BOISE STATE UNIVERSITY	Nanomaterial Laboratory Safety
Environmental Health & Safety Office	Revision 1.1

Contents

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1.0 PURPOSE

A nanomaterial, as defined by The ASTM Committee on Nanotechnology, is a particle with lengths in 2 or 3 dimensions between 1 to 100 nm that may or may not have a size related intensive property. Nanomaterials are of increasing interest due to their unique properties compared to the same material on the micro and macroscopic scales and their potential associated applications based upon these properties.

The Boise State University Chemical Hygiene Plan (CHP) provides general guidance in regard to safely handling chemicals in a laboratory setting, but nanomaterials can come with unique and/or unknown risks and warrant being specifically addressed. Labs must adhere to the CHP and may need to implement additional controls for handling nanomaterials.

2.0 SCOPE

This document outlines guidance for Boise State University laboratories performing laboratory scale experiments involving nanomaterials and their application. Responsibilities and additional guidance are outlined in the CHP.

3.0 HAZARDS - A CONSERVATIVE APPROACH

Nanomaterial research and use is accelerating substantially as more is learned about their properties and potential applications. Some of these properties raise concerns over the safe handling of these materials since limited, or in some cases conflicting, information is available regarding toxicity and routes of exposure as well as environmental impact. This limited availability of data warrants a conservative approach to minimize worker exposure and environmental impact until more is known about the nanomaterials being investigated. As more data becomes available, controls and practices may need to be reassessed.

4.0 HAZARD CONTROL

Controls must be assessed on a case by case basis dependent upon the nanomaterial, quantity, sample matrix, and steps of the process. Controls should be assessed in the following order:

- Hazard minimization, elimination, and substitution.
- Local exhaust ventilation (i.e. engineering controls).
- Work practices.

- Personal protective equipment (PPE).

4.1. Hazard Minimization, Elimination, and Substitution

Hazard control starts with determining ways to substitute, minimize, or eliminate the more hazardous materials or processes where possible. Some examples include:

- Minimizing the scale of an experiment.
- Eliminating hazardous materials used in a process.
- Substituting process chemicals for less hazardous ones.
- Using processes or techniques that produce lower airborne concentrations and minimize skin contact.

4.1.1. Sample Matrix

A sample matrix may be used with some nanomaterials, and its presence or absence must be taken into consideration when assessing risk. A sample incorporated into a solid or liquid matrix typically offers more protection against inhalation exposure compared to an unbound sample, which can be easily aerosolized. However, this is not necessarily the case for skin contact. A liquid matrix such as an organic solvent may enhance dermal absorption.

4.2. Local Exhaust Ventilation

Local exhaust ventilation (LEV) may be necessary for processes which potentially generate aerosols, fumes, or particulate. Examples may include, but are not limited to:

- Weighing operations.
- Transfering material between containers or to an apparatus.
- Using a furnace or oven.

Additional information regarding types of LEV and work practices is available in the CHP.

4.2.1. Fume Hood

A fume hood is the most commonly used LEV for protection against airborne nanomaterials. Fume hoods are certified annually by the University's Environmental Health and Safety Department (EHS) and maintained by the University's Facilities Operations & Maintenance Department (FO&M). Good practices must be employed to minimize exposure, which include:

- Sash working height should be at or below 18".
- Keep work and materials at least 6" inside the fume hood.
- Ensure the lower baffle is kept adequately clear.
- Move slowly within and around the fume hood to minimize air disturbances.

Additional information is available in the CHP.

4.2.2. Glove Box

A glove box may be a more suitable or necessary control for experiments requiring minimal air disturbance or an inert atmosphere. Glove boxes must be exhausted into the building's exhaust system (e.g. fume hood exhaust system).

4.2.3. Biosafety Cabinet

Class II biosafety cabinets (BSC) provide laminar air flow and HEPA filtered air to protect the worker as well as the material, which may be essentially for biological experiments. A class II type B2 cabinet has no integral fan (utilizes building exhaust) and is the only option for handling nanomaterials with a potential to form a flammable or explosive atmosphere in a BSC. Nanomaterials incapable of producing such atmospheres may be handled in other types of BSC. Abrasive nanomaterials can damage BSC components so their use must be restricted or limited to low dust activities.

4.2.4. LEV for Large Equipment and Processes

Large equipment or processes may require the use of a snorkel or canopy hood to capture exhaust at the source. Examples include, but are not limited to:

- Furnaces
- Reactors
- Ovens

These types of LEV must be properly designed and verified to entrain emitted material from the equipment and process. Installation, modification, and repair must be coordinated and approved by EHS and FO&M.

4.3. Work Practices

Work practices for handling nanomaterials follow many of those outlined in the CHP:

4.3.1. Safety Operating Procedures

Safety Operating Procedures (SOP) or some form of protocol must be developed to communicate safe practices, hazards, steps, and necessary engineering controls and personal protective equipment for the process. A template is available from EHS: Safety Information and Operating Procedure.

4.3.2. Preparation

- The latest material safety data sheet (MSDS) and any additional safety data must be reviewed to determine necessary hazard controls.
- Each worker must be properly trained prior to conducting any nanomaterila work.
- Dry runs for new or highly hazardous processes should be performed to determine safety issues prior to using any nanomaterials.
- Handling areas should be minimized in number and size and clearly identified.

4.3.3. Guard Against Fire and Explosion Hazards

Dust generation must be minimized to reduce inhalation exposure and contamination, and in some cases, measures must also be taken to guard against fire or explosion hazards. It may be necessary to use intrinsically safe or explosion proof equipment for certain nanomaterials.

4.3.4. Personal Hygiene

The spread of contamination and risk of exposure can be reduced by:

- Never eating, drinking, smoking, and applying cosmetics in the laboratory.

- Washing hands regularly and upon leaving the laboratory.
- Never mouth pipetting.
- Wearing appropriate PPE
- Never wearing PPE in common areas such as bathrooms, conference rooms, lunch areas or outdoors.
- Never wearing gloves while touching doorknobs, light switches, telephones, or other common items unless required by the laboratory and labeled as such.
- Proper disposal of gloves and other PPE into designated waste containers.

4.3.5. Housekeeping

Proper housekeeping can help minimize spills and reduce exposures. Key items include:

- Keeping exits, emergency equipment, and aisles clear.
- Proper storage of materials to reduce clutter and prevent contact between incompatible materials.
- Prompt clean up of spills.
- Work surfaces must be regularly cleaned using a wet method or HEPA filtered vacuum to reduce contamination. The use of poly-backed bench liners is recommended.

4.3.6. Transportation

Transportation within a lab or between labs within a building requires closed containers to minimize disturbance of the material.

Transportation of nanomaterials between campus buildings and off campus must be approved by EHS. This includes, but is not limited to, transportation via vehicle, cart, or person. Prior approval is required to ensure proper containment is used, and for transportation on or across a public thoroughfare, federal and potentially international shipping requirements must be met. These requirements may necessitate training, shipping papers, special labeling, packaging, placarding, and/or vehicle requirements.

4.4. Personal Protective Equipment (PPE)

4.4.1. Dermal Protection

Skin contact can be minimized by wearing, at minimum, a laboratory coat, safety glasses, and compatible gloves. Additional PPE may be necessary for increased risks such as splashes, sprays, or contents under pressure/vacuum. Additional guidance is available in Safety Information and Operating Procedure (SIOP) – Laboratory PPE.

4.4.2. Ingestion

Ingestion typically occurs from contamination introduced by improper handling practices. Common proper handling practices are outlined in 4.3.3 and 4.3.4, a number of which involve the proper use and selection of PPE.

4.4.3. Respiratory Protection

Processes where engineering controls are not feasible or do not eliminate an inhalation hazard may require respiratory protection. Respirators, which include disposable particulate respirators (i.e. dust mask) cannot be worn without proper training, medical evaluation, and fit testing. Please contact EHS for details and to request exposure monitoring.

5.0 EXPOSURE MONITORING

EHS may be required to perform an exposure assessment of nanomaterial work. An exposure assessment takes into consideration the materials and quantities in use, the task being performed, and the work environment including engineering controls, administrative controls, and personal protective equipment. Monitoring may be necessary to assess exposure levels to these hazards and to address the need for respiratory protection and its selection.

Laboratory workers should contact their supervisor and EHS to discuss exposure concerns and/or to request an assessment.

Additional information regarding exposure monitoring is available in the CHP.

6.0 WASTE DISPOSAL

The Environmental Protection Agency and Idaho Department of Environmental Quality do not currently have any regulations or guidance specifically addressing nanomaterial waste. Waste disposal must be addressed on a case by case basis with EHS. Hazardous chemical waste procedures are outlined in the Hazardous Waste Management Manual. The CHP contains spill response information.

APPENDIX A: REFERENCES AND RESOURCES

Government and Industry Guidance

IRSST. Health Effects of Nanoparticles, 2nd Ed.
http://www.irsst.qc.ca/files/documents/PubIRSST/R-589.pdf

M. Ellenbecker, S. Tsai. Interim Best Practices for Working with Nanoparticles Center for High-Rate Nanomanufacturing, 2008.
http://nuweb9.neu.edu/nsrg/wp-content/uploads/Best_Practices_for_Working_with_Nanoparticles_Version_1.pdf

National Institute for Occupational Safety and Health (NIOSH). Nanotechnology at NIOSH. http://www.cdc.gov/niosh/topics/nanotech/

University Programs and Guidance

Massachusetts Institute of Technology. Best Practices for Handling Nanomaterials in Laboratories.
http://ehs.mit.edu/site/sites/default/files/files/University_Best_Practices.pdf

Massachusetts Institute of Technology. Potential Risks of Nanomaterials and How to Safely Handle Materials of Unknown Toxicity.
http://ehs.mit.edu/site/content/nanomaterials-toxicity

Stanford Linear Accelerator Center. Nanomaterial Safety Plan, 2008.

http://www-group.slac.stanford.edu/esh/eshmanual/references/hazmatPlanNano.pdf

Toxicology Information

International Council on Nanotechnology.
http://icon.rice.edu/

National Nanotechnology Infrastructure Network.
http://www.nnin.org/

National Center for Biotechnology Information - PubMed.
http://www.ncbi.nlm.nih.gov/sites/entrez?db=pubmed

APPENDIX B: REVISION HISTORY

Revision: 1.0 Date: 06.21.10	Authored by:	Matt Lundgren, Lab Safety Officer Name, Title	Signature on file Signature
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