internal dose
(2)measurement method

(3) Exposure assessment
(4) Epidemiology and surveillance
(5) Risk assessment
(6) Engineering controls and personal protective equipment (PPE)
(7) Fire and explosion safety
(8) Recommendations and guidance
(9) Communication and information
(10) Applications of nanotechnology for occupational safety and health.

4 Strategic Approach

NIOSH has begun to address its strategic goals through the initiation of research to address each element of the risk management process as illustrated in Figure 1. The NIOSH approach has been to conduct research on multiple fronts in a parallel manner. Concurrent with foundational toxicology research is work being done on measuring nanoparticles in air, and using this information in field assessments to determine what workers are at risk for exposure. Parallel efforts have also been undertaken to address the strengths and weaknesses of control approaches for airborne nanomaterials. Similar efforts are underway for personal protective equipment (PPE) such as respirators and gloves. As findings of field investigations and laboratory research become available, the information will be used to develop and update guidance for evaluating and managing potential nanotechnology risks.

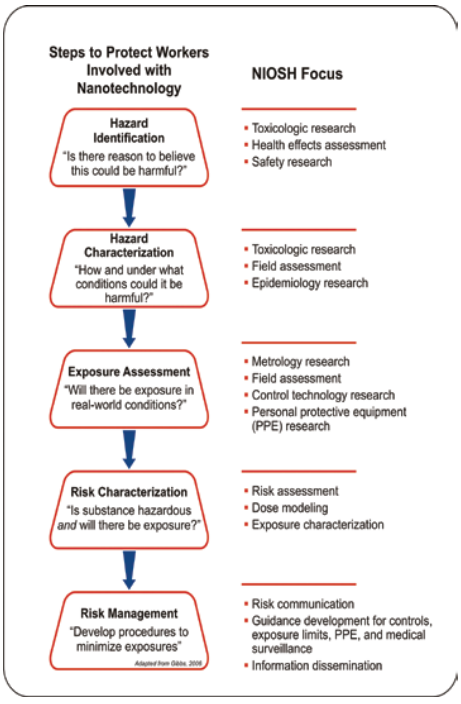

Figure 1. Steps to protect nanotechnology workers.

5 Activities and Outputs

The NIOSH NTRC has developed a thorough agenda of activities and outputs for each strategic area, based on input from stakeholders and partners. Progress toward meeting these goals is summarized as follows:

5.1 Determine the potential hazards of nanomaterials

Since 2004, the NTRC has pioneered research on the characterizing the toxicological properties and characteristics of occupationally relevant nanoparticles—particularly the toxicity of carbon nanoparticles. Preliminary work demonstrated that mice exhibited harmful pulmonary effects (such as a fibrotic response) soon after low-dose aspiration and inhalation exposure to specific nanotubes. NTRC investigators have evaluated the potential for nanoparticles to enter the bloodstream and move to systemic tissues after being deposited in the lungs. The results obtained thus far support the need to address the question of potential impact on humans and provide promising leads for strategic, ongoing studies.

To gain further knowledge about exposure and control practices, the NTRC established a field team to conduct assessments of workplaces where exposure to engineered nanoparticles may occur. By partnering with companies that produce or use engineered nanoparticles, this team collected useful information about potential worker exposures, control technologies, and risk management practices.

5.2 Applications of nanotechnology

The NTRC has identified various possibilities for applying nanotechnology to occupational safety and health, including the application of this technology in fabricating more efficient filters, sensors, and protective clothing. The NTRC and the Office of Extramural Programs at NIOSH are coordinating projects with academia and the private sector.

5.3 Promote healthy workplaces

NIOSH is promoting healthy workplaces through interventions, recommendations, and capacity building. Nationally and internationally, the NTRC has delivered a wide range of presentations on occupational safety and health issues associated with nanotechnology. In addition, the NTRC has provided seminal guidance for workers and employers in nanotechnology through the publication of a series of NIOSH documents [1-7].

5.4 Enhance global workplace safety and health

NIOSH is enhancing global workplace safety and health through national and international collaborations on nanotechnology research and guidance. The NTRC has established several national and international collaborations to advance understanding of occupational safety and health for nanotechnology workers. Key activities include: Participation in the U.S. National Nanotechnology Initiative (NNI) and

contributing to the nanotechnology strategic plan for the U.S. through the Nanotechnology Environmental Health Implications (NEHI) working group; Providing U.S. leadership on the International Organization for Standardization (ISO) TC 229, Nanotechnology Working Group on Health, Safety, and the Environment; collaborating with the World Health Organization on a project for the dissemination of best practices for safe handling of nanomaterials; collaboration with the Organization for Economic Cooperation and Development (OECD) to build cooperation, coordination, and communication among the United States and OECD by chairing the Working Party for Manufactured Nanomaterials Steering Group 8, exposure measurement and exposure mitigation.

References

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