INDUSTRY SUMMARY REPORT SERIES - 2024

An assessment of the safety regulatory system (SRS) database related to compliance for welding fume, diesel particulate matter (DPM) and respirable crystalline silica (RCS) in Western Australia

Mental Awareness, Respect and Safety (MARS) Centre Research Report

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Summary

Abstract

The Department of Mines, Energy, Industry Regulation and Safety (DEMIRS), an agency of the Western Australian (WA) Government, are the custodians of a substantial historical mining exposure dataset. The Safety Regulatory System (SRS) is arguably one of the world's largest worker exposure databases, with nearly 600,000 occupational exposure assessment results entered to date. The database has a high degree of validity from the mid-1980s, due to the introduction of formalised sampling methodologies, registered samplers, standardised job and location codes and automated quality control checks which were embedded into the system. De-identified exposure data from the SRS was analysed to assess the potential impacts of the recent changes to workplace exposure standards (WESs) for welding fumes (WF), diesel particulate matter (DPM) and respirable crystalline silica (RCS) on industry compliance within the mining sector in Western Australia (WA).

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Welding Fume

The recent reduction of the WES for total welding fume (WF) from 5 mg/m^3 to 1 mg/m^3 created significant challenges for the mining sector in WA, where historical data show a shift from 100% compliance to 100% non-compliance based on mean values and 95% confidence intervals. Welding fume exposure levels have remained consistent over time, underscoring the inadequacy of existing controls to meet the new, stricter WES.

Diesel Particulate Matter

The WA mining sector is managing diesel particulate matter (DPM) exposures well, and there has been a significant decline in exposures over the last decade. Trend modelling shows that compliance with the current WES is achievable. However, the Workplace Exposure Limit (WEL) for DPM proposed to be effective in Dec 2026 is 10 times lower and compliance may be difficult to achieve in an underground environment unless there is a move away from using diesel-powered plant. The WA industry most impacted by the new WES is gold mining, due to its many underground operations. The specific similar exposure groups (SEGs) that are at risk of non-compliance are ground & roof support, loading & transport, long hole drill & blast and production & services. Strategies need to be developed by the regulators and industry to account for the protection provided by respiratory protective equipment as RPE protection may now be considered during worker exposure assessment if all reasonably and practicable higher order controls have been implemented, and RPE is correctly worn (Safe Work Australia 2024d). More guidance from the regulator in the practical implementation of RPE protection is needed.

Respirable Crystalline Silica

The WA mining sector is deemed to be generally compliant with respirable crystalline silica (RCS) exposures as assessed against the 2019 WES of 0.05 mg/m3. Charging & blast, exploration drilling, laboratory technician, quarry labourer and sample preparation are the SEGs that had the highest exposures recorded in the database, but all mean values for 2023 were below the WES. Exploration drilling did have some exceedances above the WES, however, the sampling for these workers did not account for protection provided by RPE.

Implications for exposure control or assessment practice

Welding fume exposures

- The recent reduction of the WESs for total welding fume from 5 mg/m^3 to 1 mg/m^3 will create significant compliance challenges for the mining sector in Western Australia. Existing controls are not likely to reduce exposure levels to below the current WES, as the data indicate that levels have remained consistent over time. Achieving compliance may therefore necessitate substantial enhancements to engineering and other controls. Research supports the effectiveness of local exhaust ventilation (LEV) and on-gun fume extraction systems in lowering fume concentrations (Knott et al., 2023), though these measures are most likely already employed widely within the sector and may still be insufficient if implemented in isolation.
- Welding fume data suggest that achieving compliance with the current WES would likely ensure compliance with other individual contaminants in welding fume, as only 0.42% of compliant samples (n=2 161) recorded exceedances for vanadium (n=2), lead (n=2), manganese (n=1), iron oxide (n=2) and chromium VI (n=2). Most of those exceedances occurred more than a decade ago. The most recent exceedances were two in 2017 and two in 2019. The contaminants being 2 x iron oxide and 2 x lead. More prospective studies designed specifically to test this hypothesis in different settings are warranted to substantiate this finding.
- It has been demonstrated that powered air-purifying respirators (PAPR), integrated with welding helmets, provide the most effective protection for welders, with reductions in fume exposure of up to 99.96% (Knott et al., 2023). Recommending PAPR as industry best practice seems validated, given the established carcinogenicity of welding fumes (Loomis et al., 2022).
- Current sampling methodologies for welding fume require revision; as sampling outside PAPRs does not accurately reflect actual worker exposures, frequently categorising compliant workers as non-compliant.
- Personal sampling for non-welding workers in the same working area or in close proximity to welders is recommended. These workers may not be wearing any RPE whilst welding activities are undertaken and may be at a higher risk of exposure to welding fumes than the PAPR protected welders.

Implications for exposure control or assessment practice

Diesel Particulate and Respirable Crystalline Silica Exposures

- The WA mining industry has been managing exposures to DMP and RCS well, this is confirmed by the downward trend in exposure levels for both contaminants over time.
- Overall mean compliance with the newly proposed WES is achievable, and underground mining operations may require more management.
- Further reductions in exposure levels in underground mining may require phasing out diesel-powered plant as the current exposure levels remained relatively consistent.
- RCS compliance is high and the mean 2023 exposure data is below the WES. Drilling and exploration are still an exposure group where exceedances are recorded.

Respiratory Protective Equipment

- Decreasing WES values necessitate a review of current practices, specifically sampling methods, and exposure assessment reporting requirements, particularly concerning the protection provided by wearing RPE.
- Regulators need to develop guidance materials that the industry can use to report their workers' exposures consistently and efficiently, whilst considering RPE protection factors in accordance with SWA guidance (SWA 2024d).

Next Steps

Further research is needed to investigate the following issues:

- Exposure to welding fumes for unprotected workers employed in the vicinity of welding activities needs to be assessed. These workers could potentially be exposed to airborne hazards, similar to the public health issue of non-smokers being exposed to second-hand smoke.
- The development of standardised methods where the sampling head is placed inside the respirator for all airborne contaminants,
- The development of methods to apply standardised correction factors to samples collected in the breathing zone external to the RPE. These methods should also consider a factor for the uncertainty introduced by inadequate fit.
- The regulation, compliance, and approval of respiratory protection equipment programs.
- Safe Work Australia (SWA) are also currently proposing revisions to WES for nine contaminants where new limits be put to WHS Ministers. These are include benzene, chlorine, copper fumes, formaldehyde, hydrogen cyanide, hydrogen cyanide, hydrogen sulphide, nitrogen dioxide, titanium dioxide and a second review of RCS. The methods employed in this study could be applied to the SRS database to develop appropriate guidance for the industry and the regulator in anticipation of these changes.

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