Chapter 9.7 Working Safely with Nanotoxicology

This could be you . . .

You are removing a beaker of carbon nanotubes from an oven. You covered the beaker with foil before moving it, but the foil slips off. You spill a small amount on the face of the oven. When you try to wipe up the spill, the material simply smears across the oven door and the floor as nanomaterials are hard to handle and clean up.

9.7.1 Applicability of this chapter

9.7.1.1 You are required to follow this chapter if you do any task using nanomaterials, such as:

a. Machining, grinding, or sanding products with nanomaterials.

b. Handling powders composed of nanomaterials.

c. Handling liquids containing nanomaterials.

d. Performing liquid operations that generate aerosols.

e. Cleaning or performing maintenance on dust collection systems used to control nanomaterials.

9.7.2 What are nanomaterials and nanotechnology

Nanomaterials are defined as having at least one dimension in the range of 1-100 nanometers, and can occur naturally or be engineered to nanometer size. (One nanometer is equal to one billionth of a meter.) Nanotechnology involves the manipulation of materials at the nanometer-scale to produce structures, devices, and systems with unique properties as a function of their nanometer-scale size. The manipulation of these materials requires the ability to control with molecular or atomic precision.

9.7.3 Potential hazards of nanomaterials and nanotechnology

Nanotechnology and nanomaterials hold significant promise for technological advancements, as they exhibit unique chemical and physical properties. However, the impacts of nanocharacteristics, such as size, surface area, charge, chemical properties, solubility, and agglomeration, on human health and other biological systems currently are not fully understood. Some studies suggest these unique characteristics may allow nanomaterials to enter the body through penetration of the skin, mucus membranes, and eyes. As the most common exposure route is via inhalation, nanomaterials may be more likely to be deposited lower in the respiratory tract than traditional materials.

9.7.4 JSC Policy on nanomaterials and nanotechnology

9.7.4.1 It is JSC's policy to ensure exposures are below applicable occupational exposure limits, such as the OSHA permissible exposure limit (PEL) and American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV). Employees shall design and implement nanotechnology projects to minimize exposures to as low as reasonably achievable, following the standard hierarchy of controlling workplace hazards:

a. Eliminate, substitute, or modify the nanomaterials.

b. Engineer the process to minimize or eliminate exposure to the nanomaterials.

c. Use administrative controls to limit the quantity or duration of exposure to the nanomaterials.

d. Use PPE.

9.7.5 Evaluating exposure to nanomaterials and nanotechnology

a. **Hazard Analysis.**Employees planning to handle or engineer nanomaterials shall complete a hazard analysis for the procedure to establish precautionary measures required for normal operations and potential emergency responses, depending upon the failure or mishap. The hazard analysis shall:

   (1) Contain a listing of chemicals used in the process, including the chemical composition of the nanomaterial and any liquid used to suspend the nanoparticles.

   (2) Identify engineering controls and PPE requirements to manage and limit exposure.

   (3) Address the failure mode of the spontaneous release, including container failures both during operations and without operations in progress.

   (4) Consider physical hazards. Although not fully known, nanomaterials may pose a risk of fire, explosion, or catalytic reaction because of the surface area and their unique properties.

   (5) Use the most current Safety Data Sheets (SDS).

   NOTE: See Chapter 2.3, “Hazard Analysis,” and JSC for instructions on completing the hazard analysis.

b. **Permissible Exposure Limit (PEL).** As a minimum, any procedures using nanomaterials shall limit exposures to the most stringent of the OSHA PEL, ACGIH TLV or any applicable NASA permissible exposure limit for the chemical composition of the nanoparticles and the suspension liquid (if used). Notify Occupational Health at x36726 when preparing to use or engineer nanoparticles for assistance in determining the appropriate and applicable exposure level. Occupational Health shall conduct investigations and studies of material exposures in the work area, including sampling the concentration in the atmosphere to determine employee exposure levels.

   NOTE: There are very few permissible exposure limits developed for engineered nanomaterials. Those that do exist are based on the type of chemical or dust particle, which may or may not be a suitable way to measure exposure to that same chemical in the nanomaterial form.

c. **Chemical Hygiene Plan.** Employees who perform procedures using nanomaterials in a laboratory shall include those procedures in the laboratory’s written chemical hygiene plan. See Chapter 6.7.

9.7.6 Hazardous material tracking

Nanomaterials are tracked in the SDS database and the hazardous materials inventory. Employees developing or engineering newly developed nanomaterials shall create an SDS for each new

nanomaterial. Submit the SDS to Occupational Health for a JSC SDS number and include the amount of the material generated when updating the inventory. See Chapters 9.1 and 9.2.

9.7.7 Safety provisions for nanomaterials and nanotechnology

a. To the extent feasible, employees shall give priority to reducing employee exposure by using engineering controls, primarily local exhaust ventilation and enclosures such as glove boxes, for activities involving nanomaterials, as well as HEPA filtration of ventilation systems.

b. Employees shall plan work involving nanomaterials to control and prevent employee exposure and the contamination of work surfaces and equipment. To reduce and limit employee exposure, employees shall incorporate the following safe work practices in procedure development as required:

   (1) Use appropriate gloves when handling liquids containing nanomaterials.

   (2) Use enclosures and local exhaust ventilation when performing liquid operations that generate aerosols.

   (3) Use enclosed systems when generating gas-phase aerosols.

   (4) Use enclosed or local exhaust ventilation systems when handling powders.

   (5) Inform Center maintenance personnel of the potential presence of nanomaterials when submitting a work order for maintenance tasks.

   (6) Use enclosures and local exhaust ventilation when machining, grinding, or sanding products with nanomaterials.

c. Employees shall clean facility and equipment work surfaces to remove contamination at the end of the task or shift by good housekeeping practices, including HEPA vacuuming and wet wiping as follows:

   (1) Bag wet wipes so as not to re-aerosolize products.

   (2) Never dry sweep.

   (3) Never use compressed air for cleaning.

   (4) Use sticky mats only in areas outside nanomaterial dry powder operations.

d. Dust collection systems shall include HEPA filtration.

e. Employees shall follow these hygiene requirements in nanomaterials areas:

   (1) Never store or eat food in areas where nanomaterials are handled.

   (2) Always wash hands before eating, drinking, smoking, and leaving work.

f. Disposal of nanomaterials shall meet the substance-specific requirements in JPR 8550.1, Chapter 3, “Managing Industrial Solid Wastes.”

9.7.8 Responding to spills of nanomaterials

a. Employees shall clean up small-scale material spills using the appropriate PPE as described in paragraph 9.7.10. Approaches to cleaning up these spills include the use of HEPA-filtered vacuum

cleaners, wetting powders complete with surfactant, wetted cloths, and the application of absorbent materials.

b. Employees shall report large-scale material spills via the emergency number for the work site.

9.7.9 Transporting nanomaterials

If the composition of either the nanomaterial or the suspension liquid (if used) is considered hazardous, employees shall not transport it on site in a privately owned vehicle. Handle transportation of the material as described in Chapter 9.1, “Hazardous Materials Safety and Health.”

9.7.10 PPE for handling nanomaterials

9.7.10.1 Procedures for handling nanomaterials shall specify personal protective equipment and include the following:

a. Gloves, chemical protective-type as appropriate for the specific material. Always rinse off gloves once they are exposed to nanomaterials.

b. Laboratory coat, disposable lab coat or coverall as appropriate. Put contaminated disposable clothing in an appropriate container and dispose of it properly.

c. Safety eyewear, such as safety glasses with side shields, chemical goggles, or face shield, as appropriate.

d. Respiratory protection as necessary. All respirator users shall conform to the requirements of the JSC Respiratory Protection Program. At a minimum, respirator filtration must provide HEPA capability. See Chapter 7.2, “Respiratory Protection.”

9.7.11 Training for handling nanomaterials

Employees who work with nanomaterials shall be trained in the current health-based research, potential routes of exposure, safe work practices, sampling limitations and types, proper use of PPE, engineering controls, emergency response procedures for spills, and disposal recommendations. The supervisor or the laboratory manager shall provide the training. Training may combine classroom training on the nanotoxicological aspects of the material with the hands-on training specific to the laboratory and the procedure. Occupational Health can help in identifying the most current developments in exposure and control. See Chapter 6.7, “Laboratory Safety and Health,” for more information.

9.7.12 Responsibilities for Nanotoxicology

a. If you are a **supervisor**, you shall:

(1) Identify employees and recommend employees for nanomaterial training, as well as provide hands-on training.

(2) Request a hazard evaluation from Occupational Health at x36726.

(3) Enforce the use of engineering and administrative controls, including PPE.

b. **Employees, on-site contractors, and visiting researchers** shall:

(1) Notify Occupational Health at x36726 when using nanomaterials.

(2) Develop the hazard analysis, including an exposure control plan, with site-specific safety practices for nanomaterials; include the plan in the laboratory's chemical hygiene plan.

(3) Attend required training.

(4) Submit the SDS to the SDS Coordinator for a JSC number.

(5) Provide inventory updates for the nanomaterials in the Hazardous Material Inventory.

(6) Ensure materials are used per the JSC Hazard Communication Policy.

(7) Label materials properly, including secondary containers.

(8) Create an SDS for any newly developed nanomaterial, and maintain it.

(9) Use appropriate controls and follow PPE program procedures.

(10) Ensure materials are disposed of properly.

c. **Occupational Health** shall administer, maintain, and exercise surveillance of the nanotoxicology program, including but not limited to:

(1) Recommending engineering controls and PPE.

(2) Assisting in the hazard analysis.

(3) Determining acceptable exposure limits.

(4) Reviewing work procedures.

(5) Collecting exposure data.

(6) Providing medical evaluations and surveillance as required.

9.7.13 For more information on Nanotoxicology

a. NIOSH Publication Number 2009-125 – Approaches to Safe Nanotechnology: Managing the Health and Safety Concerns Associated with Engineered Nanomaterials

b. NIOSH Publication Number 2012-147 – General Safe Practices for Working with Engineered Nanomaterials in Research Laboratories

c. NIOSH Publication Number 2013-101 – Filling the Knowledge Gaps for Safe Nanotechnology in the Workplace

d. International Council on Nanotechnology – Phase One Report: Current Knowledge and Practices Regarding Environmental Health and Safety in the Nanotechnology Workplace, October 18, 2006

e. International Council on Nanotechnology – Phase Two Report: Survey of Current Practices in the Nanotechnology Workplace, November 13, 2006