Managing risks associated with hazardous chemicals in the workplace involves identifying hazards and eliminating or minimising risks. A key part of this work involves ensuring workplace controls are effective through the measurement of airborne contaminants.

Safe Work Australia commissioned the Queensland University of Technology and Workplace Health and Safety Queensland to examine methods for measuring airborne nanomaterials and to gather data on nanomaterials emissions and exposures in workplaces. This study involved investigating the operations of six nanotechnology processes, with a number of different engineered nanomaterials. Findings are described in the report entitled: *Measurements of Particle Emissions from Nanotechnology Processes, with Assessment of Measuring Techniques and Workplace Controls.*

**Approach for nanomaterials emissions and exposure measurement**

The report finds a three-tiered approach is effective in assessing workers’ exposure, using readily available handheld measuring instruments and conventional sampling techniques for airborne particles. Results from the assessment are used to determine whether the process needs further control.

The Tier One assessment is undertaken first, followed by Tier Two and finally Tier Three, if required. It may not be necessary to undertake all three tiers of assessment. The findings of Tier One and/or Tier Two may be sufficient to identify that; (a) controls are effective, or (b) work needs to be done to improve controls and prevent exposure.

**Tier One**
The Tier One assessment involves a standard occupational hygiene survey of the process area, plus measurement, to identify likely points of particle emission.

**Tier Two**
Tier Two assessment involves measuring particle number and mass concentration to evaluate emission sources, workers’ breathing zone exposures and effectiveness of workplace controls. A combination of instruments such as a portable condensation particle counter, optical particle counter and photometer can be used effectively.

**Tier Three**
If further information is required, a Tier Three assessment can be undertaken. This involves repeating Tier Two measurements together with simultaneous collection of particles for off-line analysis of particle size, shape and structure and chemical composition. Off-line particle analysis can be compared to real-time measurement results.

As is the case for chemicals generally, the report notes that a nanotechnology process can be considered to require control or further assessment if, based on the assessment results:

- the eight-hour time-weighted average (TWA) exposure exceeds a workplace exposure standard or other particle control value, or
- short term emissions or exposures exceed three times the particle control value for more than a total of 30 minutes per eight-hour working day, or
- a single short term value for emission or exposure exceeds five times the particle control value.

**Use of particle control values, e.g. exposure standards, to decide if controls are effective**

While a person conducting a business or undertaking (PCBU) must ensure that a worker is not exposed to airborne contaminants above the workplace exposure standard, there are very few workplace exposure standards for nanomaterials.
The report notes that workplace exposure standards for macro-sized materials are not necessarily appropriate for controlling risks from nano-sized particles, due to, for example, the high surface area/unit mass of nanomaterials. This is illustrated by the United States National Institute for Occupational Safety and Health’s Recommended Exposure Limits for titanium dioxide, which are based on size and are lower for the smaller sized material:

- 0.3 mg/m$^3$ (ultrafine sized material, i.e. nano-sized)
- 2.4 mg/m$^3$ (fine-sized material)

For comparison, the Australian Workplace Exposure Standard for macro-sized titanium dioxide is 10 mg/m$^3$ (inhalable).

To overcome this lack of workplace exposure standards for nanomaterials, other “particle control values” can be used to manage potential worker exposure. The report proposes using a hierarchy of particle control values when assessing the significance of nanomaterials emission and exposure. The most preferred option (first choice) is at the top of the list, down to the bottom as the last option.

1. A company or laboratory’s in-house control limits – if these are lower, i.e. more stringent, than the Australian Workplace Exposure Standard
2. Australian Workplace Exposure Standards
3. Overseas workplace exposure limits
4. Proposed workplace exposure limits – from research results
5. Benchmark exposure levels – which have consideration of health effects
6. Local particle reference values based on background particle levels

**Effectiveness of engineering controls in minimising potential exposure to nanomaterials**

The report notes that measurement of particle concentrations during the use of local exhaust ventilation (LEV), fume cabinets, mechanical dilution ventilation, and process enclosures confirmed that all of the control measures were able to reduce nanomaterial exposure and emission by orders of magnitude in particle concentration. The report recommends the minimum capture velocity for ventilation systems should be at least 0.25 m/sec, and the LEV hood or hoods be positioned close to the particle source and be in a position which removes particles from the breathing zone of workers.

**Application to hazardous chemicals generally**

The measurement approaches, engineering controls and particle control values described above may be applied to the control of incidental nanomaterials and other emitted particles, for example fume produced by processes, in a similar way to engineered nanomaterials. The hierarchy of particle control values can be applied for chemicals generally.

**Contribution to international knowledge on nanomaterials**

Results from this research are contributing to the international knowledge base and understanding of the hazards, risks and workplace controls for nanomaterials. A report based on this research has been provided to the OECD Working Party for Manufactured Nanomaterials for review and publication.

**More information**


Further information can be found in the OECD WPMN document *Emission Assessment for the Identification of Sources and Release of Airborne Manufactured Nanomaterials in the Workplace: Compilation of Existing Guidance.*

http://www.oecd.org/dataoecd/15/60/43289645.pdf

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