THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Working Safely with Engineered Nanomaterials Guideline

Section 1 - Purpose and Scope

(1) This Guideline applies to all staff and students at The University of Queensland (UQ) working with engineered nanomaterials during nanotechnology related research. The Guideline explains the potential hazards that may apply to working with engineered nanomaterials, provides information for their safe handling and describes the compliance requirements. In some cases, engineered nanoparticles or materials are likely to be classified as hazardous chemicals under the Work Health and Safety Act 2011 based on the physicochemical properties of the actual nanomaterial and/or that of the parent materials. Although workplace hazardous chemicals legislation does not specifically refer to nanomaterials, it deals with substances classified as hazardous chemicals in whatever size, shape or physical state.

(2) This Guideline is to be read in conjunction with other related information such as the policies, procedures and guidelines related to Occupational Hygiene and Chemical Safety and the information found on the hazardous chemicals and controlled substances webpage.

Section 2 - Nanotechnology and Nanomaterials Defined

(3) Nanotechnology is defined as:

a. The design, characterisation, production and application of structures, devices and systems by controlling shape and size at the nanometre (nm) scale.
b. The manufacture of nanoparticles or nanomaterials with at least one dimension less than 100 nanometres to give them useful chemical, physical, electrical or optical properties.

(4) Nanomaterials are categorised by both size and substance, with nanoparticles considered to be those within the nanoscale, or more specifically have at least one dimension within one (1) and 100 nm. As such, a wide range of materials fall under the category of nanomaterials. This means a wide range of potential risk factors encompass nanomaterials, which may be based on size and shape of the nanomaterial but also of the fundamental hazards of the parent or base material from which the nanomaterial or nanoparticles were engineered, and nanomaterial specific hazard/toxicity properties such as:

a. size;
b. surface area;
c. shape;
d. surface charge;
e. chemical composition; and
f. solubility.

(5) Of the engineered nanoparticles, there are many types, including:

a. carbon and inorganic nanotubes;
b. fullerenes (Three-Dimension allotropes of carbon);
c. metals and metal oxides;
d. quantum dots (semiconductor particles); and
e. dendrimers (polymeric molecules).

(6) These represent an incredible array of simple 2-dimensional nanoparticles (e.g., dots), simple 3-dimensional particles (e.g., spheres) and the more complex 3-dimensional matrices. There is evidence that the shape of a nanomaterial can influence its toxicity. This has been demonstrated most coherently for certain high aspect ratio nanomaterials (HARN). High aspect ratio means that one or two of the three dimensions of a particle are much smaller than the other dimension(s). Fibres are a classic example of high aspect ratio materials.

(7) A feature that sets nanoparticles apart from other particles is their relatively large surface area relative to their small size. This is an important aspect, as this relatively large surface area gives these particles an unusually high surface activity compared to their small size, and consequently their potential toxicity.

Section 3 - Risk Management

(8) The scientific community still does not have a good understanding of all the health effects likely to arise from exposure to different types of engineered nanomaterials. Knowledge gaps exist in key areas that are essential for predicting health risks such as routes of exposure, the way nanomaterials are taken up into the body, how nanomaterials are transported once inside the body and the ways in which nanomaterials interact with the body's biological systems. Use, handling and storage must be underpinned by a risk management approach given the wide diversity of nanomaterials and observations that different nanoforms with the same chemical composition can have different toxicological properties. The risk management approach should include:

a. Reviewing information on hazards and risk of engineered nanomaterials, e.g., HSE Understanding the Hazards of Nanomaterials and safety data sheets (SDS) of parent chemicals, and, where available, SDS of the engineered nanomaterial.
b. Prior to commencing work, completing a risk assessment in UQSafe. Risk assessments should consider nanoparticle generating processes; activities which may produce nanoparticles as a by-product; and the safe handling, use, storage, transport and waste management of nanomaterials. The Nanomaterial Control Banding Risk Assessment should be utilised as part of the risk management/assessment process.
c. Maintaining a register of nanomaterials, including the type of research, work and manufacture involved. It is recommended the template available in the Register of Nanomaterial Use and Storage is used.
d. Applying the precautionary principle (see definitions in the Appendix).
e. Appropriate labelling (e.g., nanomaterial, parent or base substance, solvent/carrier solution, relevant risk and safety phrases).
f. Completing SDS to accompany any new or manufactured nanomaterials. The SDS should be created by the designer/manufacturer of the new nanomaterial (this may include the principal researcher). Refer to the Safety Data Sheet Guideline.
g. Providing workers with appropriate information, training and supervision.
h. Evaluating the effectiveness of current nanoparticle exposure controls.

Controlling Exposure to Nanomaterials

Inhalation

(9) When nanoparticles are released into the air, in nearly all situations, they will rapidly aggregate/agglomerate so

that exposure in practice is to a much larger secondary particle than a nano-sized primary particle. The size of secondary particle will influence the residence time of the material in workroom air and may reduce the potential for a nanomaterial to be inhaled. When handling nanoparticles, containment and local extraction ventilation should be used to keep nanoparticles away from workers. Airborne nanoparticles can be relatively easily collected and retained in fume hoods and biosafety cabinets with high efficiency particle air (HEPA) filters. If nanomaterials are used in conjunction with other chemicals or biohazard materials, additional hazards may also be present.

(10) When manufacturing nanomaterials the following should be observed/noted and informed by a risk assessment:

a. Synthesis in enclosed reactors or glove boxes will assist in preventing airborne exposures.
b. Inhalation exposures can occur when processing materials and when materials are removed from reactors. Therefore, these activities should be performed in fume hoods and biosafety cabinets with HEPA filters.
c. Maintenance on reactor parts may cause the release of residual particles and should be performed in a fume hood or Biosafety Cabinet with a HEPA filter installed.
d. Care should be taken when working with nanomaterials in solution to ensure that evaporation does not occur causing free nanoparticles. If this is a possibility, the work should be carried out in a fume hood or biosafety cabinet.
e. Work techniques should be slow and careful to prevent materials from being aerosolised.

Skin Exposure

(11) Since the ability of nanoparticles to penetrate skin varies dependent upon its physicochemical properties, gloves should be worn when handling particulates or particles in solution.

(12) In all cases, the material and thickness of the gloves should be considered.

(13) The porosity and pore size of the glove should be considered, since some nanomaterials such as fibrils, are more likely to enter via gloves (such as latex) which may have a porous surface.

(14) For liquids, the glove should have good chemical resistance to the solute.

(15) For dry particulate, a sturdy glove, such as nitrile or PVC lab gloves with good integrity, should be used.

(16) Disposable nitrile or PVC lab gloves should provide good protection for most lab procedures that do not involve extensive skin contact. If contact is extensive, then gloves should be changed regularly (e.g., every 15 minutes).

(17) There should be no exposed skin around the hands and wrists.

(18) Gloves should be regularly checked for holes, cracks, etc.

(19) Hands should be washed immediately after removing gloves.

Ingestion

(20) Ingestion is not normally a route of exposure in laboratory environments provided that good hygienic principles are followed such as:

a. Avoid hand-to-mouth contact.
b. Wear gloves at all times where there is potential for exposure to nanoparticles.
c. Wash hands immediately after removing gloves.
d. No eating, drinking, smoking, applying cosmetics, etc., in the lab or before hands are washed.

Injection

(21) Injection of nanoparticles may be a risk if the work involves the use of needles, capillary tubes or other sharps:

a. The use of syringes and needles, glass Pasteur pipettes, and other sharps such as scalpels, razors, and suture needles should be minimised.
b. It is important to follow safe laboratory sharps work procedures, to avoid accidental injection.
c. Used sharps and contaminated broken glassware must be disposed of into sharps containers as soon as possible. The sharps containers must be labelled appropriately, puncture-resistant, leak-proof, and closed for transport. Containers must be located where sharps can be disposed of immediately after use.

Clean-up

(22) Use dampened cloths to wipe up powders. Apply absorbent materials suitable for the solution for large liquid spills. Never use dry sweeping or compressed air as a clean-up method. Where the inhalation risk of a nanoparticle is considered high, use a fit tested P2 respirator and double gloves when cleaning up large spills.

Disposal

(23) Proper disposal of nanomaterial waste will be based on the type of material and will be coordinated through UQ systems, in accordance with the UQ Chemical Waste Operating Procedure.

(24) Nanomaterial waste must never be disposed as general waste, nor can it be sewered.

(25) Dry nanomaterial waste should be contained in a sealed container that will remain closed.

(26) When disposing of nanomaterial waste, including contaminated debris, consideration should be given to the nature of the nanomaterial, the solvent and the parent or base material.

(27) If the nanoparticles are suspended in solution, consideration should be given to the nature of the carrier solution or solvent (e.g., flammable solvents are handled as flammable waste materials) as well as the parent or base material of the nanoparticles.

(28) Labelling of nanomaterial waste must include both the carrier solution and the parent or base material and identified as containing nanoparticles.

Section 4 - Appendix

Term	Definition
Nanoparticle	Any particle between one (1) and 100 nanometres in size.
Nanomaterial	Any material of which a single unit is sized, in at least one dimension, between one (1) and 100 nanometres.
Precautionary principle	When an activity raises threats to the environment or human health, precautionary measures should be taken, even if some cause-and-effect relationships are not fully established scientifically.

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