NIST National Institute of Standards and Technology • U.S. Department of Commerce

Dispersible Engineered Nanomaterials

NIST S 7101.54
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1. PURPOSE

The purpose of the NIST DENMs Program is to eliminate or minimize occupational exposure to DENMs and to make NIST employees and associates aware of the potential airborne and dermal hazards associated with exposure.[1]

2. BACKGROUND

This suborder supersedes NIST Health and Safety Instruction (HSI) 23, Handling of Dispersible Engineered Nanomaterials, May 2009.

3. APPLICABILITY

This suborder applies to all NIST facilities and to all NIST employees and associates who work with DENMs unless an authoritative government entity (*e.g.*, OSHA, EPA, or NIOSH) has published information confirming that a particular DENM is not hazardous.

4. REFERENCES

a. General Safe Practices for Working with Engineered Nanomaterials in Research Laboratories, Department of Health and Human Services (DHHS) [National Institute for Occupational Safety and Health (NIOSH)] Publication Number 2012-147.

b. Current Intelligence Bulletin 63: Occupational Exposure to Titanium Dioxide DHHS (NIOSH) Publication 2011-160.

c. Current Intelligence Bulletin 65: Occupational Exposure to Carbon Nanotubes and Nanofibers, DHHS (NIOSH) Publication Number 2013-145.

[1] Terms are defined in Section 7; acronyms are defined in Section 8.

d. Approaches to Safe Nanotechnology: Managing the Health and Safety Concerns Associated with Engineered Nanomaterials, DHHS (NIOSH) Publication Number 2009-125.

e. Safe Nanotechnology in the Workplace, DHHS (NIOSH) Publication Number 2008-112.

f. U.S. Environmental Protection Agency: Nanotechnology White Paper, EPA 100/B-07/001, February 2007.

g. American National Standard, Occupational and Educational Eye and Face Protection, ANSI Z87.1-1989 (or more recent version).

5. APPLICABLE NIST OCCUPATIONAL SAFETY AND HEALTH SUBORDERS

a. NIST S 7101.20: Work and Worker Authorization Based on Hazard Reviews

b. NIST S 7101.21: Personal Protective Equipment;

c. NIST S 7101.58: Respiratory Protection;

d. NIST S 7101.59: Chemical Hazard Communication; and

e. NIST S 7101.22: Hazard Signage.

6. REQUIREMENTS

Using DENMs at NIST requires OUs to be aware of their potential hazards and to provide their employees and associates with a workplace free from the recognized hazards.

These elements entail identification of potential hazards, implementation of engineering and administrative controls, guidance on the selection of PPE, and training.

a. Hazard Review Process

(1) DENMs shall be identified prior to commencement of new processes and changes to existing processes in the work area.

(2) The hazard review process shall include the following considerations to minimize the hazards of and the possibility of exposure to DENMs:

(a) Selection of DENM forms, quantities, and processes;

i. DENMs used in dry (e.g., powder) form, embedded in solid materials, or suspended in liquids all have the potential to become airborne and inhaled, depending on how they are used. Processes involving, but not limited to, the following have the potential to result in airborne DENMs in the surrounding environment:

(i) The use of dry DENMs or DENM-containing dry materials;

(ii) The abrading, cutting, cleaving, breaking, or crushing of DENM-containing solid materials;

(iii) The intentional or unintentional aerosolization of DENM-containing liquids; or

(iv) The production or handling of DENM-containing byproducts, such as those resulting from the evaporation of DENM-containing liquids.

(b) All routes of possible exposure to DENMs, including inhalation, ingestion, injection, and dermal contact (including eye and other mucus membranes);

(c) The properties of the precursor materials as well as those of the resulting nanomaterial product; and

(d) The need for DENM-specific spill-containment and cleanup equipment and procedures.

(3) If the hazard review process identifies a potential exposure to DENMs, then a consultation should be scheduled with a competent person to perform an exposure assessment, including exposure monitoring, if warranted, and to advise on the applicability of the requirements of this suborder as needed.

b. Engineering Controls

(1) Processes capable of generating airborne DENMs shall be conducted in a recirculating hood equipped with HEPA or ULPA or a chemical fume hood, ideally equipped with HEPA or ULPA.

(a) Laminar-flow clean benches should not be used for DENMs, as these systems are designed for product protection, as opposed to user protection.[2]

(2) Hoods shall be under negative air pressure with respect to the rest of the laboratory space.

(3) Hoods shall be serviced, maintained, and performance tested in accordance with manufacturers' instructions.

(4) In the event that the face velocity on a hood falls outside the range of face velocities specified by the manufacturer, e.g., as indicated by a hood-flow-monitor alarm, work shall stop until the face velocity has been restored to the specified range.

c. Administrative and Work Practice Controls

(a) Upon receipt, packages containing DENMs shall be opened and inspected within a recirculating hood equipped with HEPA or ULPA or a chemical fume hood, ideally equipped with HEPA or ULPA;

(2) When not in use, all forms of DENMs shall be in tightly-closed, chemically-compatible containers[3].

(3) All DENMs shall be segregated and stored according to the hazards associated with constituent chemical properties.

(4) All working surfaces (e.g., benches, glassware, apparatus, exhaust hoods, support equipment) shall be maintained as free as possible of DENM contamination.

(5) Surfaces on which DENMs might settle shall be wiped with a moistened towel or wipe, which shall be disposed of as hazardous waste (see below).

(6) Wet wiping or a dedicated HEPA vacuum shall be used for cleaning DENMs in dry form.
(a) Dry sweeping and the use of compressed air is prohibited.

d. Selection of PPE

(1) PPE selection shall be based on the NIST hazard review process and be in accordance with the requirements of the NIST PPE Program.

[2] If it is necessary to conduct work using a laminar-flow clean bench, schedule a consultation with the OSHE DENM Program Manager.
[3] If DENMs have the potential to react and pressurize a closed container, consult with the DENM Program Manager on obtaining an appropriate container.

(a) Hand protection, when required by the hazard review, shall take into account the properties of the DENMS, the properties of any associated chemicals to be used, and the properties of any byproducts that may result from reactions of the DENMs and associated chemicals.

(b) Eye and face protection, when required by the hazard review, shall, at a minimum, consist of ANSI Z87-compliant safety glasses.

i. Higher levels of eye protection may be necessary depending on the process and type of DENM being used. For example, safety goggles may be required when working with DENMs in liquid form with a potential to aerosolize and enter workers' eyes.

(c) Air-purifying respirators, when required by the hazard review, shall be equipped with a minimum of a P-100 filter.

e. Medical Evaluation

Employees and associates involved in incidents resulting in exposure to DENMs should have a post-incident evaluation conducted and documented by a medical professional.

f. Waste Disposal

Materials contaminated with DENMs, including PPE (e.g., used gloves), cleaning fluids, used HEPA filters, and wipes, shall be placed in sealable, labeled waste containers and disposed of as hazardous waste.[4]

g. Spill Response

(1) General

(a) The spill clean-up procedure below shall be followed if a spill of DENMs occurs and the personnel involved are familiar with the hazards of the spilled material and are confident they can safely control the hazards. Otherwise, the spill shall be reported immediately by calling the Safety Assistance Center at x5375, Option 3.

(2) Spill Clean-Up Procedure

(a) Remove all ignition sources, if possible;

(b) Contain the spill;

[4] Waste disposal procedures and containers can be obtained by calling the Safety Assistance Center at x5375, Option 3.

(c) Before selecting a cleaning method, consider the physical and chemical properties of the DENMs and potential reactions with cleaning materials and equipment (e.g., vacuum cleaner filters and canisters);

(d) If it is necessary to vacuum dry DENMs, ensure that a HEPA vacuum is used and that precautions are taken when changing the filter and/or emptying the vacuum to ensure that DENM's are not reintroduced into the work area;

(e) Dispose of the spill clean-up materials as hazardous waste; and

(f) Prohibit re-entry of the work area until it has been cleared for occupancy..

h. Hazard Signage

If an authoritative government entity has published evidence that a DENM is potentially hazardous, then specific hazard signage with the signal word "***Caution***" shall be posted where the DENMs will be handled (e.g., on recirculating or chemical fume hoods). See Appendix A for example signage.

i. Training

Training provided by OSHE on the DENMs program and activity-specific training required by applicable hazard reviews shall be assigned and documented, and its completion by affected employees and associates recorded in accordance with the requirements, roles and responsibilities of the NIST Safety Education and Training suborder.

j. Records of Hazard Assessments

The results of the exposure assessments conducted by competent persons shall be noted, referenced, or included in the activity-hazard-review documentation.

7. DEFINITIONS

a. Competent Person – A CIH, CSP, or CHMM in the NIST Office of Safety, Health and Environment (OSHE) or another NIST Organizational Unit (OU), a consultant CIH, CSP or CHMM, or an individual directed by a CIH, CSP, or CHMM capable of anticipating, recognizing, controlling, and evaluating potential occupational hazards.

b. Certified Industrial Hygienist (CIH) – An individual who is board certified by the American Board of Industrial Hygiene and has met the minimum requirements for education, experience, and through examination has demonstrated a minimum level of knowledge in occupational health subject areas such as potential nanotechnology hazards.

c. Certified Hazardous Materials Manager (CHMM) – An individual who is board certified by the Institute of Hazardous Materials Management and has met the professional challenge of illustrating competency through education, experience, and examination.

d. Certified Safety Professional (CSP) – An individual who is board certified by the Board of Certified Safety Professionals and has met the professional challenge of illustrating competency through education, experience, and examination.

e. Dispersible Engineered Nanomaterials (DENMs) – Intentionally-produced materials with one or more dimensions between approximately 1 nm and 100 nm that can be dispersed into (or onto) liquid or solid compounds or aerosolized (suspended in a gas).

f. Engineered Nanomaterials (ENMs) – Intentionally–produced materials with one or more dimensions between approximately 1 nm and 100 nm;

g. Engineered Nanoparticles (ENPs) – Intentionally-produced, dispersible particles with two or three dimensions between approximately 1 nm and 100 nm;

h. High–Efficiency Particulate Air (HEPA) Filter – A filter that is at least 99.97% efficient in removing particles 0.3 micrometers in diameter or greater passing through the filter.

i. HEPA vacuum – A vacuum which has been designed with a HEPA filter as the last filtration stage and includes a description of what the term HEPA means. The HEPA vacuum must be designed so that all the air drawn into the machine is expelled through the filter.

j. Shall/Should/May –

(1) Shall (Must or Will): Indicates that the performance of an item is mandatory.

(2) Should: Indicates that the performance of an item is not mandatory, but the full implications of not performing that item must be understood and either justified or carefully weighed before choosing a different course.

(3) May: Indicates that the performance of an item is at the discretion of the individual responsible for the action.

k. Ultra–Low Particulate Air (ULPA) Filter – A filter that is at least 99.9995% efficient in removing particles or particles of 0.12 micrometers in diameter or greater passing through the filter.

l. Work Area – For the purposes of this suborder, a defined space in a workplace where DENMs are produced or used to which there is a reasonable likelihood that workers present in the space could be exposed.

8. ACRONYMS

a. CIH – Certified Industrial Hygienist

b. CHMM – Certified Hazardous Materials Manager

c. CSP – Certified Safety Professional

d. CSO – Chief Safety Officer

e. DENMs – Dispersible Engineered Nanomaterials

f. DHHS – Department of Health and Human Services

g. HEPA – High–Efficiency Particulate Air Filter

h. NIOSH – National Institute for Occupational Safety and Health

i. PPE – Personal Protective Equipment

j. OSHE – Office of Safety, Health and Environment

k. OU – Organizational Unit

l. ULPA – Ultra–Low Particulate Air Filter

9. RESPONSIBILITIES

a. The OUs are responsible for ensuring that the requirements in Section 6 are met.

10. AUTHORITIES

There are no authorities specific to this suborder alone.

11. DIRECTIVE OWNER

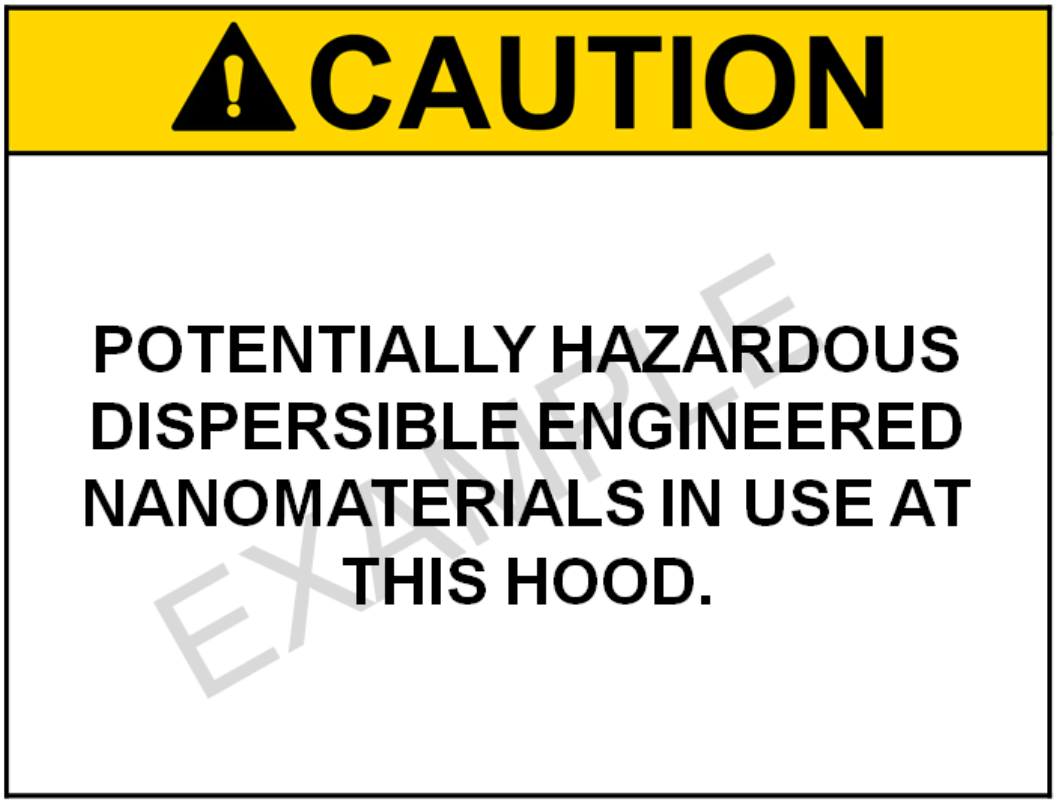
Chief Safety Officer

12. APPENDICES

a. Appendix A. Example Hazard Signage

b. Appendix B. Revision History

Appendix A. Example Hazard Signage



Appendix B. Revision History

Revision No.	Approval Date	Responsible Person	Brief Description of Change; Rationale
1	1/5/21	April Camenisch	Updated suborder links. Added Revision History appendix.