

The Measurement of the Exposure of Workers to Respirable Crystalline Silica (RCS)

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Topics

- National and international pressure to reduce the occupational exposure limits for Respirable Crystalline Silica (RCS)
- The work of the organisation for standardisation working group ISO/TC146/SC2/WG 7
 - Air quality/workplace air/silica

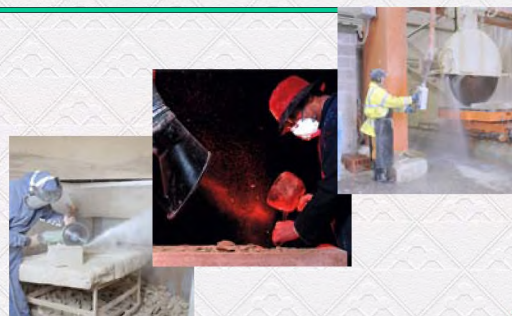


Occupational Exposure to Respirable Crystalline Silica

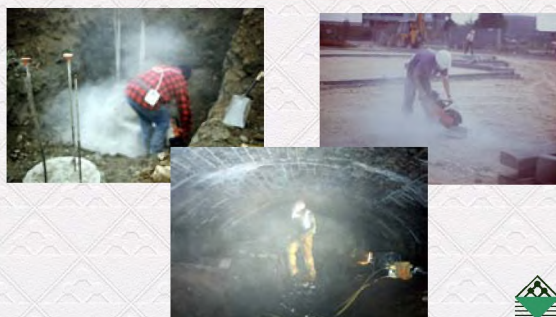
- Crystalline silica is abundant and used in a wide range of materials
- Workers working with silica containing materials represent the largest potentially exposed groups
 - 1.7 million workers in the USA
 - 100,000 workers in the UK



Workplace Exposure



Silica Exposure



Selection of current occupational exposure standards mg.m^{-3}

Country	Quartz	Cristobalite
Germany	0.15	0.15
Austria	0.15	0.15
Netherlands	0.075	0.075
Australia	0.1	0.05
France	0.1	0.05
Belgium	0.1	0.05
Italy	0.05	0.05
Ireland	0.05	0.05



Legislative Position in UK

- Control of Substances Hazardous to Health Regulations (COSHH)

Workplace Exposure Limit (WEL)

0.3 mg.m⁻³ (8 hours TWA)

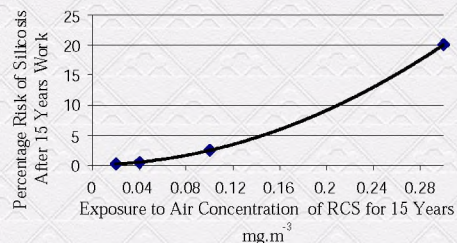
HSE are considering reducing to

0.1 or 0.05 mg.m⁻³

- Medical surveillance recommended at 0.075 mg/m³



Risk of Silicosis



Goals

- Elimination of silicosis
 - Despite improvements a persistent levels remains
- In Europe - it is proposed that to eliminate silicosis the occupational exposure standard should be below 0.05 mg.m⁻³

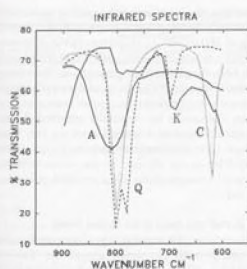


Silica Analysis Methods

- Gravimetric analysis for respirable dust
- X-ray diffraction
 - Direct on-filter analysis
 - Redeposition onto silver filters
- Infrared
 - Direct on-filter analysis
 - Redeposition onto filter
 - KBr Pellet



Infrared spectra



A = Amorphous
C = Cristobalite
K = Kaolin (clay)
Q = Quartz

Source: Madsen, et al. Appl Occ. Environ. Hyg. 10(12): 991-1002 (1995)



Methods in SA

- NIOSH 7602
 - Infrared KBr disc (6 laboratories)
- NIOSH 7500
 - X-ray diffraction - deposition (1 laboratory)
- MDHS 101
 - X-ray diffraction and infrared
 - Direct on air sample filter analysis (1 laboratory)



Limits of detection for XRD

Source	Method	Limit
NIOSH 7500	Re-deposition	5 µg
NIOSH 7602	Re-deposition	5 µg
MDHS 101	Direct analysis	3 - 6 µg



Quality of Measurement

- Primary instrument to ensure compliance with the law
- To enforce the law the precision of measurement must be sufficiently reliable
 - To reduce the incidence of dispute
 - To avoid incorrect interpretation

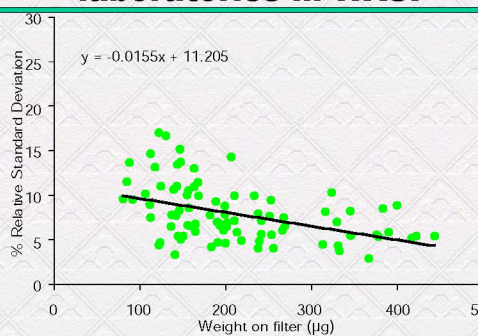


Standards for Analytical Performance

- EN482
 - Uncertainty of occupational hygiene measurements including bias and sampling
 - Within $\pm 30\%$ (0.5 – 2 the exposure limit)
- NIOSH
 - Accuracy including sampling
 - Within $\pm 25\%$



Precision between laboratories in WASP



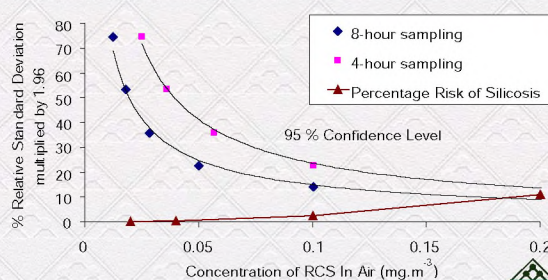
Mass Measured On-Filter

Exposure Limit mg/m ³	8- hour sample µg	4 - hour sample µg
0.3	316	156
0.1	106	53
0.05	53	26
0.025	26	13

WASP Analytical Range 60 – 460 µg



Predicted Between Laboratory Precision



The Challenge

- Some laboratories are not likely to achieve the requirements of EN482
 - especially if interferences are present
- To measure samples of 4 hours duration or less from an air concentration of 0.05 mg.m^{-3}

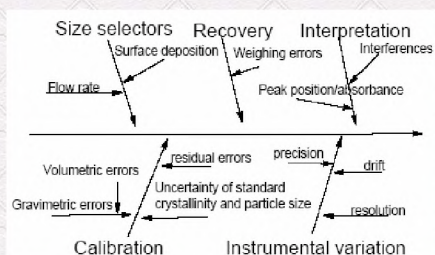


ISO Working Group TC146/SC2/WG7 Silica

- Guidance to ensure the quality of respirable crystalline silica measurements
 - Targeted at analyst
 - Under development
- Guidance for the selection of methods
 - Targeted at end those that commission work
 - May include advice about the interpretation of results
 - Not yet proposed as a new work item



Cause and Effect Diagram



Ensuring quality

- ☐ • Comparing the crystalline content and particle size distribution of the calibration standard against a certified material
- ☐ • Encouraging the measurement of a significant number of calibration standards
- ☐ • Applying recovery and quality control checks and correcting for differences with the expected result
- ☐ • Applying instrumental checks for drift, peak and resolution.
- ☐ • Interpretation



Proficiency testing

- Analysis at low levels involves interpretation
- Interferences
 - Peak shape
 - Movement of peak position
- This adds to the differences of results between laboratories
 - Some countries may demand participation in PT schemes and/or accreditation
 - 'The asbestos precedent' – why not for other disabling lung diseases?



Conclusion

- Precision of measurement is not sufficient to reliably measure at 0.05 mg.m^{-3}
- A multi disciplined approach is needed to help eliminate silicosis



Want to help improve silica measurement ?

- Contact your standards organisation and encourage their participation in our ISO working group
 - TC146/SC2/WG7
 - Air Quality\Workplace Air\Silica

