

OCTOBER 2026 / VERSION 1

Summary of audits and inspections for QGN36

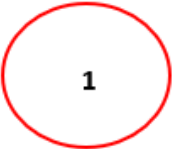


Resources
Safety & Health
Queensland

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1.0 Quick reference summary of audits/inspections

 25 site visits	 ≈ 30% of all coal mine sites	 Most coal companies had at least one site audited or inspected
 Directives	 SCPs	 Improvement Opportunities

Audits and inspections focused on managing exposure to welding fume were conducted by Resources Safety and Health Queensland Occupational Hygiene Inspectors (Coal) between 2022 and 2024.

2.0 Context

In 2017, the International Agency for Research on Cancer (IARC) working group upgraded the classification of welding fume from Group 2B Carcinogen (possibly carcinogenic to humans) to a Group 1 Carcinogen (confirmed human carcinogen) (1). It stated that there was sufficient published evidence to show that exposure to welding fume may cause both short and long-term health effects on the respiratory system and other organs, including asthma, metal fume fever, chronic obstructive pulmonary disease (COPD) and lung cancer. Hence, welding fume exposure should be considered and included within the mine's health risk assessment (HRA), with monitoring conducted to determine workers' exposure to hazards under the Coal Mining Safety and Health Regulation 2017 (CMSHR) (2).

In 2020, Resources Safety and Health Queensland (RSHQ) requested personal welding fume exposure records from all Queensland coal mines. Analysis of this data identified high exceedance rates ($\approx 20\text{--}40\%$), inconsistent results and poor compliance with wearing respiratory protection equipment (RPE) during periods of elevated airborne concentrations. Coal occupational hygiene inspectors conducted a program of inspections and audits across Queensland coal mines. These field activities identified that significant improvement opportunities exist to reduce exposures to acceptable levels at both surface and underground sites. This document provides a summary of those audits and inspections.

Further to this, RSHQ in conjunction with union and industry representatives, developed more detailed guidance material specific for the Queensland coal industry to assist in the assessment and control of welding fume in coal mines. Queensland guidance note 36 (QGN36) was published in December 2025.

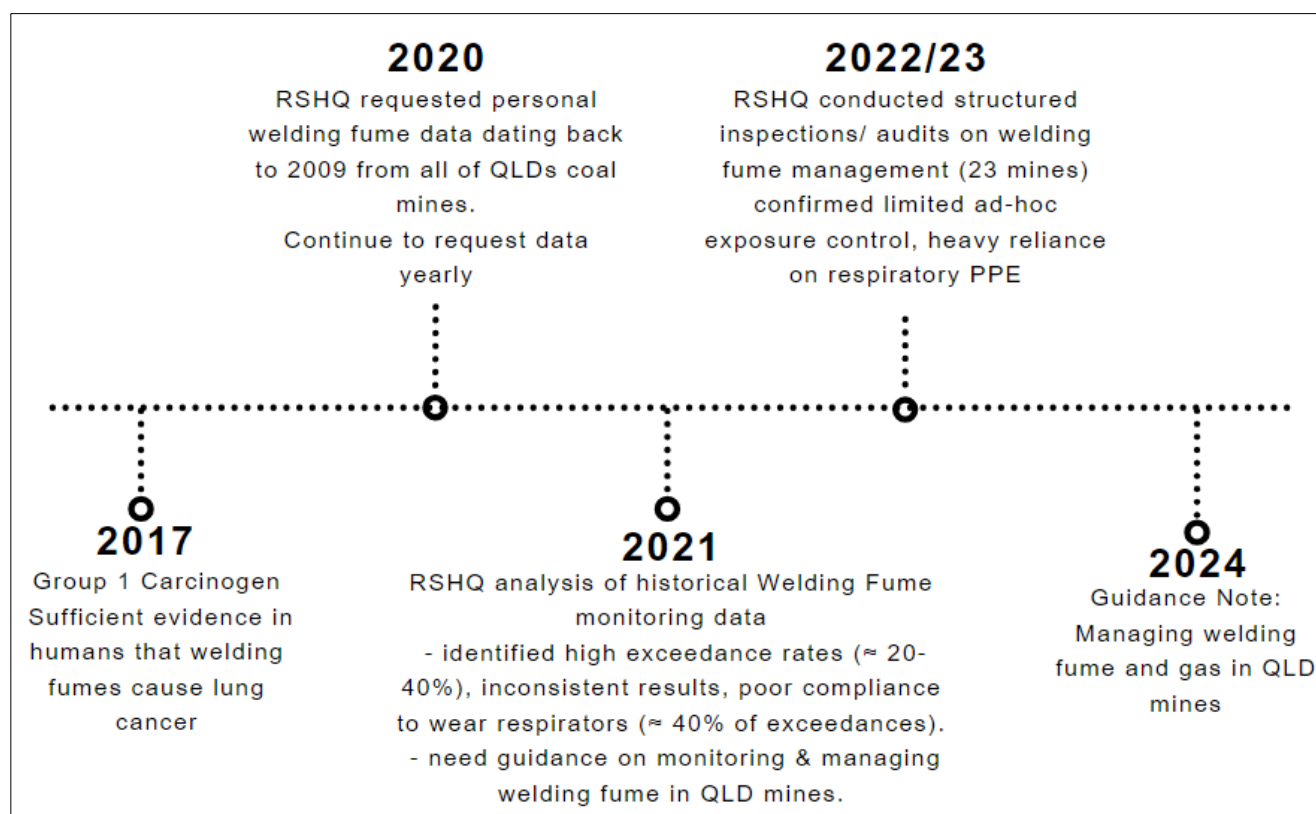


Figure 1: Timeline of recent significant events regarding welding fume in Queensland coal industry

3.0 Introduction

QGN36 provides Queensland coal mines with a framework for managing welding fume exposure on site. It outlines a structured and systematic process for the assessment and control of welding fume exposure and provides guidance on:

- the exposure profile of coal mine workers (CMWs) performing hot work activities in the coal industry
- the common types of hot work processes and consumables used in the coal industry
- defining what constitutes an acceptable level of risk (ALOR) for exposure to welding fume and gases generated during hot work processes
- application of 'risk management' principals to identify, assess and control exposure to an ALOR
- practical and effective guidance for controlling and managing fume and gas exposure from hot work processes on coal mines
- aligning welding fume and gas minimisation strategies with the hierarchy of control
- personal monitoring methods for evaluating exposure risk to CMWs on mine sites
- developing education materials for CMWs performing hot work, focusing on the health effects from exposure to welding fume and gases, and how to control and minimise these exposures.

Prior to the publication of QGN36, audits and inspections undertaken by Queensland coal mine inspectors referenced best practice principles derived from a combination of sources, including the following.

Fume minimisation guidelines from Weld Australia

This guideline (3) focuses on:

- Source control: Emphasises minimising fume generation at the source through the use of low-fume welding processes and consumables.
- Ventilation systems: Recommends local exhaust ventilation (LEV) systems to capture fumes at the source, including on tool extraction systems.
- Work practices: Encourages the implementation of good work practices, including positioning to minimize fume exposure and regular maintenance of equipment.
- Personal protective equipment (PPE): Advocates for the use of appropriate RPE when engineering controls and work practices are insufficient.

Weld fume control guidelines from HSE UK

This guideline (4) focuses on:

- Risk assessment: Stresses conducting a thorough risk assessment to identify potential sources of weld fume exposure.
- Monitoring: Recommends regular monitoring of airborne contaminants to ensure control measures are adequate and remain effective.
- Control measures: Prioritizes engineering controls such as LEV and dilution ventilation, complemented by administrative controls and PPE.
- Training: Highlights the importance of training workers on fume risks and control measures.

Coal Mining Safety and Health Act 1999

Specifically, to ensure that coal mining operations manage exposure to workplace hazards to an ALOR by:

- identifying and implementing controls
- monitoring airborne contaminants
- adhering to exposure limits
- investigating elevated exposures
- maintaining comprehensive documentation and reporting practices. (5)

Recognised Standard 14: Monitoring Airborne Contaminants in Coal Mines

This recognised standard (6) focuses on:

- Sampling strategy: Outlines a strategic approach to sampling, including personal and area sampling to capture representative exposure data.
- Frequency of monitoring: Provides guidance on routine monitoring at regular intervals, with increased frequency during high-risk activities or changes in process conditions.
- Data analysis and reporting: gives detail on the analysis of data to identify trends, assess the effectiveness of control measures, and ensure compliance with exposure limits.

4.0 Overview of inspection/audit program

In late 2022, an audit and inspection regime was initiated by RSHQ occupational hygiene inspectors (Coal). This process concluded in February 2024 after completion of 25 inspections and audits representing approximately 30% of all coal mines and approximately 50% of surface coal mines. Most coal mine operators had at least one of their mine sites inspected or audited.

Emphasis was placed on the following elements of welding fume management and control:

- gaining an understanding of the extent of hot work activities in the Queensland coal industry and the size of the population of CMWs potentially exposed
- understanding the type of welding and allied hot work processes typically undertaken on Queensland coal mines
- understanding the most common types of consumables used during hot work activities on Queensland coal mines
- identifying areas, tasks and similar exposure groups (SEGs) where CMWs may be potentially exposed to welding fume and gases, including during transient shut down work

- identifying current industry best practice for welding fume and gas exposure control
- ensuring welding fume is captured in the mine's HRA process and then subsequently integrated into the mine's safety and health management system (SHMS) to control the exposure and safety risks
- ensuring hot work procedures identify exposure to welding fume as a hazard, and include details on
 - higher order controls such as on tool extraction and LEV
 - the type and level of RPE required to be worn for various hot work activities
- maintenance of RPE including information on consumables and their change outs, as well as RPE inspection and testing schedules
- ensuring sites have processes in place to routinely evaluate welding fume control effectiveness, such as reviewing exceedances to identify opportunity to improve and implement higher order controls
- ensuring sites are providing appropriate level of training and hazard awareness information to CMWs who are undertaking hot work activities.

5.0 Type and extent of hot work activities

In general, the majority of routine hot work activity on coal mines is conducted in situ out in the field for repairs and planned shutdown maintenance activities. This hot work predominantly involves repairs to heavy mobile plant and/or fixed structures in and around coal handling and preparation plants (CHPPs). To a lesser extent hot work to repair or build smaller components of mobile and fixed plant structures is performed inside designated workshops. Welding is periodically conducted inside confined spaces during plant shutdowns and is occasionally conducted in the underground environment.

The majority of coal mines have designated welding bays either as standalone workshops or adjoined to or embedded within other larger workshops, typically used for mobile equipment maintenance. These vary significantly in terms of size, resources and set up. Some sites still have designated bucket shops and undertake significant amounts of intense welding and allied hot works processes in these facilities.

Boilermaker population and welding practices

A survey of welding activities from a representative sample of Queensland's coal mines was conducted by the coal inspectorate between 2022 and 2024 and this provides an indicative estimate of the boilermaker population and typical welding methods and materials being welded.

In summary:

Hot work activities are undertaken by a combination of full-time and contract boilermakers, with other allied trades also performing hot work activities as required. The boilermaker population is approximately 56% full-time employees and 44% contractors (refer **figure 2**).

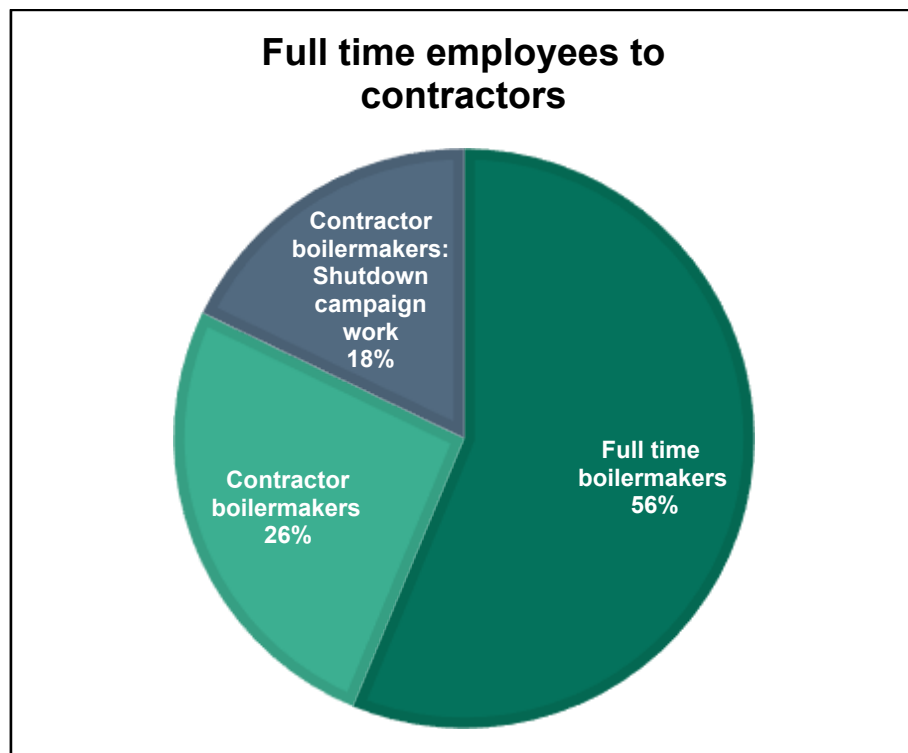


Figure 2: A breakdown of the welding population showing contractors and full-time employees (comprising 711 boilermakers across 27 mine sites)

Welding activities are predominantly conducted on mild steel material. Other materials contribute to less than 20% combined (refer **figure 3**). Note that the level of Hard facing and Bisalloy usage may have been underestimated by inadvertently combining these specialised materials with mild steel, due to framing of the survey questionnaire.

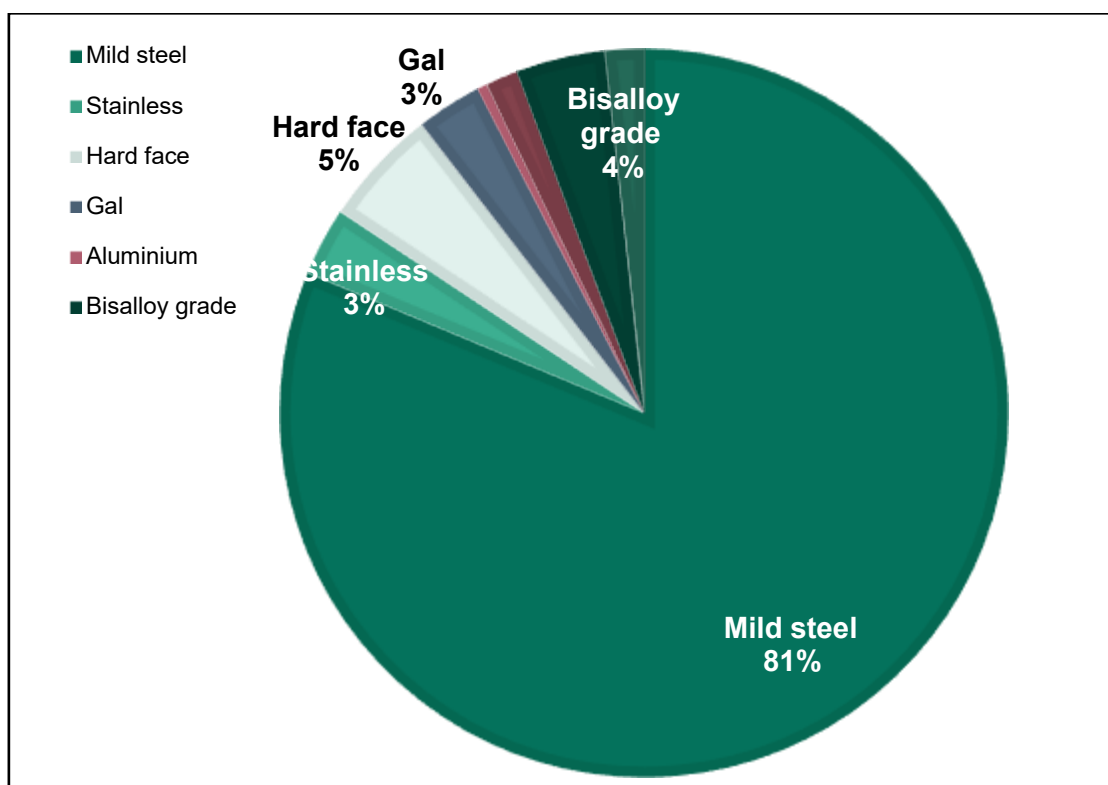


Figure 3: A breakdown of the welding materials used (comprising 555 boilermakers across 23 mine sites)

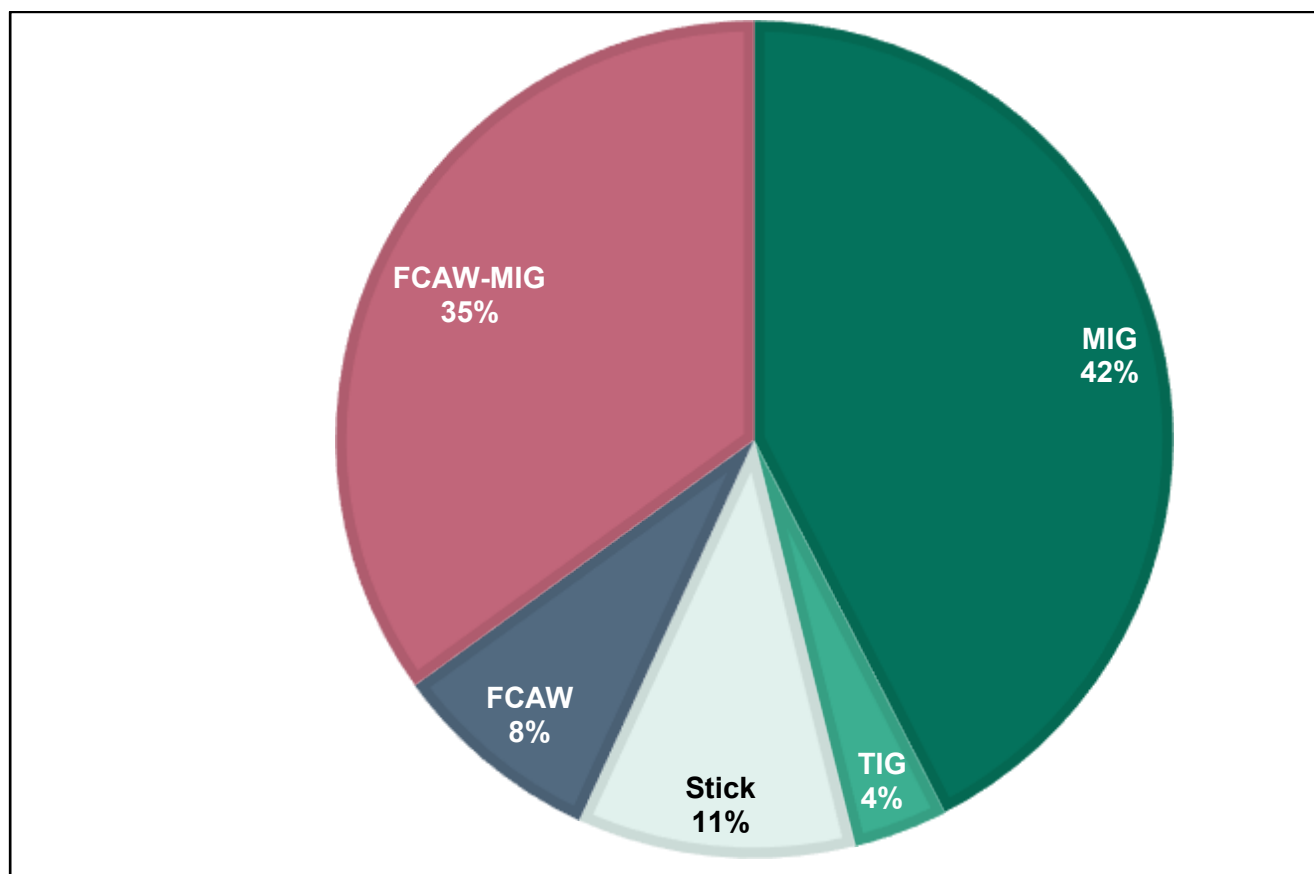


Figure 4: Common weld methods used in Queensland coal industry (comprising 497 boilermakers across 23 mine sites)

The welding methods used are predominantly flux cored arc welding (FCAW) and metal inert gas (MIG) welding methods and to a lesser extent manual metal arc or stick (refer figure 4). TIG is relatively rare in comparison. Note that the level of FCAW-MIG usage may have been underestimated by inadvertently combining this method with MIG, due to framing of the survey questionnaire.

In addition to welding, the other hot work activities conducted were predominantly arc air gouging (63%), and oxy-cutting (30%), with lance cutting, plasma cutting and LPG making up the remainder.

Welding fume exposure

Each year RSHQ requests coal mines to provide records of all personal monitoring for total welding fume, including the individual metal components. RSHQ now holds a dataset comprising of approximately 2,100 valid personal welding fume exposure records. This includes full shift (68% of total) and task based (32% of total) monitoring results with records dating back to 2009.

Figure 5 shows the average total welding fume results from personal exposure samples collected for the boilermaker SEG at coal mines over the last 5 years. Each colour represents a different mine. The average is calculated across a set of generally 6 to 10 samples for each mine. The solid red line was the occupational exposure limit, 5 mg/m³, as applied to 2023 and earlier. The dotted green line is 1 mg/m³, indicating the revised occupational exposure limit published in April 2024 by Safe Work Australia (SWA) in their most recent

review of workplace exposure limits (WEL) (7). It is evident from this data that exposure to welding fume is not being adequately controlled to below the revised WEL.

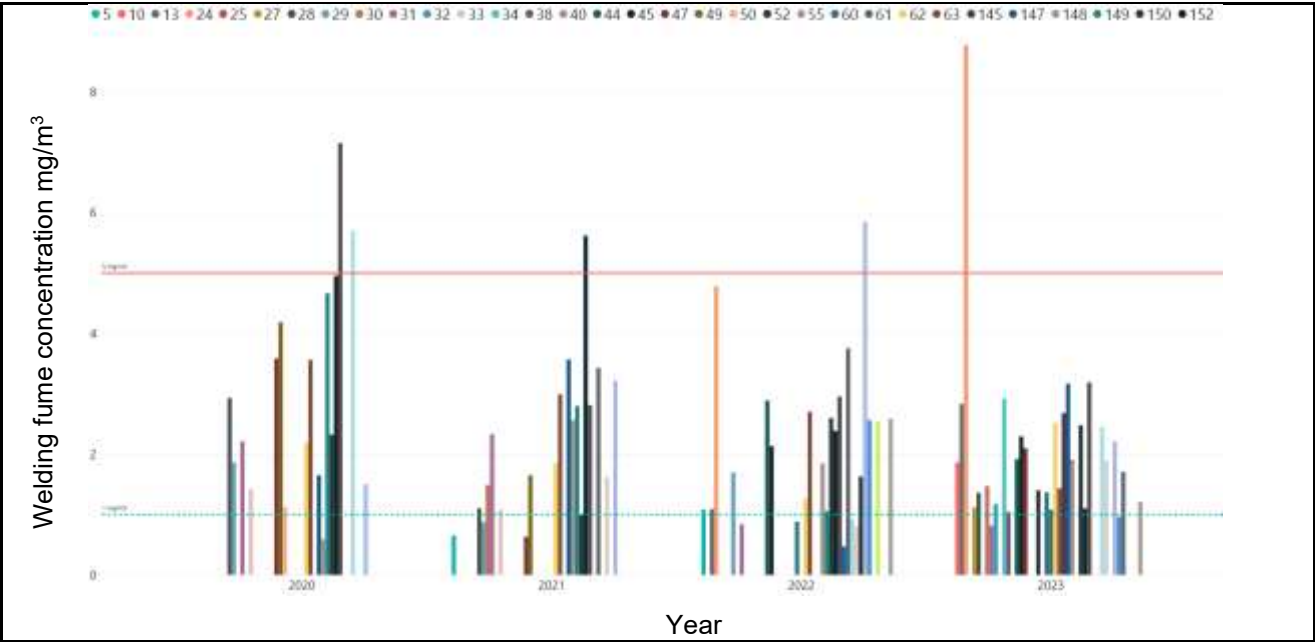


Figure 5: Total welding fume average exposures for boilmakers (includes boilermaker on the surface at both underground sites and surface sites, full shift monitoring only)

In 2023, there were 272 samples reported to RSHQ, from 48 sites, including both full-shift and task-based exposures. **Table 1:** details a breakdown of full-shift monitoring data collected during 2022 and 2023, including the exceedance rate and use of respiratory protective equipment. The table also indicates the large increase in exceedances compared with the reduced occupational exposure limit. The data indicates workers are continuing to be exposed to high levels of welding fume and self reporting that their RPE is not being worn.

Table 1: Monitoring data, showing exceedance rates and the use of RPE across the last few years

Year	# of valid full shift samples	# of exceedances	% exceedance	% of workers who were overexposed and reported not wearing RPE
2022	198	46	23%	8%
2023	213	44	21%	14%
NEW OEL to be introduced and therefore extrapolated 2023 data to show what exceedance data would look like in 2024 with 1mg/m³				
2023 data compared against new WEL	213	130	61%	17%

Corrective actions issued to sites

In general, welding fume management and control was not managed to a high standard and inconsistencies were observed across the mines reviewed. It was found that there was a heavy reliance on RPE as the primary exposure control. The use of these devices is often not adequately supported by documented procedures, maintenance programs and training. Furthermore, the use of practical engineering controls which are now readily available, such as LEV and on tool extraction was observed to have limited implementation across the industry.

As a result of this program there was a total of 30 corrective actions issued across the 25 sites. In addition, there were many areas for opportunity identified. Most sites received at least one corrective action and all sites received multiple recommendations or opportunities for improvement. The corrective actions are broken down as follows.

Directives – 1

Substandard condition or practice (SCPs) – 29

The one directive was pertaining to management of flammable gas and explosion risk. The 29 SCPs are broken down into their respective categories below in **Figure 6**. The need to review hot work procedures, and respiratory protection programs represented 90% of SCPs observed. There were 78 recommendations or opportunities for improvement, and these are detailed in their respective category in **Figure 7**.

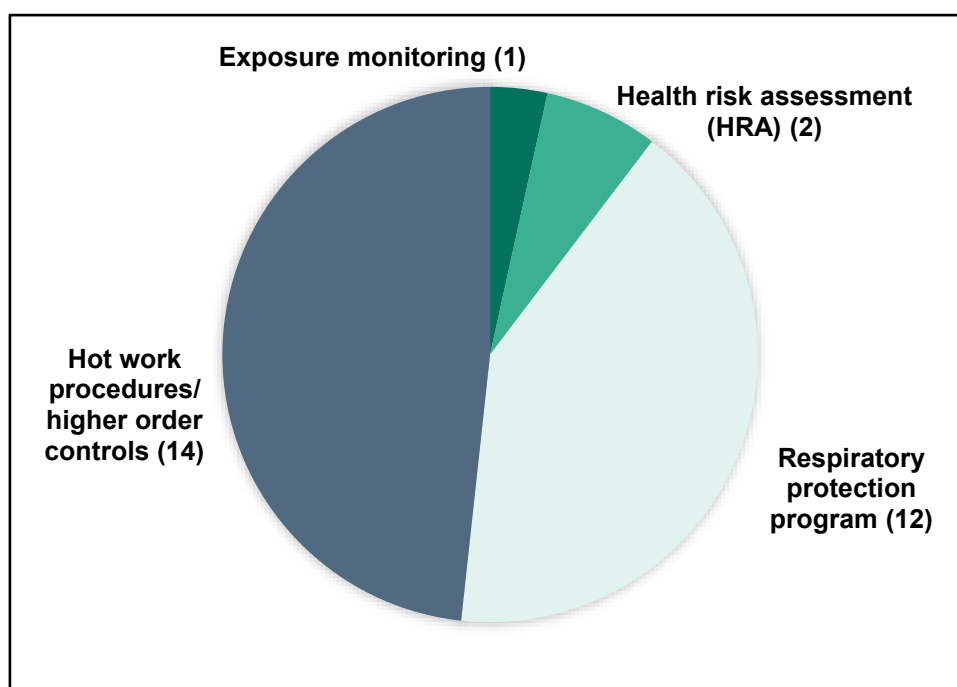


Figure 6: Number of substandard condition or practices issued by category

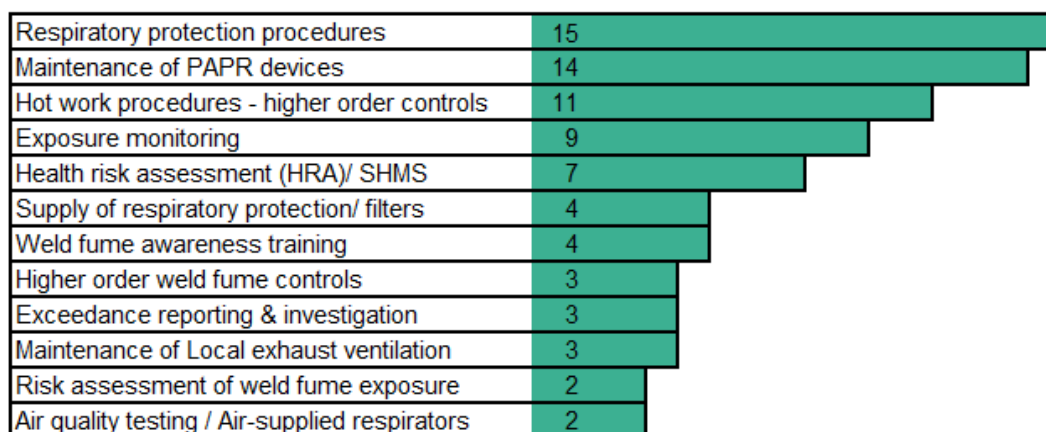


Figure 7: Number of recommendations/opportunities for improvement issued by category

Important discussion points

The following elements were consistently identified, as an improvement opportunity and are discussed in more detail below.

Review risk assessments for welding fume exposure.

Health risk assessments (HRA)

A number of sites were not conducting personal exposure monitoring for welding fume despite the sites HRA determining a moderate to high exposure risk for various SEGs. Reasons given were that the CMWs always wore RPE. In practice, inspections revealed that this was not the case. Another reason is that there is often a disconnect observed between the HRA and the mine's SHMS. It is important that the HRA is integrated into the mine's SHMS.

In general, HRAs conducted at coal mine sites where welding and hot work activities are undertaken must consider exposure to welding fume and gases. This is an important part of the process used to determine the exposure risk profile of the CMWs undertaking these tasks. This must also include contractors and itinerant work groups such as those involved in shutdowns, mine site construction and demobilisation. Where personal exposure data is available, it should be used to assess exposure risk, determine ongoing monitoring requirements, and most importantly determine need for additional controls. If there is no monitoring data available, a baseline monitoring program will be necessary. Recognised standard 14 provides a suitable methodology for establishing a baseline exposure profile and for determining ongoing monitoring requirements. This should be overseen by an occupational hygienist.

The HRA process should be integrated into the mine's SHMS and should be referenced when developing standard operating procedures (SOPs) and/or any related safe work instructions (SWIs).

SHMS requirements (SOPs)

It was observed that many sites failed to identify welding fume and gas exposure as a hazard in their hot work SOPs and/or hot work permits. When undertaking risk assessments for the development of SOPs required under CMSHR section 96C(ii) (2) for cutting and welding, it is essential that exposure to welding fume and gas

is identified as a hazard, risk assessed and controls applied. By applying appropriate risk management, sites can significantly mitigate the risks associated with exposure to welding fume, particularly through application of the control hierarchy and implementation of higher order controls (LEV, on tool extraction systems, automation/robotic welding).

Reviewing exposures

A number of sites were not routinely reviewing personal monitoring results. This was evident by the failure to investigate and act on recorded exceedances. It is important that processes are in place to:

- routinely (e.g. annually) analyse and review welding fume SEG data to understand long-term exposure risk
- review elevated exposures (e.g. those above 50% of the shift adjusted workplace exposure limit) to understand control effectiveness and factors contributing to elevated exposures.

Both of these review processes are an important and necessary part of the process to ensure exposures are managed to as low as reasonably achievable (ALARA).

Review respiratory protection programs

During the inspections, there was a perception from sites that all boilermakers routinely wore high-level RPE including powered air purifying respirators (PAPR). Inspections revealed that this was not always the case. This has also been supported by the historical data revealing that when recording exceedances, up to 15% of boilermakers reported they did not wear respirators. This number increased dramatically for workers who were only monitored for task-based activities.

The audits and inspections also revealed that RPE practices were performed poorly on a large number of sites, highlighting the need for significant improvements.

The areas most notably that required attention include:

- reviewing and updating PPE and RPE procedures to clearly specify the requirements for welding fumes, including what type of RPE is to be worn for the task, the frequency of filter replacements, and the use of organic filters in addition to particulate filters
- making sure that site stores have available the correct RPE type and consumables, including filters and cartridges and fittings
- ensuring regular fit testing of RPE to ensure adequate protection
- ensuring periodic 'air quality' testing of supplied-air type RPE, with documentation in the SHMS in accordance with AS 1715 standards (8)
- ensuring air lines and connection points for supplied-air RPE to be adequately labelled and distinguished from instrument air and other gas supply lines
- ensuring boilermakers understand how to routinely inspect their RPE devices, including checks for leaks, flow, damage to hoses and general cleanliness
- ensuring PAPR is included in the planned equipment maintenance schedule for periodic inspections.

These steps are necessary to improve the overall effectiveness of RPE and ensure welding fume exposure is ALARA.

Recommendations for site senior executives

The following recommendations are made to site senior executives for review and consideration. Inspectors will be on site to discuss how sites have considered/actioned these recommendations, as required:

- Ensure that welding fume is considered and reviewed within the mine's current HRA. The HRA should be integrated into the mine's SHMS.
- The use of PAPR is not a valid reason for not monitoring worker exposure. Mine sites will be asked to justify decisions for not collecting sufficient personal monitoring results to enable exposure assessment.
- There are a significant number of major shutdowns conducted across surface coal mines that involve extensive hot work activities. Mines and occupational hygienists need to consider field maintenance and shut down welding activities when developing and reviewing their monitoring plans.
- Ensure the site's SOPs and SWIs identify welding fume as a primary hazard and include specific controls to manage workers' exposure.
- Continue to review personal welding fume exposure monitoring data periodically and implement controls to maintain exposures ALARA. The principles and processes in Recognised Standard 14 – 'Monitoring respirable dust in coal mines' (6) can be applied to other airborne contaminants such as welding fume.
- Currently there is a heavy reliance on the use of RPE as a primary exposure control. A shift in focus should be placed toward higher level controls such as exhaust ventilation and considering the substitution of reduced fume generating welding processes and parameters, shield gas or filler materials.
- The maintenance and inspection of PAPR, as well as record keeping/documentation with respect to air quality testing of supplied air-line type respirators using supplied air from compressors, needs significant improvement
 - Where PAPR type RPE is worn, these devices should be regularly inspected and maintained within the mine's scheduled maintenance program.
 - Similarly, for in-line filter banks and head coverings used for supplied-air type RPE, these devices should be periodically inspected, tested and maintained.
 - Records of these inspections and maintenance should be kept.
 - Consumables for these devices, such as filters, hoses and fittings, must be readily available in stores or at the boilermaker's workshop.
- Selection of RPE should always be conducted in accordance with Australian Standard AS1716 Respiratory protective devices (9).
 - Where negative pressure and/or close fitting respirators are worn, facial fit testing should be conducted on individual wearers to confirm the level of protection provided is adequate.
- Following the release of 'QGN36: Managing welding fume in coal mines' at the end of 2024, ensure the site has undertaken a gap analysis and has implemented reforms to adequately manage welding fume exposure, to an ALOR.

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7.0 Abbreviations

ALOR	Acceptable Level of Risk
CMSHA	Coal Mining Safety and Health Act 1999
CMSHR	Coal Mining Safety and Health Regulation 2017
CMWs	Coal Mine Workers
COPD	Chronic Obstructive Pulmonary Disease
FCAW	Flux Cored Arc Welding
HRA	Health Risk Assessment
IARC	International Agency for Research on Cancer
LEV	Local Exhaust Ventilation
MIG	Metal Inert Gas
PAPR	Powered Air-Purifying Respirators
PPE	Personal Protective Equipment
RPE	Respiratory Protective Equipment
RSHQ	Resource Safety and Health Queensland
SWA	Safe Work Australia
SCPs	Substandard condition or practice
SEG	Similar Exposure Groups
SHMS	Safety Health Management System
STICK	Manual Metal Arc Welding (MMAW)
TARP	Trigger Action Response Plan
TIG	Tungsten inert gas or Gas Tungsten Arc Welding (GTAW)

Appendix A: Examples of good practice for welding fume exposure



Figure A1: clean working space and designated area for monitoring workers' exposures



Figure A2: Clear signage on the hazards of welding in workshop where welding is conducted



Figure A3: Local exhaust ventilation being used and well maintained



Figure A4: On-tool extraction

Appendix B: Examples of poor practice



Figure A5: Compromised and poorly maintained PAPR



Figure A6: Compromised and poorly maintained PAPR



Figure A7: Poorly maintained LEV systems



Figure A8: Compromised and poorly maintained LEV systems