



Nanoparticle Use Addendum to the Laboratory Chemical Hygiene Plan

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1.0 Nanoparticle Use Addendum Purpose

The purpose of this Nanoparticle Use Addendum to the WWU Chemical Hygiene Plan (CHP) is to describe laboratory work practices and procedures that are necessary to ensure that University laboratory employees are protected from health and physical hazards associated with nanoparticle use in laboratories.

This Nanoparticle Use Addendum addresses this purpose by including the best current practices identified by the National Institute for Occupational Safety and Health (NIOSH), part of the Centers for Disease Control and Prevention of the U.S. Department of Health and Human Services. In addition, materials from the Institut de Recherche Robert-Sauvé en Santé et en Sécurité du Travail (IRSST) in Montreal, CA, and from several universities with significant nanotechnology research programs were consulted for best current practices.

2.0 Scope

This addendum to the WWU Chemical Hygiene Plan applies to all laboratory employees working on laboratory-scale operations involving use of nanoparticles. (See Part 3 below for a definition of terms.) This addendum also encompasses non-laboratory employees who work with nanoparticles or who are required to enter a laboratory where potential exposure may occur.

In general, the protective procedures and information described in this section are applicable to students, except when their exposures are minimal.

3.0 Definitions and Background

- **Nanotechnology:** engineered structures, devices, and systems that have a length scale between 1 and 100 nanometers. At these length scales, materials begin to exhibit unique properties that affect physical, chemical, and biological behaviors.
- **Nanoparticles:** structures with at least one dimension in approximately the 1 to 100 nanometer range.
- **Nanometer:** one billionth of a meter. For perspective, a sheet of paper is about 100,000 nanometers thick; a nanometer is a millionth of a millimeter.

Particles in the nano-size range have always been present in the earth's air. Nanoparticles may be naturally occurring (such as, in volcanic ash), produced as unintentional byproducts (such as, in auto emissions) or intentionally created or engineered. As of the summer 2008, little information is known about the hazards of nanoparticle use for human beings.

Particles created at the nanoscale size range have different properties than larger particles of the same material. Studies have shown that low-solubility, ultrafine particles are more toxic than larger particles on a mass for mass basis. There are strong indications that particle surface area and surface chemistry are primarily responsible for observed responses in cell cultures and animals.

Some types of nanoparticles may be carried deeply into tissues. For example, particles may be respired deeply into the lungs; they may pass through the blood-brain barrier; or they may translocate between organs.

There are currently no exposure standards for nanoparticles aside from those in place for larger-sized particles of a particular chemical. As of 2008, NIOSH recommends that exposures **should be minimized** until more safety and health information is available.

Exposures to nanoparticles may occur via the same routes as exposures to larger particles: inhalation, ingestion or skin penetration.

3.1 Nanoparticles as Dry Powders or in Gas-phase Systems

The greatest risk of exposure comes from inhalation of airborne material following dispersal into air. Individual nanoparticles are too small to see; no evidence of airborne dispersal may be evident.

Generating nano particles in the gas phase in non-enclosed systems significantly increases the chances of aerosol release into the workplace.

Handling nano-structured powders leads to an increased possibility of aerosolization and inhalation exposure.

3.2 Nanoparticles in Liquid Form: Slurries, Suspensions or Solutions

Aerosols of nanoparticles may occur from slurries, suspension or solutions. These aerosols pose an exposure concern for both inhalation and dermal exposure routes.

- Working with nanoparticles in liquid media increases the possibility of tiny splashes or droplet deposits outside of a container. When this occurs without adequate hand protection provided by gloves, the risk of skin exposure increases.
- Working with nanoparticles in liquid media during pouring or mixing operations, or where a high degree of agitation is involved, leads to an increased likelihood of inhalation of respirable droplets formed.

3.3 Other Nanoparticle Concerns

Maintenance on equipment and processes used to produce or fabricate nanoparticles pose a potential exposure risk to workers performing these tasks.

Cleaning of dust collection systems used to capture nanoparticles pose a potential for both skin and inhalation exposure.

Nanoparticles may enter the environment. The environmental effects of these small-size particles are also unclear.

4.0 Responsibilities

Responsibilities for use of nanoparticles are the same as described in the WWU or departmental Chemical Hygiene Plan.

5.0 Standard Operating Procedures

The following standard operating procedures **must be followed** when using nanoparticles or the reasons for not doing so are to be well documented:

- Follow standard procedures for laboratory work with chemicals of unknown toxicity when working with nanoparticles. Refer to the hazard assessment certification in Section 5 of the *WWU Safety Information Book*.
- Wear a lab coat. Launder lab coats using an approved laundry service. Avoid taking lab coats to private homes for laundering.
- Wear safety glasses or goggles as described in your department's hazard assessment certification.
- Wear disposable nitrile gloves when handling nanomaterials. Whenever skin exposure (and, thus, skin penetration) is a concern, **double glove**. Use a glove that covers the wrist and any skin on the arm exposed by the lab coat.
- Wear appropriate personal clothing in laboratories that work with nanomaterials: long pants and closed-toed shoes.

- If activities are required that cannot be controlled using ventilation, wear respirators. The use of and selection of respirators is a responsibility of the Office of Environmental Health and Safety. All respirators users comply with the University's Respiratory Protection Program found in Section 13 of the *WWU Safety Information Book*.
- Provide protective arm sleeves where high levels of exposure or splashes of solutions containing nanoparticles are anticipated.
- Avoid placing office areas and general-purpose workstations inside laboratories that handle nanomaterials.
- Wash hands immediately after handling nanomaterials and removing gloves.
- Eat, drink, apply cosmetics and chew gum away from areas where nanoparticles are used in any form.
- Limit access to the laboratory to trained personnel only when nanoparticles are being used.

5.1 Laboratory Contamination and Cleaning

Avoid contamination within and around a laboratory. Use appropriate techniques from the following control procedures:

- Never work on an open bench with dry nanoparticles. Handle dry nanomaterials in a chemical fume hood, certified biological safety cabinet, glove box or a vented, filtered enclosure.
- Vacuum benches and floors daily with a HEPA vacuum in laboratories that handle dry nanoparticles.
- Transport nanoparticles in closed containers with sealed, secondary containment device.
- Use absorbent, plastic-backed bench covers when handling solutions containing nanoparticles.
- Conduct aerosol-producing activities (such as, sonication, vortexing and centrifuging) only in a chemical fume hood, biological safety cabinet, glove box or a vented, filtered enclosure.
- After each work activity, clean bench tops using a cleaning solution.
- Perform activities likely to release nanoparticles, such as, the opening and emptying of reactors, borosilicate tubes, or weighing of dry nanoparticles, ONLY in a chemical fume hood or other vented enclosure.
- Trap exhaust from all furnaces used to produce nanoparticles and vent to local exhaust source. Never exhaust aerosols of engineered nanoparticles inside laboratories.

6.0 Waste Disposal

All solutions and solid materials, including bench covers and gloves, are disposed of as hazardous waste following established University guidelines, unless they are specifically known to be non-toxic. Consult with the Environmental Health and Safety office.

Clean or evaluate all equipment used to handle nanomaterials prior to disposal or re-use for other purposes.

Evaluate laboratory equipment and exhaust systems prior to repair, remodeling or removal. Notify the Environmental Health and Safety office for assistance in notifying maintenance staff.

Chemical waste disposal procedures can be found in *WWU Safety Information Book*, Section 10 (Hazardous Waste Program).

7.0 Spill Response

Clean spills of nanoparticles with a HEPA vacuum or wet wipe the area with towels, or both. Never dry sweep. If a large spill occurs, immediately leave the area and close the doors. Call the Environmental Health and Safety office for assistance.

8.0 Hazard Identification

8.1 Catalytic Effects

Many chemical reactions can be catalyzed by small amounts of material. If the potential catalyst is a solid, while the reactants are liquids or gases, the effectiveness of the catalyst may depend on the surface area of the particles. Nanoparticles could cause very rapid reactions that would otherwise proceed more slowly. Small-scale testing can help to identify effects and preclude a violent reaction.

8.2 Fire and Explosion

As of the summer of 2008, data are unavailable relating to fire and explosion hazards from nanoparticles. While unlikely that small amounts of material could create a risk, larger amounts of combustible powders could.

Dense clouds of nanometric powder may be impossible to see, even though a suspension of the same product with larger particles is easily visible. Nanoparticulates which are combustible materials could pose a dust explosion and fire hazard.

The Principle Investigator's risk assessment should address issues of ignition energy, the ability to self-charge or auto-ignite and settling time of the material in use.

9.0 Employee Training

Training for each person participating in work with nanoparticles should include the following points. The contents of this addendum may serve as a component of the training.

- A briefing on the potential hazards of the research activity.
- The proper procedures and techniques for handling nanoparticles safely and with minimal exposure.
- A review of the Material Safety Data Sheet for purchased nanomaterials.

Training is to be documented in writing including the names of personnel, dates and topics covered.