

## **Hierarchy of Controls**

### **Control: Eliminate**

#### **1. Underground Crushers/Production**

Crushing and running some production facilities underground reduces the reliance on 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**

Appropriate use of remote-control vehicle technology not only after firing

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### **Control: Engineering**

#### **1. Fleet Management**

##### **1.1. Curtailment of Emissions at Source (Before emissions occur)**

###### **1.1.1. Engine Control Settings**

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

###### **1.1.2. Engine Maintenance, Repair and Reliability**

Back pressure test, cylinder compression test, filter and injector maintenance, firm and correct/secure mounting of fittings

###### **1.1.3. Exhaust Treatment System**

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, alternative 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, II, III where practical

### **1.2.3. Tyre Management**

Pressure and Maintenance management

## **2. Ventilation System Maintenance**

Limit bag leakage, bag repairs, bag quality, correct tying off

## **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/safety-based data systems to alert crews of high emissions

## **5. Road Maintenance**

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

## **6. Vehicle Selection**

New and Used equipment selection process based in part on low emission merits

## **7. Vehicle Pre-Delivery Emissions Test**

New, used and contractor vehicles subject to emissions testing prior to site entry

#### **8. New Technology Selection Program**

The trial of new emission reduction tech, discourage ad-hoc arbitrary trials

#### **9. Spare parts and Inventory**

Sufficient supply of quality parts to service vehicles

### **Control: Administrative**

#### **1. Training, Toolbox Talks and Induction**

Targeted communication material at all levels of management and staff

#### **2. Risk Management**

Risk Assessment policy and processes in place

#### **3. Compliance Management**

Local legislation, codes of practice and guidelines identified. Governance principles – 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 catered for

#### **8. Real time Ambient Atmosphere monitoring**

Use of real time monitoring to detect exceedances

#### **9. Committee Meetings**

Program in place to facilitate decision making, information and engagement of stakeholders

#### **10. Document and Records Management System**

Single, long-term, secure repository visible to all stakeholders: similar to amine record

#### **11. Data Systems Management**

The capture, analysis and interpretation of emissions data

#### **12. Emissions benchmarks**

Identification of all emissions benchmarks and targets

#### **13. External Audit Procedures**

A method of measuring success via independent auditors. Adherence to ISO 19011 and reporting corrective and preventative actions.

#### **14. Workshop Supervisor Checklist**

Checklist for workshop to verify vehicle emission maintenance on vehicles at time of service

#### **15. Remote Vehicle Emissions Monitoring**

Remote/on-demand monitoring of vehicle emissions. ECU and exhaust sensor points

#### **16. Information Management System**

Integration of the corporate WH&S/ERP. Asset Mgt and MRO/reliability systems with workshop service sheets and work flows.

#### **17. TARP/Emergency Procedures**

Trigger Action Response Procedure and emergency procedure system in place including audible alarms

#### **18. Stakeholder Map**

A map of who is responsible for emissions in the company, internal and external reporting and communication systems

#### **19. Stakeholder Communication**

What, how and when communication material is distributed to stakeholders.

#### **20. Recycling**

Air Filters and other components have the ability or be recycled

#### **21. Reliability Engineering**

Resources applied to machinery lifecycle maintenance as it effects emissions management. Follow SAE JA10011/2

## **22. Structured Documents**

Deployed policies, standards, guidelines and standard operating procedures

## **Control PPE**

### **1. Advanced PPE**

Use of new technology RPE where appropriate. Regular fit tests