RESPIRATORY PROTECTIVE EQUIPMENT INDUSTRY CONSIDERATIONS

Air Quality Working Group Information Package - Part 10 of 12

December 2018

Respiratory Protective Equipment

The Australian Tunnelling Society (ATS) recognises the importance of health and safety in our industry in addition to valuing the strong experience and contribution of its members to support key stakeholders in our ever-growing sector. The ATS recognise that collaboration with industry stakeholders is essential to both raise awareness of the important issue of silica dust control, but also to enable effective strategies to be developed that will ultimately be practical and a positive step forward.

The Air Quality Working Group (AQWG) was formed in 2017 as a collaborative platform to enable industry to work together to develop and implement strategies to improve occupational health outcomes, with an initial focus on respirable crystalline silica ("silica dust").

The AQWG membership collectively produced reference material for purposes of communicating information that currently does not exist in the tunnel construction industry's body of knowledge. There are 12 parts to the information package, and each part must be considered in the context of the other. This document represents Part 10 of 12 total parts as listed in **Table 1**. Documented material is considered to benefit the wider tunnelling industry and therefore is freely available on the ATS website.

Table 1 – Complete list of material produced by the AQWG

Part	Document Title	Document Reference
Part 1	NSW Air Quality Working Group Background & Methodology – Silica Dust Exposure and the Tunnelling Industry	Doc No. AQWG_0_0.07
Part 2	Good Practice to Control Silica Dust Exposure during NSW Tunnel Construction	Doc No. AQWG_1_0.08
Part 3	Silica Dust Awareness Package	Doc No. AQWG_2_0.21
Part 4	Silica Dust Awareness Package Speakers Notes	Doc No. AQWG_2a_0.04
Part 5	Design and Procurement - Industry Considerations	Doc No. AQWG_3_0.09
Part 6	Scrubber System - Case Study	Doc No. AQWG_4_0.09
Part 7	Ventilation During Tunnel Construction - Industry Considerations	Doc No. AQWG_5_0.08
Part 8	Portal Misting System - Case Study	Doc No. AQWG_6_0.05
Part 9	Roadheader Cabin Air Filtration - Case Study	Doc No. AQWG_7_0.06
Part 10	Respiratory Protective Equipment - Industry Considerations	Doc No. AQWG_8_0.07
Part 11	Monitoring RCS Exposure - Industry Considerations	Doc No. AQWG_9_0.07
Part 12	Health Monitoring for NSW Tunnel Construction Workers – Industry Considerations	Doc No. AQWG_10_0.14

This document provides practical information on the use of Respiratory Protective Equipment (RPE) where selected as a method to manage the risks associated with silica dust exposure during the construction of tunnels.

What is RPE and why is it important?

During tunnel construction, particular activities may generate high silica dust concentrations that cannot be controlled entirely through the use of higher-order controls. In such circumstances, RPE is often selected to prevent worker exposure to supplement higher-order control measures (UK HSE, 2013).

Silica dust exposure can lead to the development of silicosis, an incurable lung disease where lung tissue becomes hardened and results in the loss of lung function. RPE is important as it is designed to be worn to prevent the inhalation of air contaminated with silica dust. Like all other forms of personal protective equipment (PPE), RPE selection should be the last option and only considered after the evaluation of all other controls.

Minimum requirements

Methods on the selection, use and maintenance of RPE are prescribed in AS/NZ 1715 and include cleaning and storage to prevent contamination or damage (SAI Global, 2009). The reader is encouraged to consult such reference in addition to this document.

Types of RPE used to control silica dust

RPE used to control silica dust exposure includes full-face or half-face respirators (both re-usable) and disposable half-face respirators, commonly referred to as a “dust mask”. It also includes the use of Powered Air Purifying Respirators (PAPRs) in some cases. Such respirators are fitted with particulate filters, classed as “P1”, “P2” or “P3” which respectively indicate the increased level of protection the filter and specific mask combination affords the wearer.

Protection level

The level of protection a respirator provides against silica dust is termed the expected level of protection. AS1715 specifies the required Minimum Protection Factor (MPF) which is used in the selection of RPE (as well as many other factors) The MPF is dependent on the filter class (P1, P2 or P3) and the type of respirator (e.g. full-face, half-face, air purifying or powered air etc.).

When selecting RPE, the following equation should be applied to determine the MPF:

$$\text{Minimum Protection Factor} = \frac{\text{Silica exposure concentration}}{\text{Silica time adjusted workplace exposure standard (TWA-WES)}}$$

RPE commonly used in the tunnel construction industry is presented in **Table 2** and includes the assigned protection factor afforded where such RPE is used in accordance with the manufacturer’s information and instruction (SAI Global, 2009).

Using RPE correctly

The use of RPE is frequently selected to control silica dust exposure as it is often considered an “easy” control method. In reality, the use of RPE is exceptionally difficult to implement as the correct use and subsequent protection relies on training and personal compliance, the later often requiring continual reinforcement in the workplace.

The correct use of RPE relies on multiple factors, including:

- The provision of training such that the wearer can correctly select, use and maintain the respirator they are required to wear;
- Testing the adequacy of the seal between the RPE and the wearer's face to ensure the wearer is issued with a respirator that "fits" the size and shape of their face;
- The presence of facial hair between the sealing surface of the RPE and the wearers skin (refer to "Clean Shaven" below);
- Replacement of filters (or the disposable respirator); and
- Wearer compliance when exposed to silica.

Respirator Fit Testing

The correct use of RPE relies on an adequate seal between the facepiece of the RPE and the face of the wearer, commonly referred to as a "facial fit". Facial fit is the single most common factor contributing to inward dust leakage and exposure. As such, validated fit test methods should be implemented to determine if the RPE issued "fits" the wearer and to verify the adequacy of the seal against the wearers face when working. There are 2 kinds of fit tests that may be used:

1. Qualitative Fit Test. This involves placing a hood over the workers head (while wearing the respirator), a substance is sprayed inside the hood (e.g. bitrex or saccharin), and the test subject confirms if they can detect the sprayed substance. Fit test kits are available for this purpose, but must only be used by competent persons who know how to conduct a test, recognise invalid results, and can properly clean and maintain the equipment.

2. Quantitative Fit Test. This involves the use of a machine such as a TSI PortaCount for example, to measure the actual amount of leakage into the respirator. As above, only competent persons who know how to conduct a test, recognise invalid results, and can properly clean and maintain the equipment should perform this fit testing.

Clean Shaven

Facial hair significantly influences the adequacy of the seal against the wearers face, resulting in less than adequate protection and leakage. All personnel required to wear respiratory protection that relies on a positive seal against the wearers face must be clean-shaven such that the respirator provides protection as intended.

Figure 1 demonstrates the size of crystalline silica in relation to male facial hair. If respiratory protection is used that relies on correct facial fit to be effective (such as a dust mask for example), then the wearer must be clean shaven to prevent facial hair interfering with that fit. A *Clean Shaven Policy* is typically implemented on tunnelling projects where this type of RPE is used.

Clean-shaven requirements should be documented, signposted, communicated and enforced with all affected workers.

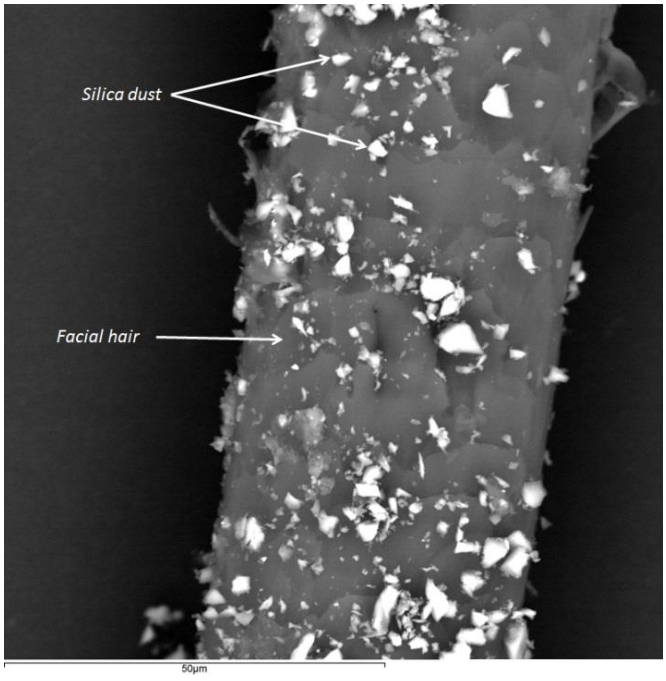

Figure 1 – Male facial hair sized in relation to silica dust. Image obtained through the use of a Scanning Electron Microscope

Note that not all respiratory protection relies on facial fit to be effective. Alternative types of RPE exist that enable the presence of facial hair whilst still maintaining its effectiveness. It is recommended to consult both with the manufacturer of the product intended for use and an occupational hygienist for further advice as needed.

Filters replacement

There are no categorical rules applied to replacing particulate filters as it is influenced by exposure concentrations, the wearers breathing rate and other factors such as environmental humidity (or if the filters become wet). The breathing resistance of the filter will gradually increase as the filter becomes progressively clogged with trapped particles. Therefore, as a general rule, particulate filters should be replaced when the wearer perceives an increased resistance to breathing.

RPE storage

RPE should be stored in a plastic container or bag to prevent contamination, prevent moisture absorption and prevent exposure to sources of heat and exposure to direct sunlight.

When to wear RPE

Results of health risk assessments should be applied to determine designated RPE areas or “zones”. Such areas should be mapped and appropriately signposted or otherwise clearly communicated to all persons working in the area.

RPE should also be worn by persons in circumstances where particular activities are known to generate high silica dust concentrations and should include those persons working proximal to such tasks and activities.

Table 2 – Common types of RPE used in tunnelling and associated Minimum Protection Factors[1]

10 x Minimum Protection Factor (MPF)						
RPE Type	**Reusable half face**			**Disposable half face**		**PAPR**
Example	 **3M 7501/ 7502/ 7503**	 **Scott Safety Profile[2]**	 **CleanSpace 2 Half face**	 **3M 9322A+**	 **3M 8322**	 **3M Adflo PAPR**
Filter	P2 or P3		P3	P2 or P3		P1 *(with any head covering or facepiece)*
≤ 50 x Minimum Protection Factor (MPF)						
RPE Type	**Reusable full face**			**PAPR**		
Example	 **3M 6000 Series**	 **Sundström SR200**		 **3M Adflo TR-302E Powered Air Turbo**		
Filter	P2 replaceable filter			P2 filter *(with any head covering or full facepiece)* P3 *(with any head covering)*		
≤ 100 x Minimum Protection Factor (MPF)						
RPE Type	**Reusable full face**					
Example	 **3M 6000 Series**	 **Moldex 9000 Series**		 **Sundström SR200**	 **Scott Safety Promask Twin**	
Filter	P3 replaceable filter					
> 100 x Minimum Protection Factor (MPF)						
RPE Type	**Full face air-line** *(positive pressure demand or continuous flow modes)*	**Full face air hose** *(with electric blower)*	**Head covering air hose** *(with electrical blower)*	**Head covering air-line** *(continuous flow)*	**PAPR**	
Example	 **3M 6800DIN**				 **3m Powerflow™**	
Filter	N/A				P3 *(with full facepiece or head covering and blouse)*	

[1] RPE selection considerations for mechanically generated silica dust

Disclaimer

This document has been developed by volunteers of the ATS Air Quality Working Group and draws on the collective experience of those working across some of Australia's largest tunnelling projects. The publication comprises 12 parts, and each part should be considered in the context of the other parts.

The information contained in this document is for general information and educational purposes only; it is not a comprehensive list of all factors to be considered when using RPE and is not a substitute for legal or technical advice.

Accordingly, you should consult with appropriate professionals and make your own inquiries as to the suitability of the information for your specific purposes. This document should not be reproduced in whole or in part, in any manner or form, without the prior written permission of the ATS. While details of suppliers are provided, it is noted that the ATS does not make recommendations on specific suppliers or organisations. Material is provided for information only and Contractors would be expected to make independent enquiries as to the suitability of such for their own use.

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Bibliography

SAI Global. (2009). *Selection, Use and Maintenance of Respiratory Protective Equipment.* Sydney, NSW: Standards Australia.

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