Laboratory Standard Operating Procedure for:

Nanomaterials

Description

This standard operating procedure outlines the handling and use of nanomaterials. Review this document and supply the information required in order to make it specific to your laboratory. In accordance with this document, laboratories should use appropriate controls, personal protective equipment, and disposal techniques when handling nanomaterials.

Nanomaterials can be reagents, catalysts, or the desired product of research. "Nanomaterials" describes materials with at least one dimension ranging from 1-100 nanometers. Hazard characterization is often difficult because of high diversity in both the chemical components and particle geometry of nanomaterials. Use of nanomaterials must be documented by filling out the Occupational Safety and Environmental Health (OSEH) nanomaterials survey.

Potential Hazards

Be aware that toxicity of nanomaterials may be greater than for the parent material, and that their greater surface area may make nanomaterials more flammable, explosive or reactive than larger materials of the same composition. The risks of fire/explosion/reaction increase with the amount of nanomaterial; researchers should bear this in mind if scaling up a process.

Although insufficient information exists to predict the health hazard posed by the exposure to nanomaterials, current research indicates that exposure via inhalation and skin contact can result in these materials entering the body. Results from human and animal studies show inhaled nanomaterials can deposit in the respiratory tract. Animal studies also show nanomaterials can enter the bloodstream and translocate to other organs. Nanomaterials have the greatest potential to enter the body if they are in the form of individual materials, agglomerates of nanomaterials, and materials from nanostructured materials that become airborne or come into contact with the skin.

According to NIOSH the following workplace tasks may increase the risk of exposure to nanomaterials:

- Working with nanomaterials in liquid media without adequate protection (e.g., gloves) will increase the risk of skin exposure.
- Working with nanomaterials in liquid media during pouring or mixing operations, or where a high degree of agitation is involved, will lead to an increased likelihood of inhalation and respirable droplets being formed.
- Generating nanomaterials in the gas phase in non-enclosed systems will increase the chances of aerosol release to the workplace.
- Handling nano structured powders will lead to the possibility of aerosolization.
- Maintenance on equipment and processes used to produce or fabricate nanomaterials will pose a potential exposure risk to workers performing these tasks.
- Cleaning of dust collection systems used to capture nanomaterials will pose a potential for both skin and inhalation exposure.

Engineering Controls

Labs that handle nanomaterials must have non-recirculating general ventilation systems (100% exhaust air) with ventilation rates of 8-10 air changes per hour. Lab pressurization must be negative to the hallway.

Activities that are likely to release nanomaterials (such as the opening and emptying of reactors, borosilicate tubes, weighing of dry nanomaterials) shall not be performed on the open bench. These activities shall be performed in a fume hood (or other vented enclosure), biological safety cabinet, glove box or a vented filtered enclosure.

Exhaust from all furnaces used to produce nanomaterials must be trapped and connected to a local exhaust source.

If aerosols may be produced, nanomaterials (and any suspensions of nanomaterials) must be handled in a chemical fume hood, exhausted biological safety cabinet with negative pressure ductwork, or other exhausted enclosure. Aerosols may be produced during any open handling of dry powder, and during open or pressurized manipulations of suspensions.

Controls beyond those described above are warranted when aerosol generation of nanomaterials will be extensive, or will involve acutely hazardous parent materials or tubular or fibrous-shaped nanomaterials. These controls might include a higher level of containment and/or HEPA-filtration or other cleaning of exhaust.

For a detailed discussion of risk assessment for work with nanomaterials, see Paik, SY, et al. (2008) Application of a Pilot Control Banding Tool for Risk Level Assessment and Control of Nanoparticle Exposures. *Annals Occup Hygiene* 52(6), 419-428.

Work Practice Controls

Label containers of nanomaterials with particle size along with other standard items required for the label.

Set up a designated area for work with nanomaterials and suspensions thereof, and label it. Determine a means for decontaminating the work area. Daily wet cleaning (with a compatible solvent) or HEPA vacuuming is required for any work that may generate aerosols. Note that HEPA vacuuming is not recommended for reactive materials, as they may react with other materials collected in the vacuum, or with components of the vacuum itself. Wet cleaning or HEPA vacuuming of lab equipment and exhaust systems is required prior to repair, disposal or reuse.

If weighing dry powders and the balance cannot be located in a fume hood or BSC, tare a container then add the material to the container in a hood, then seal the container before returning to the balance to weigh the powder.

Change gloves regularly (at least every two hours) and wash hands at the time of the glove change.

If using a HEPA vacuum, change the filter inside a chemical fume hood or biological safety cabinet. If the HEPA vacuum may be used for incompatible materials, maintain a log of vacuum use so that collection of incompatible materials can be avoided. Keep containers closed as much as possible.

Once work with nanomaterials is complete, wipe the work area down with a soap and water solution.

Avoid lab contamination by selecting from the following control procedures:

- Restrict the handling of nanomaterials to areas well within the lab.

- Handle dry nanomaterials in a fume hood, biological safety cabinet, glove box or a vented filtered enclosure. Do not work on the open bench with dry nanomaterials.
- Transport dry nanomaterials in closed containers. Handle solutions containing nanomaterials over disposable bench covers.
- Aerosol producing activities (such as sonication, vortexing and centrifuging) may not be conducted on the open bench. Perform these activities in a fume hood, biological safety cabinet, glove box or a vented filtered enclosure.
- Clean bench tops using a cleaning solution after each work activity.
- Dry sweeping must not be used. Daily vacuuming of benches and floors with a HEPA vacuum should be performed in labs that handle dry nanomaterials.
- All solutions and solid materials must be disposed of as hazardous waste following established University guidelines

Personal Protective Equipment

Lab coats must be worn. Lab coats must be laundered monthly via an approved laundry service or using University provided lab coat laundry services. Lab coats may not be taken to private homes and laundered. Arm sleeves are required where high levels of exposure or splashes of solutions containing nanomaterials are anticipated. Standard safety glasses are required when working in any lab. Gloves (disposable nitrile) must be worn when handling nanomaterials. Because skin penetration is a concern gloves must cover the wrist and any skin on the arm exposed by the lab coat. Appropriate personal clothing is required in all laboratories including those that work with nanomaterials. Long pants and closed toed shoes are required.

If splashes may occur, wear goggles and a face shield. Otherwise, wear standard laboratory safety glasses. In cases where the arms or torso may be exposed to liquid suspensions or dry materials, wear Tyvek sleeves and/or gowns (or other air-tight non-woven textile).

Respirators may be required for activities that cannot be controlled using ventilation. The need for, and selection of respirators, is the responsibility of EHS. All respirators users will comply with the University's Respiratory Protection Guideline.

Offices and general-purpose workstations may not be located inside laboratories that handle nanomaterials. Hand washing facilities must be provided in all labs. Hand washing must be performed after handling nanomaterials.

Transportation and Storage

- Nanomaterials must be in sealed shatter-resistant containers during transportation. If the container is not shatter-resistant, use a secondary container.
- Containers must be labeled with nanomaterial name (or composition) and approximate particle size, along with any known hazard warnings.
- If the material may be flammable, reactive, or explosive, keep away from heat and open flame.
- Keep these powders away from any incompatible materials. *(List any specific incompatibles.)*

Waste Disposal

- As a prudent measure, manage nanoparticle wastes, including contaminated lab debris, as a part of your normal laboratory hazardous waste stream.

- Collect and store waste materials in a tightly closed container. Include information describing the nanoparticulate nature of the materials on the waste label (e.g., contains nanosilver material).
- All solutions and solid materials must be disposed of as hazardous waste following established University guidelines.

Because most spent, unused and expired chemicals/materials are considered hazardous wastes, they must be properly disposed of. ***Do not dispose of chemical wastes by dumping them down a sink, flushing in a toilet or discarding in regular trash containers.*** Contact EHS at (313) 593-0921 for waste containers, labels, manifests, waste collection and for any questions regarding proper waste disposal. Also, refer to EHS's Hazardous Waste Webpage for more information.

Exposures/Unintended Contact

 ***If the employee is in need of emergency medical attention, call 911 immediately.*** 

For an actual chemical exposure/injury:

- Flush exposed eyes or skin with water for at least 15 minutes, then seek medical attention (see below).
- Note: In case of inhalation, seek medical attention.

Report all work related accidents, injuries, illnesses or exposures to WorkConnections within 24 hours by completing and submitting the Illness and Injury Report Form. Follow the directions on the WorkConnections website Forms Instructions to obtain proper medical treatment and follow-up.

Complete the EHS Laboratory Incident and Near-Miss Report form.

TREATMENT FACILITIES:

Midwest Medical Center -- *Campus Employees (including student employees)*
Mon-Fri 7:30 am - 4:30 pm
9301 Middlebelt Road
Romulus, MI 48174
Phone: 734-941-1000

After hours - go to:

Midwest Medical Center
Open 24/7
4700 Schaefer
Dearborn, MI 48126
Phone: 313-581-2600

Henry Ford Medical Center-Fairlane -- *University students (non-life threatening conditions)*
19401 Hubbard Drive
Dearborn, MI 48126
Phone: 313-928-8278

Click here for more information.

Spill Procedure

- When a spill occurs, ***personal safety should always come first***.
- Alert and clear everyone in the immediate area where the spill occurred.
- Use proper personal protective equipment as indicated above.
- Spills of dry nanomaterials must be cleaned with a HEPA vacuum or, if appropriate, use moist sorbent pads or wet the powder with a suitable solvent and then wipe with a dry cloth. For liquid suspensions, use appropriate sorbents to absorb spill.
- Collect residue, place in container and contact EHS (313) 593-0921 for proper disposal.

MAJOR CHEMICAL SPILL

- Attend to injured or contaminated persons and remove them from exposure.
- Alert people in the laboratory to evacuate.
- If spilled material is flammable, turn off ignition and heat sources. Don't light Bunsen burners or turn on other switches.
- **Call Public Safety at (313) 593-5333 or 911 from a campus phone immediately for assistance.**
- Close doors to affected area.
- Post warnings to keep people from entering the area.
- Have person available that has knowledge of incident and laboratory to assist emergency personnel.

Additional Spill Links:

- Chemical Spill Control Information

Report all emergencies, suspicious activity, injuries, spills, and fires to Public Safety by calling at (313) 593-5333 or 911 from a campus phone. Register with the University of Michigan-Dearborn Emergency Alert System.

Training of personnel

All personnel are required to complete the ***Comprehensive Laboratory Safety*** session (**BLS009** *or equivalent*) via MyLINC. Furthermore, all personnel shall read and fully adhere to this SOP when handling nanomaterials.

Training on lab-specific procedures is required for all personnel working with these materials, and must be documented (topics covered, date, employee names and signatures). Laboratory-specific training for work with nanomaterials must include information on the relatively greater hazards of working with nanomaterials, and on the uncertainty of health effects.

Certification

I have read and understand the above SOP. I agree to contact my Supervisor or Lab manager if I plan to modify this procedure.

Name	Signature	UM ID #	Date

Prior Approval required – Is this procedure hazardous enough to warrant prior approval from the Principal Investigator? ☐ **YES** ☐ **NO**

Principal Investigator _____ **Revision Date** _____