

Hierarchy of Controls

Purpose: to reduce diesel emissions in underground hard rock mines



- The aim is to have an integrated suite of controls that collectively provide decision-making support to mine operations.
- Source Information: A range of local and overseas independent authoritative sources that publish what is considered best practices. These sources are available upon request.

Control: Eliminate

1. Underground Crushers / Production

Crushing and running other production facilities underground eliminates the need for some members of the diesel fleet to haul to the surface.

Control: Substitute

1. Electric Vehicles

Replace diesel engines with electric, hybrid or similar.

Control: Isolate

1. Remote Vehicle Control

Use of vehicle remote control technology where appropriate and not just after firing.

Control: Engineering

1. Fleet Management

1.1. Curtailment of Emissions At Source (Before Emissions Are Emitted)

1.1.1. Engine Control Settings

ECU settings, charger cooler compression and cooling, air/fuel mixtures, filters, throttle settings, timing, injector settings.

1.1.2. Engine Maintenance, Repair & Reliability

Back pressure test, cylinder compression test. Maintenance of filters and injectors. All fittings correctly mounted and firmly secured.

1.1.3. Exhaust Treatment Systems

OEM supplied and aftermarket products. DOC, EGR, DPF, SCR, and crankcase ventilation.

1.1.4. Fuel and Lubricant Handling

Storage, use of additives, water contamination, cross contamination, alternate fuel types, dirt and sediment contamination.

1.1.5. Raw Undiluted Exhaust Emission Test

Calibration to g/kWh benchmarking units of measure, including gas and DPM, integration with condition-based maintenance algorithms.

1.1.6. Tailpipe Undiluted Exhaust Emission Test

Include gas and DPM, combined with *Particulate Index* and *Ventilation Rate* calculations.

1.2. Control Of Airborne Emissions

1.2.1. Enclosed Cabs on Vehicles

Filtration systems and recirculation systems designed for dust and emissions.

1.2.2. Engine Overhaul

OEM supplied upgrades from Stage I to II to III where practical.

1.2.3. Tyre Management

Pressure and maintenance management.

2. Ventilation System Maintenance

Limit bag leakage, bag repairs, bag quality, whether they are tied-off correctly.

3. Ventilation System

Conventional ventilation emission control techniques, use of remote / on-demand panels, fan characteristics, circulation, and cooling.

4. Mine Control System

Use of electronic vehicle and individual proximity and safety-based systems to alert crews of high emissions.

5. Road Maintenance

Roll resistance calculations. After market surface suppression sprays, and the use of aggregate.

6. Vehicle Selection

New and used equipment selected for use on site based in part on their low emission merits.

7. Vehicle Pre-Delivery Emissions Test

New and used vehicles subjected to an emissions test prior to entry on site. Contractor vehicles included.

8. New Technology Selection Program

The trial of new emission reduction technology should be encouraged. Ad hoc arbitrary trials to be discouraged.

9. Spare Parts & Inventory

Sufficient quality parts to be in place to properly service vehicles.

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Control: **Administrative**

1. **Training, Toolbox Talks and Induction**
Targeted communications material at all levels of management and staff.
2. **Risk Management**
AS/NZS ISO 31000 risk assessment in place.
3. **Compliance Management**
Local legislation, codes of practice and guidelines are identified. Corporations Act and ASX Governance Principals – anomalies identified.
4. **Company Policy, Guidelines, Standards, SOP**
Goal is for workers to be 'unconsciously competent'.
5. **Adherence to Standards**
ISO/ANZ standards identified and followed.
6. **Job Rotation**
Job rotation plan mixing surface and underground crews.
7. **Engine Idle Policy**
Engine idle policy for heavy and light vehicles. Open and closed cab configurations to be catered for.
8. **Real-time Ambient Atmosphere Monitoring**
Use of real time monitoring to detect exceedances.
9. **Real-time Personal Atmosphere Monitoring**
Use of real time monitoring to detect exceedances.
10. **Committee Meetings**
Program in place to facilitate decision-making and disseminating information and keep all stakeholders engaged.
11. **Document and Records Management System**
A single lasting secure repository visible to all stakeholders; similar to a mine record.
12. **Data Systems Management**
The capture, analysis and interpretation of emissions data.
13. **Emission Benchmarks**
Identification of all emission benchmarks and targets.
14. **External Audit Procedures**
A method of measuring success. Carried out by third party quality auditors. Adherence to ISO 19011. Report corrective / preventative actions.
15. **Workshop Supervisor Checklist**
Checklist for workshop supervisors to verify vehicle emission maintenance is satisfactorily complete after regular services.
16. **Remote Vehicle Emission Monitoring**
Remote and on-demand monitoring of vehicle emissions. Access to ECU and exhaust sensor points.
17. **Information Management Systems**
Integration of the corporate WH&S/ERP, Asset Mgt, and MRO/Reliability systems with workshop service sheets systems and workflows.
18. **TARP / Emergency Procedures**
Trigger Action Response Procedure and emergency procedure system in place. This would include audible alarms.
19. **Stakeholder Map**
A map of who is responsible for emissions in the company. How is information communicated internally and externally. Reporting systems.
20. **Stakeholder Communications**
What communications material is distributed to stakeholders; how and when is this achieved.
21. **Recycling**
Air filters and other components have the ability to be recycled.
22. **Reliability Engineering**
Resources applied to machinery lifecycle maintenance as it effects emissions management. Follow SAE JA10011/2.
23. **Structured Documents**
Deployed policies, standards, guidelines, and standard operating procedures.

Control: **PPE**

1. **Advanced RPE**
Use of new technology RPE where appropriate. Regular fit tests.