November 14, 2008

MEMORANDUM FOR: See Distribution List

Through: Dr. Robert Celotta
Director, NIST Center for Nanoscale Science and Technology

From: NIST Engineered Nanoparticle Safety Committee

Subject: Engineered Nanoparticle Safety

The National Institute of Standards and Technology (NIST) is committed to the safety of its employees, the public, and the environment. NIST recognizes there is no job more important than making sure everyone who comes to work healthy and safe, goes home the same way. This memorandum, prepared by the NIST Engineered Nanoparticle Safety Committee (ENSC), is issued to reinforce responsibilities and provide information for managing engineered nanoparticles in NIST research. The ENSC is developing Health and Safety Instruction (HSI) and training materials for the safe handling of engineered nanoparticles at NIST. The HSI will be presented to the NIST Safety Operational Committee for consideration to adopt as NIST policy and posting on the NIST Safety, Health and Environment Division HSI website[1] and the training materials will be available for NIST staff.

Currently, no set of standards exists to fully evaluate potential risks associated with engineered nanoparticles. Nevertheless, with the establishment of nanotechnology at NIST as a research focus with a direct emphasis on innovation and traceable measurements to enhance U.S. competitiveness in this theatre, engineered nanoparticle research and development activities will increase significantly for the foreseeable future at NIST.

ENGINEERED NANOPARTICLE SAFETY AT NIST

NIST managers, researchers, contractors, guest researchers, guest scientists, and collaborators working in NIST facilities, termed NIST personnel and associates from this point forward, are to exercise due diligence in meeting their responsibilities to protect the health and safety of themselves, other workers, the public and the environment when engaged in engineered nanoparticle research, acquisition, operations, and support. NIST personnel and associates engaged in engineered nanoparticle research are to maintain current knowledge for the safe handling of engineered nanoparticles. Approaches for the safe handling of engineered nanoparticles are published by the National Institute of Occupational Safety and Health (NIOSH).[2,3] This material is an essential primer on engineered nanomaterial safety (Appendix 1). NIST personnel and associates engaged in engineered nanoparticle research should be familiar with the NIOSH document, its contents and the NIOSH nanotechnology website.[4]

NOTES on NANOPARTICLES

Nanoparticles means dispersible particles having in two or three dimensions greater than 0.001 micrometer (1 nanometer) and smaller than about 0.1 micrometer (100 nanometers) and which may or may not exhibit a size-related intensive property.[5] **Engineered nanoparticles** are intentionally produced, whereas incidental nanoscale or ultrafine particles are byproducts of processes such as combustion and vaporization. **Engineered nanoparticles** are designed with very specific properties (including shape, size, surface properties, and chemistry), and collections of the particles in an aerosol, colloid, or powder will reflect these properties. Incidental nanoscale particles are generated in a relatively uncontrolled manner and are usually physically and chemically heterogeneous compared with engineered nanoparticles.[3]

"The potential for engineered nanomaterials to enter the body is among several factors that scientists examine in determining whether such materials may pose an occupational health hazard. Nanomaterials have the greatest potential to enter the body if they are in the form of **nanoparticles, agglomerates of nanoparticles, and particles** from nanostructured materials that become airborne or come into contact with the skin."[6] "Nanomaterial-enabled products, such as nanocomposites and surface coatings, and materials comprised of nanostructures such as integrated circuits are unlikely to pose a risk of exposure during their handling and use. However, some of the processes (formulating and applying nanoscale coatings) used in their production may lead to exposure to nanoparticles. Processes generating nanomaterials in the gas phase, or using or producing nanomaterials as powders or slurries/suspensions/solutions pose the greatest risk for releasing nanoparticles. Maintenance on production systems (including cleaning and disposal of materials from dust collection systems) is likely to result in exposure to nanoparticles if it involves disturbing deposited nanomaterial."[7]

Due to the explicit reference to nanoparticles as the chief entity of concern by the National Institute of Occupational Safety and Health, this document and the ENSC solely addresses **engineered nanoparticles**.

The ENSC, established to manage and coordinate engineered nanoparticle safety across the NIST Laboratories, is developing HSI and training materials on engineered nanoparticles for NIST personnel and associates engaged in engineered nanoparticle research. The ENSC will recommend that NIST adopt many of the policies already in place at the U.S. Department of Energy's Nanoscale Science Research Centers, which are described in *Approach to Nanomaterial ES&H* (DOE NSRC Document).[8] The ENSC thus encourages NIST management, staff and associates to refer to this document (Appendix 2) in the interim for guidance while assessing the preparation, handling and disposal of NPs[9]. While the HSI is in under development by the ENSC, NIST personnel and associates engaged in engineered nanoparticle research should acutely adopt the following key conceptual foundations in the DOE NSRC Document:

- In conformance with the general principle in the National Research Council's *Prudent Practices for Handling Hazardous Chemicals in Laboratories*[10], laboratory personnel should treat "all new compounds, or those of unknown toxicity, as though they could be acutely toxic in the short run and chronically toxic in the long run." Moreover, although exposures are believed likely to be extremely low in comparison to those that might be seen in other workplaces, the NIOSH observation[11] that all poorly soluble, low toxicity ultra fine particulates might be carcinogenic, even those normally considered to be nuisance

particulates, makes it important to carefully manage worker exposure and avoid environmental releases.

- Although there is no specific guidance on evaluating and controlling the risks posed by engineered nanoparticles, preliminary research suggests that some controls used in conventional laboratory settings will work effectively for them. "Effectively" may mean sufficient to reduce the following to an acceptable level[12]:

    - the risk of worker injury or ill-health and
    - the risk of negative environmental impacts.

The ENSC is also communicating with NIOSH and its Nanotechnology Field Research Team[13] in an effort to assess current NIST workplace processes, materials, and control technologies associated with engineered nanoparticle research. Outputs from this interaction will augment the ENSC's efforts to develop engineered nanoparticle HSI for NIST personnel and collaborators.

RESPONSIBILITIES

Everyone engaged in engineered nanoparticle research shares responsibility for protecting the safety and health of themselves, other workers, the public and environment from the hazards presented by the conduct of their activities and should be familiar with current knowledge on the safe handling of engineered nanoparticles. NIST personnel engaged in engineered nanoparticle research are responsible for conveying to contractors, guest researchers, guest scientists, and collaborators working in NIST facilities the expectation that appropriate programs and safeguards must be in place to maintain a level of worker, public, and environmental safety consistent with the information presented in this memorandum.

NOTES

[1]Health and Safety Instructions, http://www-i.nist.gov/admin/ohsd/hsinstrc.htm
[2]The National Institute for Occupational Safety and Health (NIOSH), part of the Centers for Disease Control and Prevention (CDC), is the leading federal agency conducting research and providing guidance on the occupational safety and health implications of exposure to engineered nanomaterials
[3]*Approaches to Safe Nanotechnology*, National Institute for Occupational Safety and Health, Version 1.1 (July 2006), http://www.cdc.gov/niosh/topics/nanotech/safenano/
[4]NIOSH Safety and Health Topic: Nanotechnology, http://www.cdc.gov/niosh/topics/nanotech/default.html
[5]ASTM E2456-06, "Standard Terminology Relating to Nanotechnology"
[6]*Approaches to Safe Nanotechnology*, National Institute for Occupational Safety and Health, Version 1.1 (July 2006), http://www.cdc.gov/niosh/topics/nanotech/safenano/ p. x
[7]ibid, pp x-xi
[8]DOE Nanoscale Science Research Centers *Approach to Nanomaterial ES&H*, Revision 2 – June 2007, www.doe.gov
[9]The ENSC notes following sections of the DOE NSRC Document[7] will not be part of near-term HSI at NIST: Section 4.1 Nanoparticle Worker Identification, 4.2 Workplace Characterization and Exposure Assessments, and 4.3 Worker Health Surveillance. Data and guidance with respect to these topical areas are sparse at this time and are under

development NIOSH. The ENSC will stay abreast of current developments relating to these topical areas and will ensure that this knowledge, as it becomes available, is reflected in the practices for the safe handling of engineered nanoparticles at NIST.

[10] *Prudent Practices in the Laboratory*: *Handling and Disposal of Chemicals*, National Research Council, National Academy Press, Washington, D.C. 1995, p. 3

[11] NIOSH draft CURRENT INTELLIGENCE BULLETIN: *Evaluation of Health Hazard and Recommendations for Occupational Exposure to Titanium Dioxide*, lines 86 through 89: "While the potential cancer potency of fine TiO_2 appears to be relatively low at current occupational exposures, NIOSH is concerned about the potential carcinogenicity of ultrafine TiO_2 if workers are exposed at the current mass-based exposure limits for respirable or total mass fractions of TiO_2."

[12] Note: "acceptable levels" with respect to nanomaterial exposure have not been established by NIOSH as the science is under development. "Employers should take steps to minimize worker exposures until more information is available"[14]

[13] *The Nanotechnology Field Research Team Update*, DHHS (NIOSH) Publication No. 2008-120, http://www.cdc.gov/niosh/docs/2008-120/

[14] NIOSH *Safe Nanotechnology in the Workplace: An Introduction for Employers, Managers, and Safety and Health Professional.* DHHS (NIOSH) Publication No. 2008–112, http://www.cdc.gov/niosh/docs/2008-112/

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Chair, NIST Safety Operational Committee

APPENDICES (links to PDFs)

Appendix 1. *Approaches to Safe Nanotechnology*, National Institute for Occupational Safety and Health, Version 1.1 (July 2006)

Appendix 2. DOE Nanoscale Science Research Centers *Approach to Nanomaterial ES&H*, Revision 2 – June 2007

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