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Standard Operating Procedure
for
**The Handling and Storage of Engineered
Nanomaterials**

REVISION

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1. PURPOSE AND SCOPE

To provide minimum requirements for the safe handling and storage of Engineered Nanomaterials at the College of Nanoscale Science and Engineering (CNSE).

1.1 Scope

- 1.1.1 This specification applies to the storage and handling of engineered nanomaterials at the College of Nanoscale Science and Engineering (CNSE).
- 1.1.2 This program applies to CNSE employees/students, tenant employees, contractors and sub-contractor who may be performing an activity or operation within the facility that involves the handling and/or storage of nanomaterials. Tenant employees, contractors and sub-contractors may comply with their own organization's program provided that it meets and/or exceeds the minimum requirements set forth in this procedure.
- 1.1.3 CNSE employees/students, tenant employees, contractors and sub-contractors will be notified of the requirement to follow this program and are required to comply with the restrictions and limitations imposed upon them by CNSE during site activities.
- 1.1.4 The following procedures are based in part on information from the American Chemical Society, National Institute of Occupational Safety and Health and CNSE Chemical Handling Guidelines (EHS-00005). This SOP will be updated as more information and research into the health effects and specific hazards of nanomaterials are published. *Due to limited research available on engineered nanomaterials, researchers must handle these materials as if they are hazardous.*

2. DEFINITIONS

The following definitions apply to various **Nanomaterials** used at the CNSE facilities:

- 2.1 **Agglomerate** - a group of particles held together by relatively weak forces (for example, Van der Waals or capillary), that may break apart into smaller particles upon processing, for example.
- 2.2 **Aggregate** - a discrete group of particles in which various individual components are not easily broken apart, such as in the case of primary particles that are strongly bonded together (for example, fused, sintered, or metallically bonded particles).

- 2.3 **Engineered Nanomaterial** - is any material which has structured components with at least one dimension less than 100 nanometer, including carbon nanotubes, carbon nanofibers, fullerenes, quantum dots and any other materials of different elemental composition that meet the definition.
- 2.4 **Fine Particle** - a particle smaller than about 2.5 micrometers and larger than about 0.1 micrometers in size.
- 2.5 **Nano** - (1) The SI definition, a prefix used to form decimal submultiples of the SI unit “meter”, designating a factor of 10^{-9} denoted by the symbol “n”. (2) Pertaining to things on a scale of approximately 1 to 100 nanometers (nm). (3) A prefix referring to an activity, material, process or device that pertains to a field of knowledge defined by nanotechnology and nanoscience.
- 2.6 **Nanoparticle** - a sub-classification of ultrafine particle with lengths 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. The length scale may be a hydrodynamic diameter or a geometric length appropriate to the intended use of the nanoparticle.
- 2.7 **Nanoscale** - having one or more dimensions from 1 to 100 nanometers (nm).
- 2.8 **Nanoscience** - the study of nanoscale materials, processes, phenomena, or devices.
- 2.9 **Nanostructured** - containing physical or chemically distinguishable components, at least one of which is nanoscale in one or more dimensions.
- 2.10 **Nanotechnology** - a term referring to a wide range of technologies that measure, manipulate, or incorporate materials and/or features with at least one dimension between approximately 1 and 100 nanometers (nm). Such applications exploit the properties, distinct from bulk/macroscopic systems, of nanoscale components.
- 2.11 **Non-transitive nanoparticle** - a nanoparticle that does not exhibit size-related intensive properties.
- 2.12 **Particle** - a small object that behaves as a whole unit in terms of its transport and properties.
- 2.13 **Transitive nanoparticle** - a nanoparticle exhibiting a size-related intensive property that differs significantly from that observed in fine particles or bulk materials. This term is used when the material has properties that emerge only on the nanoscale. It is reserved for the

special case of nanoscale materials which have behavior that does not smoothly or simply extrapolate from the bulk, and also encompasses those systems which have features that respond to external forces in an interactive manner.

- 2.14 **Ultrafine Particle** - a particle ranging in size from approximately 0.1 micrometer (100 nanometers) to 0.001 micrometers (1 nanometer). The length scale may be measured by a particle's geometric, aerodynamic, mobility, projected-area, or hydrodynamic dimension.

The following definitions apply to various **Hazardous Materials** used at the CNSE facilities:

- 2.15 **Hazardous Chemical** - according to the Occupational Safety and Health Administration (OSHA) means any chemical which is a physical hazard or a health hazard.
- 2.16 **Physical Hazard** - means a chemical for which there is scientifically valid evidence that it is: a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.
- 2.17 **Health Hazard** - means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed individuals. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes.
- 2.18 **Highly Toxic** - A material which produces a lethal dose or lethal concentration that falls within any of the following categories:
- 2.18.1 **Ingestion** - A chemical that has a medium lethal dose (LD₅₀) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
- 2.18.2 **Absorption** - A chemical that has a median lethal dose (LD₅₀) of 200 milligrams or less per kilogram of body weight when administered by continuous contact 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
- 2.18.3 **Inhalation** - A chemical that has a median lethal concentration (LC₅₀) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

- 2.18.4 Mixtures of these materials with ordinary materials, such as water, might not warrant classification as highly toxic. While this system is basically simple in application, any hazard evaluation that is required for the precise categorization of this type of material shall be performed by experienced, technically competent persons.
- 2.18.5 **Injection** - Injection of toxic or highly toxic chemicals into the body through syringes, hypodermic needles, puncture wounds, pressurized lines, or broken glassware.
- 2.19 **Toxic** - A chemical falling within any of the following categories:
- 2.19.1 **Ingestion** - A chemical that has a median lethal dose (LD₅₀) of more than 50 milligrams per kilogram, but no more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
- 2.19.2 **Absorption** - A chemical that has a median lethal dose (LD₅₀) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
- 2.19.3 **Inhalation** - A chemical that has a median lethal concentration (LC₅₀) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than 2 milligrams per liter but not more than 20 milligrams per liter of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

3. RESPONSIBILITIES

- 3.1 It is the responsibility of each CNSE project manager, tenant (tool owner/operator), professor, student, Principal Investigator (PI) or individual who utilizes and/or stores nanomaterials at the CNSE facilities to ensure that the proper procedures, as detailed below, are followed for handling and storage of such materials. The individual using nanomaterials is also considered a hazardous waste generator and is responsible to properly characterize, package and label the waste with the appropriate hazard information, as described in EHS specification number EHS-00009
- 3.2 It is the responsibility of each CNSE Manager (host) who contracts the services of contractor/ vendor personnel (contractor) to perform work on CNSE property to ensure that the contractor is aware of the potential hazards associated with the required work and the proper procedures

(detailed below) for handling and storage of the nanomaterials utilized in their activities.

- 3.3 It is the responsibility of the CNSE manager, tenant, tool owner/ operator, professor, student, Principal Investigator (PI) or individual ordering nanomaterials to arrange for the safe and proper storage of those nanomaterials when received on-site.
- 3.4 Nanoscale materials should not be delivered to, and shall not be stored in office areas. They should be delivered to the Shipping and Receiving dock (NFN), where they can be stored temporarily until placed in bulk storage or delivered to the ultimate user.
- 3.5 When delivered to a laboratory or cleanroom area, the nanomaterial should be in a sealed container and placed into appropriate storage cabinets prior to use.
- 3.6 It is the responsibility of the CNSE manager, tenant, tool owner/ operator, professor, student, Principal Investigator (PI) or individual ordering nanomaterials to either provide individuals who have been properly trained in safe chemical handling and transportation or arrange to have the CNSE chemical handling group, properly handle and store the chemicals received at CNSE. The chemicals shall be stored within approved chemical storage rooms or cabinets, and transported to the appropriate point of use locations (i.e. laboratories, clean rooms, equipment rooms, etc.) following safe handling practices as detailed below.

4. REFERENCES – ASSOCIATED DOCUMENTS

- 4.1 National Institute of Occupational Safety and Health's Approaches to Safe Nanotechnology: <http://www.cdc.gov/niosh/topics/nanotech/safenano/>
- 4.2 National Nanotechnology Initiative: <http://www.nano.gov/>
- 4.3 Environmental Protection Agency Perspective on Nanotechnology: <http://es.epa.gov/ncer/nano/index.html>
- 4.4 College of Nanoscale Science and Engineering EHS document - **EHS-00002**, Hazard Communication Program.
- 4.5 College of Nanoscale Science and Engineering EHS document - **EHS-00009**, Hazardous Waste Management Plan.
- 4.6 College of Nanoscale Science and Engineering EHS document - **EHS-00010**, Personal Protective Equipment Requirements.

- 4.7 College of Nanoscale Science and Engineering EHS form - EHS-00005, Chemical Handling.

5. POTENTIAL HEALTH CONCERNS

- 5.1 The potential for nanomaterials to enter the body is among several factors that scientist 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.
- 5.2 Based on results from human and animal studies, airborne nanomaterials can be inhaled and deposit in the respiratory tract; and based on animal studies, nanoparticles can enter the blood stream, and translocate to other organs.
- 5.3 Experimental studies in rats have shown that equivalent mass doses of insoluble ultrafine particles (smaller than 100nm) are more potent than large particles of similar composition in causing pulmonary inflammation and lung tumors in those laboratory animals. However, toxicity may be mitigated by surface characteristics and other factors. Results from *in vitro* cell culture studies with similar materials are generally supportive of the biological responses observed in animals.
- 5.4 Cytotoxicity and experimental animal studies have shown that changes in the chemical composition, structure of the molecules, or surface properties of certain nanomaterials can influence their potential toxicity.
- 5.5 Studies in workers exposed to aerosols of manufactured microscopic (fine) and nanoscale (ultrafine) particles have reported lung function decrements and adverse respiratory symptoms; however, uncertainty exists about the role of ultrafine particles relative to other airborne contaminants (e.g., chemicals, fine particles) in these work environments in causing adverse health effects.
- 5.6 Engineered nanoparticles whose physical and chemical characteristics are like those of ultrafine particles need to be studied to determine if they pose health risks similar to those that have been associated with the ultrafine particles.

6. POTENTIAL SAFETY CONCERNS

- 6.1 Although insufficient information exists to predict that fire and explosion risk associated with nanoscale powders, nanoscale combustible material could present a higher risk than coarser material with a similar mass

concentration given its increased particle surface area and potentially unique properties due to the nanoscale.

- 6.2 Some nanomaterials may initiate catalytic reactions depending on their composition and structure that would not otherwise be anticipated from their chemical composition alone.

7. WORKING WITH ENGINEERED NANOMATERIALS

- 7.1 Nanomaterial-enabled products such as nanocomposites, 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.
- 7.2 Processes generating nanomaterials in the gas phase, or using or producing nanomaterials as powders or slurries/suspensions/solutions pose the greatest risk for related 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.
- 7.3 The following workplace tasks may increase the risk of exposure to nanoparticles:
- Working with nanomaterials in liquid media without adequate protection (e.g., gloves) will increase the risk of skin exposure.
 - Working with nanomaterials in liquid during pouring or mixing operations, or where in high degree of agitation is involved, will lead to an increase likelihood of inhalable and respirable droplets being formed.
 - Generating nanoparticles in the gas phase in non-enclosed systems will increase the chances of aerosol release to the workplace.
 - Handling nanostructured powders will lead to the possibility of aerosolization.
 - Maintaining equipment and processes used to produce or fabricate nanomaterials or the clean-up of spills or waste material will pose a potential for exposure to workers performing these tasks.
 - Cleaning of dust collection systems used to capture nanoparticles can pose a potential for both skin and inhalation exposure. Cleaning or

change out of such systems should be done inside an exhausted enclosure.

- Machining, sanding, drilling, or other mechanical disruptions of materials containing nanoparticles can potentially lead to aerosolization of nanomaterials.

8. EXPOSURE ASSESSMENT AND CHARACTERIZATION

8.1 Until more information becomes available about the mechanisms underlying nanoparticle toxicity, it is uncertain as to what measurement technique should be used to monitor exposures in the workplace. Current research indicated that mass and bulk chemistry may be less important than particle size and shape, surface area, and surface chemistry (or activity) for nanostructured materials.

8.2 Many of the sampling techniques that are available for measuring airborne nanoaerosols vary in complexity but can provide useful information for evaluating occupational exposures with respect to particle size, mass, surface area, number concentration, composition, and surface. Unfortunately, relatively few of these techniques are readily applicable to routine exposure monitoring.

8.3 Regardless of the metric or measurement method used for evaluating nanoaerosol exposures, it is critical that background nanoaerosol measurements be conducted before production, processing or handling of the nanomaterial/nanoparticle.

8.4 When feasible, personal sampling is preferred to ensure an accurate representation of the worker's exposure, whereas area sampling (e.g., size-fractionated aerosol samples) and real-time (direct reading) exposure measurements may be more useful for evaluating the need for improvement of engineering controls and work practices.

9. RISK ASSESSMENT- STEPS TO PROTECT WORKERS INVOLVED WITH NANOMATERIALS

9.1 A complete process for managing occupational safety and health implications during the development of new technologies and materials consists of a set of progressive elements:

- Identifying and characterizing the hazard
- Assessing the extent of exposure

- Characterizing the risk, and
- Developing control and management procedures.

- 9.2 As exposure assessment data become available, a determination can be made whether or not an occupational risk exists, and if so, the risk can be assessed and characterized.
- 9.3 The risk characterization should make it possible to determine whether workplace exposure to a given technology or type of material are likely to result in adverse health effects.
- 9.4 The exposure assessment data will also provide a means to determine what controls are effective in preventing exposure that could cause adverse effects. The critical routes of exposure are being identified, and research is being conducted on health effects and mechanisms of action of specific nanoparticles.
- 9.5 There is a body of knowledge about particles between 100nm and 1 μ m for which experience in hazard, risk, and control can be used. It appears that nanomaterials that are presently manufactured have no major physical features that would make them behave differently from fine and ultrafine particles in terms of the ability to control them in the workplace. However, the limits of this assumption need continued evaluation.

10. CHEMICAL APPROVAL

- 10.1 All purchases of nanomaterials must have approval from the Environmental Health and Safety (EHS) Department before ordering. In order to get a material approved the requester shall complete and submit the Chemical Authorization Form (EHS-00002-F1) and the associated MSDS, to the EHS Department for review and approval.
- 10.2 Only nanomaterials having dimensions greater than 2.5 nm will be approved by EHS. Nanomaterials with dimensions less than this limit will not be able to be controlled using engineering means.
- 11.2.1 The purpose of this review is to ensure that the chemical properties and associated hazards, labeling, exhausts, drains, and disposal requirements are in strict adherence with site and regulatory requirements. It also ensures that all of the necessary safety and health information regarding the use of the nanomaterial is reviewed with the user prior to introduction and use.
- 10.2.1 Once the Chemical authorization form is reviewed and the necessary requirements met, the material will be approved for use.

- 10.3 Purchasing shall not place an order for a new nanomaterial without the date that the material was approved by the EHS department. Purchasing will request that an MSDS accompanies the shipment.
- 10.4 Once approved, the nanomaterial shall be entered onto the "Approved Chemical List". The "Approved Chemical List" is maintained by the EHS department and is updated on a weekly basis. This listing shall include the product name, manufacturer, owner of the chemical, the hazard ratings and the date of the most recent MSDS.
- 10.5 A copy of the "Approved Chemical List" shall be made readily available on the CNSE Intranet and in the EHS office.
- 10.6 Prior to accepting a nanomaterial shipment the receiver shall ensure that the nanomaterial has been approved for use at the site. The Receiving department shall also compare the name of the shipment with that on the "Approved Chemical List". If the name is different or the material is not on the list the material shall be quarantined and/or returned to the vendor until the proper approval steps, as listed above, are followed.
- 10.7 All nanomaterials must only be procured through the Purchasing department. Samples delivered without prior approval shall not be received and shall place the vendor in jeopardy regarding future business.
- 10.8 The requester shall ensure that all appropriate labeling and listed EHS requirements are satisfied at all times when the nanomaterial is used.

11. LABELING

- 11.1 All nanomaterial containers, chemical storage cabinets, and production equipment which uses or stores nanomaterials, shall be clearly labeled as to their contents. Nanomaterials shall always be stored in non-breakable, sealable secondary containers.
- 11.2 Secondary container 'chemical' labels shall be of the Hazardous Material Information System (HMIS) color bar type and shall contain the following information: the product name (as identified on the MSDS), the major chemical components, hazard information in the form of the HMIS ratings for Health, Flammability, and Reactivity.
- 11.3 Chemical labels shall be prominently displayed on the nanomaterial secondary container and written in English.

12. STORAGE

- 12.1 Nanomaterials shall be stored in closed non-breakable secondary containers according to the compatibility and hazard label recommendations for the specific chemical.
- 12.2 No nanomaterials shall be stored in office areas.
- 12.3 Storage areas will be inspected on a regular basis for safety concerns such as improper storage, leaking/damaged container(s), damaged labels, quantities in excess of approved limits.
- 12.4 Individual users are responsible for completing regular inspections.

13. SAFE WORK PRACTICES

The following safe work practices shall be employed when using nanomaterials:

- 13.1 The required Personal Protective Equipment must be worn when; using, handling, transferring or transporting chemicals - see Personal Protective Equipment Program (EHS-00010).
- 13.2 Cover open wounds.
- 13.3 Wash hands thoroughly when work with the material is completed.
- 13.4 Mouth pipetting is prohibited.
- 13.5 Use of sharps (such as glass Pasteur pipettes, needles, razor blades etc.) should be avoided or minimized.
- 13.6 Avoid skin contact with nanoparticles or nanoparticle-containing solutions by wearing double gloves. Do not handle nanoparticles with your bare skin.

14. ENGINEERING CONTROLS

- 14.1 Nanoparticle powders shall only be handled in designated areas which are equipped with ULPA-filtered (captures particulates >0.12um or 120 nm) powered-exhaust laminar flow hoods, glove bags or glove boxes. Glove bags are the preferred method of control.
- 14.2 Fume exhaust hoods shall be used to expel fumes from tube furnaces or chemical reaction vessels.

- 14.3 Dispose of waste nanoparticles according to hazardous chemical waste guidelines set forth in Section 20.
- 14.4 Wet clean-up methods should be employed as the primary clean-up technique. Vacuum cleaners used to clean up nanoparticles should be tested, ULPA-filtered units. Do not dry sweep or use regular vacuum cleaners.
- 14.5 A dedicated ULPA vacuum is required in any lab where nanomaterials will be used. This ULPA vacuum will be labeled for 'nanomaterial use only' and stored in a dedicated storage area.
- 14.6 Equipment previously used to manufacture or handle nanoparticles should be evaluated for potential contamination prior to disposal or reused for another purpose.
- 14.7 Lab equipment and exhaust systems should also be evaluated prior to removal, remodeling or repair.
- 14.8 Given the differing synthetic methods and experimental goals, no blanket recommendation can be made regarding aerosol emissions controls. This shall be evaluated on a case by case basis.
- 14.9 Consideration should be given to the high reactivity of some nanopowders with regard to potential fire and explosion hazards.
- 14.10 Efforts should be made to always work with nanomaterials in solution, being cognizant of the synergistic effects of some chemicals such as dimethyl sulfoxide. The primary exposure route for nanomaterials is inhalation. Working with the materials in solution minimizes the risk of an inhalation exposure.
- 14.11 Materials in solution will still present an absorption hazard. All personal protection equipment must be employed and users should prevent any contact with the solution, regardless of chemical protective clothing. Nanomaterials of certain sizes have been found to easily move through chemical protective gloves.

15. PERSONAL PROTECTIVE EQUIPMENT

- 15.1 All personnel are required to wear the following Personal Protective Equipment whenever handling nanomaterials:
- Proper laboratory attire (long pants and closed-toe shoes)
 - Long sleeve apron or long sleeve lab coat

- Safety glasses or chemical goggles
- Double pair of nitrile or chemical resistant gloves

15.2 Special circumstances that do not meet this specification must be authorized by the EHS Department. A correspondence from the EHS Department specifying the specific exemption and time limit is required.

16. TRAINING REQUIREMENTS

16.1 All users must demonstrate competency and familiarity regarding the safe handling and use of nanomaterials prior to purchase.

16.2 The Principal Investigator (PI) is responsible for ensuring each user is knowledgeable and trained on the hazards of the materials they are working with and have received the following EHS training:

16.2.1 Safety Orientation and Hazcom Safety Training

16.2.2 Advanced Safety/Lab Safety Training

16.3 The PI will also arrange for a 'One-on-One' hands-on training with them or other knowledgeable laboratory personnel as assigned by the PI.

16.4 Attendance records of the above EHS training classes will be kept on file by the EHS Department.

17. EXPOSURE SYMPTOMS AND PERSONNEL DECONTAMINATION

17.1 For most exposures, decontamination should occur as follows:

17.2 Small Skin Exposures-

- Wash contaminated skin in sink with tepid water for 15 minutes
- Have buddy locate the MSDS, if applicable
- Contact Security/ERT at 437-8600 or x7-8600 for further direction
- Notify EHS Department

17.3 Eye Exposure-

- Locate the emergency eye wash

- Turn eye wash on and open eyelids with fingers
- Rinse eyes for at least 15 minutes
- Have buddy contact Security/ERT at 437-8600 or x7-8600 for assistance and locate the MSDS, if applicable
- Notify EHS Department

17.4 Large Body Area Exposure-

- Locate the emergency safety shower
- Stand under shower and turn it on
- Rinse whole body while removing all contaminated clothing
- Have buddy contact Security/ERT at 437-8600 or x7-8600 for assistance and locate the MSDS, if applicable
- Rinse body for at least 15 minutes
- Notify EHS Department

18. NANOMATERIAL SPILLS

- 18.1 For all nanomaterial spills and releases call 437-8600 or x7-8600 to report the problem.
- 18.2 The laboratory should be prepared to clean up minor spills (25ml/25g or less) of highly toxic/carcinogenic materials should they occur in a properly operating fume hood.
- 18.3 Chemical spill clean up guidance can be found in Chemical Handling (EHS-00005).
- 18.4 Lab personnel and ERT cleaning up a spill will wear all Personal Protective Equipment listed above and manage all clean-up debris according to the waste disposal section.
- 18.5 Notify EHS of any spills, even if the lab staff handled the cleanup.
- 18.6 If a spill is large or occurs outside of a fume hood, the laboratory occupants should immediately vacate the lab, close all doors and contact ERT at 437-8600 or x7-8600.

- 18.7 If the lab personnel determine that the spill is not contained to the lab or could cause harm to people outside the lab, they should pull the building fire alarm and go to the appropriate Rally Point to await the Emergency Response Team (ERT). The knowledgeable person should provide the ERT with the following:
- 18.7.1 Common name of the material involved
 - 18.7.2 A copy of the MSDS, if possible or applicable
 - 16.7.3 Any pertinent information related to the emergency, such as location in the lab, other hazards in the lab, etc.
- 18.8 Always call the Emergency number 437-8600 or x7-8600 in the event of a large chemical spill.

19. WASTE DISPOSAL

- 19.1 Until further evidence is published, researchers must handle waste nanomaterials as a hazardous waste.
- 19.2 The authorized person using nanomaterials is responsible for the safe collection, preparation and proper disposal of waste unless otherwise stated below.
- 19.3 Hazardous waste shall be disposed of as soon as possible and in accordance with all CNSE procedures.
- 19.4 Hazardous waste generators must obtain Hazardous Waste Management training from EHS.
- 19.5 All waste containers must be labeled with a Hazardous Waste label which includes the type of waste, the name of the responsible generator and the date that the waste was placed in the satellite accumulation area.
- 19.6 Utilize plastic containers, Nalgene HDPE or Justrite containers for liquid waste.
- 19.7 Solid contaminated waste must be moistened/wetted if appropriate, sealed to prevent aerosol and dust generation, double bagged and placed in a non-breakable box/container.
- 19.8 Follow all standard chemical waste procedures listed in the Chemical Handling standard (EHS-00005) and Hazardous Waste Management (EHS-00009).

20. OCCUPATIONAL MEDICAL SURVEILLANCE

20.1 The unique physical and chemical properties of nanomaterials and the available information about biological and health effects in animals associated with exposures to some types of engineered nanoparticles in lab studies, and available information about the occupational health effects in incidental ultrafine particles all underscore the need for medical and hazard surveillance for nanotechnology.

20.2 NIOSH is in the process of formulating guidance relevant to occupational health surveillance for nanotechnology.

20.3 Personnel working with nanomaterials are not required to obtain either a pre- or post-employment medical examination specific to nanomaterial use.

20.4 Following any suspected nanomaterial release or spill, employees must report to a supervisor and EHS if they believe that they have been exposed.

20.5 Known or Suspected Nanomaterial Overexposure

20.5.1 If a known or suspected overexposure to nanomaterial occurs at the facility:

- (a) Seek medical care for the individual(s) exposed without delay from the Occupational Health Center open between the hours of 8:00 AM and 5:00 PM. If an incident occurs outside the Occupational Health Clinic's operating hours, seek assistance from the local Emergency Department by calling 911. Have emergency ambulance/Fire Department take all seriously injured persons directly to the Emergency Department.
- (b) Notify the supervisor of the injured individual(s) to ensure action is taken to prevent any further injury to other personnel. The supervisor shall notify the EHS Department within 24 hours after the initial reporting of the incident. The EHS Department will inform Occupational Health Center and other relevant personnel of actions being taken or required as part of the medical investigation. Complete an injury report form and submit to the EHS Department within 24 hours.

21. APPENDICES

21.1 **Appendix A-** EHS Checklist for Possession and Use of Nanomaterials at CNSE

Appendix A

EHS Checklist for Possession and Use of Nanomaterials at CNSE

This checklist is provided to assist EHS with the approval process for possession and use of nanomaterials at CNSE. This form may be kept on file in the EHS office and in the laboratory with the SOP to serve as documentation.

Date and Initial (responsible party)	Requirement
(Requestor)	1. Complete a Chemical Authorization Form (EHS-00002-F1) for the Nanomaterial and submit this form to EHS with the manufacturer specific MSDS.
(Requestor and EHS)	2. Meet with EHS to review the approval form and the requirements for the use of the material.
(Requestor and EHS)	3. EHS and requestor meet to complete an EHS-00010-F1 Job Hazard Analysis/Risk Assessment (JHA) for each application in which this material will be used. These JHAs must be kept on file in the laboratory and updated every 5 years or when a process changes.
(EHS)	4. EHS verify that the appropriate training for every worker who will use the material has been received. Training shall include all listed in Section 12.
(Requestor and EHS)	5. Conduct a walk-through with EHS. Develop Action list of requirements for approval of the chemical.
(EHS)	6. EHS adds the material to the Approved Chemical Listing and notifies the requestor.