



GROUP SAFETY STANDARD 8 WORKPLACE VENTILATION

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1. INTENT

This standard details the requirements for achieving a safe and healthy environment for people working within enclosed spaces (such as underground mines) through the provision of air of a suitable quality and quantity.

2. APPLICATION

All IGO sites and projects shall comply with the provisions of this standard, and all relevant legislative requirements for the location.

Where this standard identifies Australian and New Zealand Standards, IGOs international sites and projects shall ensure any other Standards relevant to the location meet the minimum requirements established through this standard.

Sites shall identify and comply with the legal and other requirements, including building codes, relating to:

- Mine ventilation
- Natural and mechanical ventilation systems
- The provision of air of a suitable quality and quantity to enclosed spaces

Workplace ventilation is the supply and movement of air of a suitable quality and quantity within an enclosed space to achieve a safe and healthy environment for people. In the context of IGO activities these enclosed spaces include, but are not limited to:

- Underground
- Processing areas such as gold rooms
- Workshops (particularly those running combustion engines)
- Laboratories
- Offices
- Accommodation and support areas

3. UNDERGROUND VENTILATION

3.1 Underground Ventilation Officer

An Underground Ventilation Officer shall:

- Be appointed at each underground mine
- Have overall responsibility for the mine ventilation, the ventilation system, the ventilation control plan and the plan of the ventilation
- Have access to the legal and other requirements that apply to mine ventilation
- Have the authority, in consultation with management, to close down operations in areas where inadequate ventilation is identified

3.2 Risk Assessment

Each IGO underground mine shall maintain a risk assessment of the ventilation hazards relevant to underground operations. Risk assessments shall involve operators, maintenance, personnel and supervisors as well as people who would typically work in the environment, and shall consider the following:

- Mine design
- Oxygen content
- Toxic and asphyxiant gases
- Flammable gases
- Airborne dust
- Fumes
- Products of combustion
- Humidity
- Temperature
- Naturally occurring radioactive materials (NORMs)

3.3 Ventilation System Design

The mine ventilation system design shall be based on risk assessment and shall be designed to provide air of sufficient volume, velocity and quality to ensure a healthy and safe atmosphere including in a range of potential emergency situations.

A computer-generated model of the mine ventilation system shall be developed and maintained. Ventilation system design shall ensure that:

- Air supplied to the ventilation system is obtained from the purest source available
- Ventilation circuits do not allow uncontrolled airflows to recirculate
- Ventilation plant, equipment and structures are maintained
- Dead-end openings are not worked unless adequate auxiliary ventilation is provided
- No work area at the mine is ventilated with contaminated air. (Change to: No work area at the mine is ventilated with air that is unsafe for breathing i.e. airborne contaminant and gas levels must be below the exposure standard and be as low as reasonably achievable; and the Oxygen concentration must be between 18 % and 22 %.)
- Mine areas that have high working temperatures or high humidity meet the requirements of **IGO Group Occupational Health Standard 3 - Thermal Stress Management** which may require the use of refrigeration systems
- Areas within the mine with the potential to generate large volumes of atmospheric contaminants have a direct connection to the primary exhaust ventilation circuit return airway
- Parallel ventilation circuits are utilised at the mine to ensure that atmospheric contaminant levels in each workplace are minimised (change to: Parallel ventilation circuits are used where possible to minimise contaminant levels in each workplace.)
- Air intake velocities in roadways are managed to control dust generation
- The second means of egress from the mine is protected from contamination by the installation of permanent control devices (change to: Where practical, the second means of egress must be in a fresh air airway. The use of the second means of egress should only be required if the primary egress is blocked. Underground fires may cause air reversals and may affect the safety of the second means of egress.)

The design of ventilation control devices (such as doors and seals) shall be documented and these shall be appropriate for their intended use. The specifications for ventilation control

devices shall be included in the ventilation control plan including their planned mode of operation and signage requirements (e.g. doors left closed or open).

Fans shall be designed, constructed and installed to be fit for purpose and prevent access during operation and unauthorised starting or stopping.

Main fans shall:

- Monitor air volume and pressure, vibration and bearing temperature (change to: Main fans shall be equipped with real-time monitoring of the fan operation and should include but is not limited to pressure, vibration, bearing temperature, airflow and motor current.)
- Have a design which prevents damage in the event of an explosion (consider: The risk of damage by a large catastrophic event involving air pressure such as air blasts, gas or dust explosions and blasting must be assessed, and the primary fan placement and design must consider these risks.
- Have an auxiliary power supply in case of mains supply failure
- Be alarmed to indicate failure
- Have permanent lighting
- Have arrangements to cut the power supply to booster and auxiliary fans in the ventilation circuit supplied by the main fan in the event that the main fan is off

Booster fans shall

- Monitor the operating status of the fan, the air quantity and pressure
- Prevent recirculation
- Allow for the fan to be bypassed in case of failure.
- Have arrangements to cut the power supply to auxiliary fans in the ventilation circuit supplied by the booster fan in the event that the booster fan is off (Consider: The trigger action response plan (TARP) for primary fan failures (including booster fans) must be designed to allow for personnel to be evacuated if the primary ventilation system cannot be restored).

Auxiliary fans shall be designed and installed to prevent recirculation

3.4 Ventilation Control Plan

Each IGO underground mine shall prepare a Ventilation Control Plan based on the outcomes of a risk assessment. The Ventilation Control Plan shall describe the:

- Roles, responsibilities and competencies of personnel with responsibility for ventilation
- The design and management of all aspects of ventilation and the ventilation system for the mine including ventilation control devices, and shall include a plan of the ventilation system
- Control measures to be taken to reduce, dilute or extract the concentration of any airborne contaminants or asphyxiant or explosive gases to meet air quality and safety standards
- Maintenance of the ventilation system
- Inspection, measuring and monitoring required of the system and air quality

- The action to be taken in the event of incidents and non-conformities
- Audit and review requirements

The Ventilation Control Plan shall be reviewed:

- Following changes to the ventilating system or the mine operating system or which may affect the ventilation system.
- Following an incident where ventilation has been identified as a contributing factor
- Following complaints about the ventilation system or when the ventilation system has been found to be inadequate
- After an audit where non conformities related to ventilation are identified

3.5 Plan of the Ventilation System

A plan of the ventilation system for the mine shall be prepared to meet the requirements of **AS4368 (1996) Mine plans - Preparation and symbols** and shall show the:

- Direction, course and volume of air flow (intake air blue, exhaust air red)
- Position of all ventilation stations, air doors, stoppings, fans, regulators and other ventilating plant and structures, fresh air bases, refuge chambers, telephones, secondary egress routes, fire extinguishers, water hydrants etc.

The plan shall be reviewed at least every three months and whenever a change is made.

A copy of the plan of the ventilation system shall be available at all times to the mine rescue team, mine emergency management team and for inspection by the workforce.

3.6 Ventilation System Operation

Procedures shall be in place to ensure that:

- There are no unnecessary activities in the vicinity of the intake airways that could generate dust or fumes
- Dust suppression is provided if needed in the main intake air roadway
- Airways at the mine are maintained free from obstruction except for the purpose of control
- The volume of primary intake air to the mine exceeds the total air volume requirement specified for the diesel equipment operating in the mine at any one time.
- The volume of air flowing into each area of the mine meets the legal requirement for the diesel equipment operating in each of those areas at any one time.
- Each working place ventilated by a multiple duct ventilation system is adequately ventilated
- Barricading, with signage is displayed, to prevent unauthorised entry into temporary unventilated areas.

3.7 Contaminant Control

Procedures shall be in place to ensure that:

- The formation or emission of toxic, asphyxiant and explosive gases in the mine is monitored and controlled

- An evaluation of the potential for oxygen depletion in the underground workings has been carried out
- Contaminants are controlled in all workplaces where blasting and loading operations take place including:
 - the release of ammonia gas due to the reaction between ammonium nitrate and shotcrete is managed
 - blast fumes are cleared from all rise face areas by the use of a compressed air and pipe arrangement following blasting operations
 - the time for blasting fumes to clear from an area is measured or evaluated
 - re-entry processes following blasting are established
 - The hazards associated with stopes being filled with tailings containing residual chemicals are managed.

3.8 Monitoring

The Ventilation Control Plan shall specify the air monitoring that is required to be conducted to confirm that air quality and quantity is adequate. The Ventilation Control Plan shall specify:

- when monitoring shall be undertaken including
- before work commences
- at suitable intervals while work is in progress
- after activities such as blasting
- after a disruption to the ventilation system
- after a change is made that may affect the ventilation or ventilation system
- what shall be monitored including
- direction, course, volume and velocity of air flow
- air quality, including gases, contaminants, temperature and humidity
- air quantity at critical points
- vehicle emissions
- where monitoring is to be undertaken and whether this location is to be signposted
- the sampling method by which the monitoring is to be performed
- who is responsible to undertake the monitoring

Appropriate instruments and equipment shall be available to implement the required monitoring. All measuring equipment shall be maintained and calibrated to manufacturers' specifications.

Records shall be kept for each item of calibrated equipment and include the latest date of calibration, the calibration factors and the next due date

Records of the monitoring shall be maintained for at least 7 years and shall be accessible to the workers and other persons.

3.9 Diesel Equipment

Procedures shall be in place to ensure that:

- A register of all underground diesel units is maintained on site and includes the ventilation requirements for each diesel unit

- Enclosed cabins and cabin air conditioning equipment are provided on underground trackless diesel equipment, underground crushers and remote-controlled equipment stations when required by risk assessment
- Low sulphur, clean, diesel fuel is provided for underground engines
- Exhaust treatment devices are fitted to underground diesel engines when required (consider: Exhaust treatment devices fitted to diesel engines of 125 kW¹ rated power and greater.)

3.10 Disused Areas

Procedures shall be in place to ensure that:

- Areas of the mine that have been isolated from the ventilation system are documented in the ventilation control plan
- Disused areas of the mine are isolated from the primary ventilation system by an effective barricade to prevent unwanted leakage of ventilating air and barricaded to prevent unplanned entry
- Notices are displayed at every entrance to a disused area forbidding entry to the area.
- Ventilation is re-established before re-entry and work recommences in the area

3.11 Maintenance, Inspection and Testing

Maintenance, inspection and testing of all mechanical ventilation systems for underground ventilation facilities shall be undertaken by competent persons in accordance with manufacturer' specifications and be included in the electronic asset integrity / maintenance program for the facility.

Statutory inspections and testing shall be documented and carried out in accordance with legislative requirements.

Asset maintenance files / histories shall be maintained, accurate and available for the life of each asset. Registered plant files / histories shall be maintained as per legislative requirements.

3.12 Emergencies

Underground mines shall carry out an assessment of the ventilation system and have modelled and identified potential mine emergencies that may have an effect on the ventilation system. (consider: An up-to-date ventilation model must be available to use during emergencies in addition to pre-assessed emergency scenarios. The actual emergency scenario must be assessed by a competent person on real-time information rather than using the pre-assessed scenarios alone. Pre-assessed modelling is to be used for initial guidance only.

The mine's Emergency Management Plan shall include contingency plans to manage the effects on the mine ventilation system from the potential mine emergencies modelled. (consider: The mine's Emergency Management Plan shall refer to the potential mine emergencies modelled to be used as a guideline only and shall provide tools for modelling of the actual event based on information from underground reports.)

¹ This is mandated in MSIR 1995 Regulation 10.50 Sub Regulation (3) (d).



3.13 Auditing

Audits of the effectiveness of the ventilation arrangements shall be conducted at regular intervals, not exceeding two years. The audit shall be carried out a suitably qualified and competent person.

3.14 Training

All personnel shall undertake training in ventilation systems relevant to their work and their work environment so that they know how to best utilise the ventilation system or assist it to work efficiently.

All underground personnel shall be trained to understand the meaning of any warning produced by an air monitoring device; and what to do in response to the warning.

Underground ventilation technicians, undertaking measurements of air and atmospheric contaminants on behalf of the underground ventilation officer, shall be appropriately trained and competent.

Mine supervisors and operators shall receive basic mine ventilation training.

3.15 Defect and Hazard Investigation

A procedure shall be in place to manage the reporting and rectification of ventilation defects within the ventilation system.

Investigations of ventilation systems shall be initiated following worker reports of possible overexposures to air contaminants, possible risk of fire or explosion from flammable gas or vapour levels at or near the lower explosive limit (LEL), or indoor air quality complaints. Investigation shall comply with ***IGO GSS 1 - Incident Reporting & Management***.

Non conformities with this standard shall be recorded in the INX incident reporting system and the appropriate regulatory authority shall be notified if required. Corrective actions shall be managed in the INX action tracking system.

4. SURFACE VENTILATION

4.1 Surface Ventilation Officer

A Surface Ventilation Officer shall:

- Be appointed at each underground mine
- Have overall responsibility for the development and maintenance of a surface ventilation control plan.
- Have access to the legal and other requirements that apply to workplace ventilation
- Have the authority, in consultation with management, to close down operations in areas where inadequate ventilation is identified.

4.2 Ventilation Reviews - Pre-Acquisition, Pre-Lease and For Existing Surface Facilities

Prior to the acquisition or lease of a facility a ventilation review shall be undertaken by a competent person to provide a report on:

- Whether the ventilation provided complies with legal and other requirements such as building codes
- Whether the internal air quality meets occupational exposure standard requirements
- The implications that the type/s and design of the ventilation and ventilation equipment provide for ongoing facility operation
- Sources of indoor air pollution and whether these have been mitigated in appropriate balance with other design criteria (such as energy management)
- Whether point sources of air pollution are appropriately and effectively managed by exhaust ventilation systems
- Whether there is a known history of problems relating to internal air quality in the facility such as sick building syndrome
- The adequacy of the monitoring and maintenance systems related to ventilation and air quality
- Potential areas of deficient ventilation

Ventilation reviews shall also be undertaken of existing IGO facilities at regular intervals that shall be specified.

4.3 Ventilation Review – Project Design

Ventilation reviews shall be undertaken by a competent person during the prefeasibility and feasibility stages of project design for surface facilities to provide a report:

- On the implications of the selection of type/s of ventilation and ventilation equipment
- On potential sources of indoor air pollution, whether these have been appropriately managed (e.g. by exhaust ventilation) and whether these have been mitigated in appropriate balance with other design criteria (such as energy management)
- Verifying that the design achieves the desired occupational exposure standards
- On the proposed monitoring and maintenance systems
- On potential areas of deficient ventilation

4.4 Ventilation Design Standards

Mechanically ventilated buildings shall comply with **AS 1668.2 The use of ventilation and air conditioning in buildings Part 2 Mechanical ventilation in buildings**.

Naturally ventilated buildings shall comply with **AS 1668.4 The use of ventilation and air conditioning in buildings Part 4 Natural ventilation of buildings**.

During surface facility design the decision shall be made and documented about whether a building, or part of a building, is to be designed to be either naturally or mechanically ventilated.

4.5 Identification and Management of Sources of Indoor Air Pollution

Sources of potential indoor air pollution (including odours) shall be identified and eliminated or mitigated to levels that meet required standards and are 'as low as reasonably achievable'.

This may be achieved through the use of controls including:

- Elimination
- The provision of general exhaust / dilution ventilation (typically found where contaminant emissions are from low hazard sources, uniformly spread and in moderate climatic conditions and where dilution is a suitable solution)
- The provision of 'at source' local exhaust ventilation such as fans, hoods, ducts, air cleaners, and stacks etc. (where personnel are in close proximity to the source and it is desirable to capture the contaminant before it disperses into the air and where contaminant emissions are typically relatively hazardous)

4.6 The Selection of Equipment Generating Point Source Pollution

Purchasing procedures for equipment that can affect the quality of indoor air shall require an assessment of the potential impact of that equipment on workplace air quality.

4.7 Potential Areas of Deficient Ventilation

Areas and facilities that have the potential to have ventilation deficiencies, or affect ventilation, shall be identified and eliminated or the potential deficiency mitigated to a level that is 'as low as reasonably achievable'.

These include areas such as confined spaces, rooms with non-opening windows or windows that do not meet minimum opening requirements, areas with high occupant densities, smoking areas etc.

4.8 Maintenance, Inspection and Testing

Maintenance, inspection and testing of all mechanical ventilation systems for surface facilities shall be undertaken by competent persons in accordance with manufacturer' specifications and be included in the electronic asset integrity / maintenance program for the facility.

Statutory inspections and testing shall be documented and carried out in accordance with legislative requirements.

Asset maintenance files / histories shall be maintained, accurate and available for the life of each asset. Registered plant files / histories shall be maintained as per legislative requirements.

Where building maintenance is provided as part of a lease the contract shall require that evidence that an appropriate maintenance and inspection program is in place, and effective, shall be provided to IGO by the facility manager at regular intervals.

4.9 Monitoring

The monitoring required confirming that air quality and quantity provided by the ventilation system is adequate shall be identified and documented to state:

- When monitoring shall be undertaken including
- What shall be monitored including

- Where monitoring is to be undertaken and whether this location is to be signposted
- The sampling method by which the monitoring is to be performed
- Who is responsible to undertake the monitoring

Monitoring shall be undertaken as required using appropriate instruments and equipment.

All measuring equipment shall be maintained and calibrated to manufacturers' specifications.

Records shall be kept for each item of calibrated equipment and include the latest date of calibration, the calibration factors and the next due date

Records of the monitoring shall be maintained for at least 7 years and shall be accessible to the workers and other persons.

5. PERFORMANCE MEASURES

Conformance with this standard will be assessed through regular audits and assessments.

6. RELATED DOCUMENTS

6.1 Common Management System Standards

- CMSS 03 - Risk Management
- CMSS 08 - Documentation, Control of Documents, Data and Records Management
- CMSS 12 - Management of Change

6.2 HSES Standards

- IGO GOHS 03 - Thermal Stress Management
- IGO GSS 01 - Incident Reporting & Management
- IGO GSS 04 - Mobile Plant and Equipment

6.3 External Documents

- AS 1668.2: The use of ventilation and air conditioning in buildings - Part 2 Mechanical ventilation in buildings
- AS 1668.4: The use of ventilation and air conditioning in buildings - Part 4 Natural ventilation in buildings
- AS 4368: Mine plans - Preparation and symbols
- Draft Model Work Health and Safety Regulations - Chapter 9 Mines (2011)
- SafeWork Australia Code of Practice Ventilation of Underground Mines (2011)
- WA Mines Safety and Inspection Regulations (1995)