NSW GOVERNMENT | Chief Scientist & Engineer

# Expert Technical Advice Regarding Trolex AIR XS Silica Monitor – Summary Report

**1 December 2025**

**Acknowledgement of Country**

The Office of the Chief Scientist & Engineer acknowledges the Traditional Custodians of the lands where we work and live. We celebrate the diversity of Aboriginal peoples and their ongoing cultures and connections to the lands and waters of NSW.

We pay our respects to Elders past, present and emerging, and acknowledge the Aboriginal and Torres Strait Islander people that contributed to the development of this Report.

Expert technical advice regarding Trolex AIR XS Silica Monitor
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Office of the Chief Scientist & Engineer

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1 December 2025

**The Hon Sophie Cotsis MP**
Minister for Industrial Relations
Minister for Work Health and Safety

Dear Minister Cotsis,

**Re: Specialised technical advice regarding Trolex AIR XS Silica Monitor**

In February 2024, you requested that the Chief Scientist & Engineer facilitate independent scientific and technical advice to SafeWork NSW in relation to the efficacy of a real-time silica monitor, the Trolex AIR XS.

The Office of the Chief Scientist & Engineer (OCSE) facilitated the engagement of two experts, Dr Erik Schartner (University of Adelaide) and Carl Strautins (Safe Environments Pty Ltd), to undertake independent assessments on the Trolex AIR XS. The Terms of Reference for this advice can be found at Appendix A. These experts have delivered their assessments to OCSE, which have in turn been provided to Safework NSW and Trolex Ltd.

The attached summary report prepared by OCSE provides an overview of the key themes contained in these independent assessments.

Devices intended for use in the protection of human health must have clearly defined measures of efficacy in specific use-cases which calibrate observed measurements to relevant standards and/or workplace exposure limits. SafeWork NSW, and the NSW Government more broadly, should state a clear definition of efficacy related to the desired outcome (i.e. the purpose of the device) when procuring new technology.

The expert assessors were unable to make definitive conclusions on the efficacy of the Trolex Air XS device based on the data presented. While the data supporting the Trolex Monitor as an indicative real-time RCS device is promising, further trials and supporting analysis is required to make a definitive assessment of its efficacy. Further, any limitations of the device need to be clearly communicated to end-users such that they can make an informed decision as to whether it would fulfil their workplace safety requirements.

As such, until the efficacy of the Trolex Monitor has been demonstrated and clearly communicated to end users, it should not be solely relied upon for real-time RCS measures and the protection of human health.

Yours sincerely,

H. Durrant-Whyte.

**Prof. Hugh Durrant-Whyte**
**NSW Chief Scientist & Engineer**

# Background

## Process of the technical review

In February 2024, the Hon. Sophie Cotsis MP, Minister for Industrial Relations and Minister for Work Health and Safety, wrote to the Hon. Anoulack Chanthivong MP, Minister for Innovation, Science and Technology, requesting that the NSW Chief Scientist & Engineer provide expert technical advice to SafeWork NSW in relation to the independent testing of a real-time silica monitor, the Trolex AIR XS monitor (the 'Trolex Monitor').

As set out in the Terms of Reference (ToR; Appendix A), the Office of the NSW Chief Scientist & Engineer (OCSE) facilitated the engagement of two experts to undertake independent technical reviews of the Trolex Monitor on behalf of Safework NSW. The experts were selected based on complementary knowledge and expertise relevant to the TOR in material chemistry, sensing or detection technology, sampling methods, data analysis, commercial and industrial applications, and occupational health and safety, and with careful consideration of any conflicts of interest.

The experts were:

- **Carl Strautins**, Epidemiologist, Occupational Hygienist & Materials Scientist and Managing Director, Safe Environments Pty Ltd
- **Dr Erik Schartner**, School of Physics, Chemistry and Earth Sciences, University of Adelaide

The experts conducted a desktop review primarily based on technical documents provided by SafeWork NSW and Trolex Ltd. These included research reports, testing reports, independent studies, case studies and discussions regarding the development of the Trolex Monitor. The experts undertook their assessments independently of each other.

The experts presented their initial findings to OCSE, which informed two workshops in July 2025, one with SafeWork NSW and the other with Trolex Ltd. These workshops allowed SafeWork NSW and Trolex Ltd to address any queries and submit further information or data to assist in the final expert assessments, which were delivered to OCSE in September 2025.

This report has been prepared by OCSE to provide a summary of the review process and findings from expert assessments.

## Respirable Crystalline Silica (RCS)

Silica (silicon dioxide, $SiO_2$) is a common mineral in rocks and soils, occurring in both non-crystalline (e.g. diatomaceous earth) and crystalline (e.g. sandstone, quartz) forms. Respirable Crystalline Silica (RCS) refers to small crystalline silica particles generated in workplaces by cutting, grinding or polishing silica-based materials. RCS is prevalent in industries such as mining/earthworks and in the installation of engineered stone (kitchen countertops). RCS particles impact human health once inhaled, where they can cause significant injury and disease (silicosis) as they penetrate deeper into lung tissues.

Under NSW WHS Regulations, crystalline silica is a restricted hazardous chemical, and employers must manage risks associated with RCS for their workforce. The current NSW workplace exposure standard (WES) for RCS is 0.05 mg/m$^3$ over an 8-hour time-weighted average (TWA), with requirements on employers to use preventative actions such as air and health monitoring to ensure workers' safety.

## The Trolex AIR XS device

SafeWork NSW's Work Health and Safety Roadmaps, from 2016 to 2022[1], included a target to reduce workplace exposure to priority hazardous chemicals and materials by 30 per cent[2] and was supported by the 2017-2022 Hazardous Chemicals and Materials Exposures Baselines and Reduction Strategy[3]. This Strategy specifically identifies crystalline silica as one of the two priority chemicals (formaldehyde being the other).

To this end, in 2018 SafeWork NSW sought a research partner to develop a device that would detect the presence of RCS in workplaces in real-time[4]. This procurement process has been subject to other investigations[5], and is mentioned here for context only. This process led to the engagement of Trolex Ltd to develop the Trolex AIR XS Monitor (the 'Trolex Monitor'). As described on the Trolex website:

> "*The Trolex TX8100 AIR XS Silica Monitor is the first and only product in the world to detect and distinguish respirable crystalline silica (RCS) in real time. Designed to function in challenging industrial environments, it detects all forms of crystalline silica and can track changing levels of RCS in complex dust mixtures over time*."[6]

Importantly, the experts note in their technical assessments that different versions of the Trolex Monitor were tested throughout the development and trial stages, and presented in the data provided for assessment. However, the versions used in various tests (including any specific testing of the TX8100) were not always explicitly stated.

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[1] These were the relevant Roadmaps at the time the Trolex Monitor was developed; the 2022 Roadmap has subsequently been superseded by the 2023 Roadmap and SafeWork NSW Strategic Plan 2024-2029, which both retain the 30% target https://www.safework.nsw.gov.au/about-us/our-strategy

[2] SafeWork NSW's *Work Health and Safety Roadmaps 2022*; Action Area 2

[3] 2017-2022 *Hazardous Chemicals and Materials Exposures Baseline and Reduction Strategy*, https://www.safework.nsw.gov.au/__data/assets/pdf_file/0004/320278/2017-2022-Hazardous-chemicals-and-materials-exposure-baseline-and-reduction-strategy-SW08592.pdf

[4] Audit Office (27 February 2024) 2017-2022 *Hazardous Chemicals and Materials Exposures Baseline and Reduction Strategy*, https://www.audit.nsw.gov.au/sites/default/files/documents/Final%20Report%20-%20SafeWork%20NSW.pdf

[5] This includes the NSW Audit Office investigation into SafeWork NSW's performance in regulatory compliance functions for work health and safety in NSW (SafeWork NSW (2024) *Effectiveness of SafeWork NSW in exercising its compliance functions*, https://www.audit.nsw.gov.au/our-work/reports/effectiveness-of-safework-nsw-in-exercising-its-compliance-functions. Further, SafeWork NSW was referred to the Independent Commission Against Corruption (ICAC) over the handling of the contract (report pending).

[6] Trolex AIR XS description, viewed 18 September 2025 at https://trolex.com/product/air-xs/

# Summary of key findings from expert assessments

This report provides a high-level summary of two independent expert technical assessments of the Trolex Air XS device claims and performance specifications, and whether these are supported by the presented trial data and accompanying information. These assessments are based on data supplied by both SafeWork NSW and Trolex Ltd, as well as follow-up consultation with both parties.

The commercial-in-confidence nature of the data on which these assessments are based precludes disclosure of detailed findings and supporting analysis contained within the assessments. However, both independent assessments have been provided in full to Safe Work NSW and Trolex Ltd.

Some of the insights discussed below are applicable more generally to any device used for indicative measurements of airborne contaminants. To maintain a distinction on this point, specific findings refer to the 'Trolex Monitor', while general findings use 'monitors' or 'devices'. Similarly, although the Trolex Monitor is designed for applications involving RCS, concepts discussed may also serve as a representative example for other contaminants.

Two key themes were identified by the experts within their assessments: the definition of efficacy, and the appropriate generation and analysis of data to measure the performance of the device against this definition.

## Expert assessment of the Trolex AIR XS Monitor

While the experts found that the data presented in support of the Trolex Monitor as an indicative real-time RCS device is promising, it is not possible to make definitive conclusions on the efficacy of the device without further information and significant additional validation data. Further trials and supporting analysis would be required to conclusively support statements on the efficacy of the Trolex Monitor. Further, relevant supporting data should be peer-reviewed and published to provide greater transparency regarding device performance and limitations. This would increase end-user confidence and is particularly important for devices that do not face regulatory barriers to market. Further, end users should be provided with defined calibration methods to validate the monitor against RCS components in different environments.

In summary, any limitations of the technology (such as in terms of accuracy or specificity) need to be clearly communicated to end-users such that they can make an informed decision as to whether the device would fulfil their workplace safety requirements.

**Key Finding 1**

Independent expert assessments are unable to make definitive conclusions on the efficacy of the Trolex Air XS device based on the data presented. While the data supporting the Trolex Monitor as an indicative real-time RCS device is promising, further trials and supporting analysis would be required to make a definitive assessment of the device’s efficacy.

## Defining efficacy

The experts note that documentation and promotional material for the Trolex Monitor are not clear on proposed use-cases or how efficacy has been evaluated in the context of those use-cases.

Expert assessment of the data and supporting information provided concluded that the Trolex Monitor is intended for use as an indicative monitor, not as a compliance device. While the device is intended to provide real-time monitoring of RCS levels that could inform workplace responses to changes in the work environment, further analysis is necessary to establish its suitability for this use-case. Although both are designed to safeguard human health, compliance and indicative monitoring devices have distinct features and functions:

- Compliance devices provide data in a format/framework (such as time-weighted average concentration) that can be used to ensure that they meet national/international standards and/or regulations.
- Indicative monitors provide data that can signal an early warning about potential exposure or a more general assessment of the work environment, but are typically not suitable for compliance purposes.

Expert assessments stated that to demonstrate efficacy, indicative monitors that target RCS must be capable of sufficient specificity and sensitivity. That is, the ability to reliably identify and differentiate RCS from other materials and to provide quantitative information about the concentration of RCS as it changes over time.

An agreed definition of efficacy within the context of existing regulatory and environment and relevant standards should be established prior to development. This would define specific use-case parameters for the successful development of monitors related to the protection of human health. For example, industry, end-users and regulators need to know if the device can detect exceedances of the relevant standards and/or workplace exposure limits.

**Key Finding 2**

Devices intended for use in the protection of human health must have clearly defined measures of efficacy in specific use-cases which calibrate observed measurements to relevant standards and/or workplace exposure limits.

SafeWork NSW, and the NSW Government more broadly, should state a clear definition of efficacy related to the desired outcome (i.e. the purpose of the device) when procuring new technology.

## Efficacy parameters: selectivity/specificity, sensitivity, accuracy and reliability

To satisfy a reasonable definition of efficacy, trial data related to any device intended for use as an indicative monitor should demonstrate the following capabilities:

- Selectivity/specificity and sensitivity to RCS (i.e. detection and quantification of only RCS among a mixture of materials)
- Reliability and accuracy in measurements.

These criteria are essential to ensure any air-monitoring method (whether gravimetric, analytical, or direct-reading) produce results that are scientifically valid and provide meaningful data in workplace safety monitoring. Supporting statistical analysis of trial data, including examination of error margins and uncertainty, is also important in demonstrating the efficacy of any device for end-users.

Selectivity/specificity refer to the ability of a device to detect material of interest only within a heterogeneous mixture. Selectivity/specificity are particularly important when considering how a device would be deployed and used in real-world environments. In environments containing dust of mixed composition, reduced selectivity/specificity could lead to false-positives (i.e. incorrectly identifying non-RCS material as RCS) or, more significantly from a health perspective, false-negatives (i.e. not accurately identifying the presence of actual RCS among other non-RCS material).

With respect to the Trolex Monitor and its measurement of RCS via light scattering, selectivity/specificity would be the ability to differentiate RCS from other non-silica materials with similar optical properties (i.e. birefringence) and other non-birefringent materials. Birefringence refers to a change in refractive index (a quantity related to the speed that light travels through the material) dependent on polarisation of incident light. Some non-silica materials may exhibit

birefringence comparable to RCS, including naturally occurring minerals (e.g. basalt, amphiboles, feldspars and wollastonite).

Sensitivity of a device refers to the ability of a device to respond to different concentrations and different size compositions of target material particles, which can then be linked to health-based exposure standards. In other words, the ability to accurately quantify the presence of RCS against the NSW workplace exposure standard (WES) for RCS of 0.05 mg/m$^3$ over an 8-hour time-weighted average (TWA)[7]. Monitors should also be validated against sampling conventions and general performance requirements. For example, ISO 7708[8] defines health-related sampling of airborne particle size fractions, and ISO 20581[9] defines procedures for determining the concentration of chemicals in workplace atmospheres.

As RCS does not refer to a single material, origin or size distribution, it is critical to demonstrate the performance of any device in the context of common materials encountered in industry settings that contain RCS. Whilst undertaking device trials using only silica-based mediums is an important step in the development and validation process, further validation against mixed-media is critical to reduce uncertainties associated with any predictive value and/or bias. Therefore, to establish the selectivity /specificity of a device for a target material, the experts stated that the device must demonstrate the capability to distinguish between target (i.e. RCS) and non-target materials. In a trial setting, this could be tested in several ways. For example, conducting trials that include a significant number of variable materials and interferents (different levels and/or combinations of RCS and non-RCS materials, different particle sizes, etc.) would simulate real-world environments prior to testing and deployment in such environments.

To effectively protect human health, the accuracy of a monitor needs to be established using industry benchmarks and/or validation against established reference values. Demonstrating or quantifying the reliability and repeatability of measurements is critical for understanding the overall efficacy of any device. Any indicative monitor should identify and accurately measure RCS concentration and then relate this to public safety (i.e. to workplace exposure limits) within a known error range.

There are existing standards, with defined measures of accuracy and uncertainty, that could provide a framework of measurements for real-time RCS monitors. For example, ISO 20581 sets a relative expanded uncertainty of ≤ 50% error limits (mixtures of airborne particles and vapour) for short-term reference periods. Another example is ISO 24095[10], which provides guidance on validation of RCS measurement using X-ray diffraction and/or Fourier-transform infrared (FTIR) spectroscopy. Alignment with these standards (as examples of potential applicable standards) would enable end-users to directly compare with accepted international references.

These validation measures can then be directly related to calibration factors for end-users, providing guidance to tailor the monitor and monitoring regime to specific requirements and environmental factors using reference values to ensure precise and reliable measurement, and directly link exposure to health outcomes.

[7] SafeWork NSW (2024) Work safely with crystalline silica and engineered stone, https://www.safework.nsw.gov.au/hazards-a-z/hazardous-chemical/priority-chemicals/crystalline-silica/work-safely-with-crystalline-silica-and-engineered-stone

[8] ISO 7708 Air quality – Particle size fraction definitions for health-related sampling (1995, Edition 1) https://www.iso.org/standard/14534.html

[9] ISO 20581 Workplace air – General requirements for the performance of procedures for the measurement of chemical agents (2016, Edition 1) https://www.iso.org/standard/68455.html

[10] ISO 24095 Workplace air – Guidance for the measurement of respirable crystalline silica (2021, Edition 2) https://www.iso.org/standard/69899.html; guidelines are for the quality assurance of measurements of RCS using direct on-filter or indirect XRD or infrared analysis methods.

## Supporting efficacy: experimental design and statistical analysis

To demonstrate device efficacy, a range of experimental and field trials should be designed in such a way that allows for the testing (i.e. performance measurements) against efficacy parameters in a repeatable and reliable manner. The primary aim of such trials would be to define a direct relationship between device measurements and potential exposure thresholds, within defined tolerance limits.

Data generated from these trials should have consistent measures (including timeframes and measurement units) to enable statistical analysis and comparisons. Without appropriate statistical analysis, it is hard to make conclusions on whether a device meets listed specifications in product documentation or meets regulatory and/or standards requirements.

In addition to demonstrating efficacy (within the frameworks described and performance parameters of specificity/sensitivity, accuracy and reliability), data and associated analysis should clearly quantify any uncertainty and/or error ranges. For example, in low-prevalence RCS environments (i.e, with significant presence of other interferences) a small drop in specificity increases uncertainty in predictive values. Another key performance parameter that should be defined is the limit of detection/limit of quantification, which is the lowest concentration at which a device can reliably detect/quantify the target materials.

**Key Finding 3**

Relevant supporting data should be peer-reviewed and published to provide greater transparency regarding device performance and limitations and calibration requirements.

# Appendix 1: Terms of Reference

**Terms of Reference for specialised technical advice regarding Trolex Air XS Silica Monitor**

In February 2024, the Hon Sophie Cotsis MP, Minister for Industrial Relations and Minister for Work Health and Safety, requested the NSW Chief Scientist & Engineer provide independent scientific and technical advice and guidance to SafeWork NSW in relation to the efficacy of a real-time silica monitor, the Trolex Air XS.

The Trolex Air XS Silica Monitor (the **Monitor**) is designed to detect and distinguish respirable crystalline silica in real-time in industrial environments.

The Office of the NSW Chief Scientist & Engineer (**OCSE**) will facilitate engagement by SafeWork NSW of suitable independent experts to:

a) undertake a desktop review of the existing testing and research that has been undertaken on the Monitor to date, including seeking to obtain existing evidence from Trolex UK where relevant and practicable, to advise on the efficacy of the Monitor.
b) if efficacy cannot be determined through the desktop review in a), advise whether a hypothesis and testing protocol can be developed to determine efficacy
c) subject to the outcome of a) and b), provide advice regarding next steps in relation to independent testing of the efficacy of the Monitor

OCSE will identify suitable independent external experts and work with SafeWork NSW to define the scope of work and deliverables and facilitate engagement. SafeWork NSW will directly contract the experts to undertake the studies.

OCSE will assist SafeWork NSW and the experts to undertake the studies, including gaining access to project materials, engaging with stakeholders, reviewing draft work and assisting with technical or scientific questions.

OCSE will publish a summary document of the expert reports on its website (taking into consideration and removing any commercial in confidence information) on completion of the commissioned studies.