



DIESEL PARTICULATE IN COAL MINES

1st Edition

QUESTIONS AND ANSWERS

1999

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Diesel vehicles have been part of the Australian coal mining industry for many years. During that time concern has arisen within the industry as to the possible adverse health aspects from exposure to engine exhaust fumes.

The Joint Coal Board, through the tri-partite Standing Committee on Dust Research and Control, decided to include a watching brief on diesel particulate. In December 1997 a Sub-Committee was formed in order to ensure the health of mineworkers is not put at undue risk by the exposure to diesel particulate.

The Diesel Particulate Sub-Committee has produced this booklet to promote a better understanding of the hazards and appropriate control methods associated with diesel particulate in the coal mining industry.

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QUESTIONS AND ANSWERS

1. *What is Diesel Particulate (DP) ?*

Broadly speaking, diesel exhaust or diesel emissions can be separated into two distinct groups - a gaseous component and a particulate component. The particulate component is comprised mainly of very small particles of carbon called diesel particulate (DP).

2. *How is DP Generated ?*

Diesel fuel is a mixture of liquid hydrocarbons but with a much higher boiling and flash point than petrol. When combusted in an engine, the majority of emissions are carbon dioxide, nitrogen, oxygen and water vapour plus a small percentage of noxious gases, products of incomplete combustion and DP. The composition of emissions is related to the fuel used and the air/fuel ratio. This alters to meet the variable demands for power and engine combustion efficiency.

3. *Is DP Harmful ?*

DP is small enough to be inhaled and retained in the lungs. The particles have hundreds of chemicals from the exhaust adsorbed (attached) onto their surfaces. DP may be cancer-causing, possibly at the risk level of passive cigarette smoking exposure. A plausible biological mechanism has been assumed by which DP exposure might be causally linked to lung cancer. Medical research has not yet established a firm opinion as to what components of DP are responsible for any particular health effects.

The Joint Coal Board Chief Medical Officer has compiled this answer after considering a wide range of documents and competing views.

4. *What are Milligrams and Micrograms ?*

Measurements of DP are expressed in micrograms (μg) per cubic metre of air. A microgram is one millionth of a gram. However, in many references, you may see the DP measurements expressed as milligrams (mg) per cubic metre of air. A milligram is one thousandth of a gram. The current standard for respirable coal dust is three milligrams per cubic metre of air ($3\text{mg}/\text{m}^3$).

5. *How is DP Measured ?*

DP is made up of very fine carbon cores which stick together into chains or clumps mainly less than 1 micron (1 millionth of a metre in size). The personal sampling device used for collecting respirable coal dust is fitted with a second stage separator so that only the small size DP is captured and very little coal dust. The filter from the sampler can be weighed to determine the amount of DP mg/m³ in a similar manner as is done for a filter obtained for respirable dust. Further laboratory analysis can be carried out on the DP to determine the amount of carbon particles (called elemental carbon or EC) and also the amount of adsorbed organic chemicals (called organic carbon or OC). Results obtained in Australian coal mines indicate that around half of the DP collected on the filters is made up of these ultra small carbon particles. The current monitoring techniques are research tools and require considerable technical skills to obtain satisfactory exposure results with acceptable accuracy.

6. *Are there any Exposure Standards for DP ?*

Due to the potential for adverse health effects from occupational exposure, regulatory authorities in countries such as the USA, Germany, Switzerland and Canada are translating this concern into workplace exposure standards. The USA has recently proposed a standard of 0.16 mg/m³ total carbon (TC) for metalliferous mines but has decided not to propose a similar standard in coal mines for technical reasons. The approach in USA coal mines is based on minimising employee exposure. At this stage, no standard has been recommended for Australia. DP exposures in Australian coal mines are lower than that found in USA coal mines (approximately half) and much lower than the DP levels experienced in USA and Australian metalliferous mines

7. *What Levels are Found in the Coal Mining Industry ?*

Research in NSW and Qld underground coal mines has recorded levels of 0.01-0.37 mg/m³ EC and 0.01-0.64 mg/m³ DP. Exposure levels vary considerably depending on working conditions and control strategies. Generally, transport duties produce the lowest results with heavy workloads, particularly longwall moves, power tramping or LHD work producing the highest results. Effects of eye irritation and discomfort from odours occur more readily at levels in excess of 0.1 mg/m³ EC or 0.2 mg/m³ DP. Research work is continuing and will be included in an Australian data base. These exposures can be viewed via the Joint Coal Board's Web Site at (www.jcb.org.au).

8. *Is DP a Problem in Open Cut Mines ?*

DP concentrations found in diesel vehicle repair garages or warehouses that use diesel forklifts, are usually much higher than those in ambient air. Workshops with the access doors closed, or multi-vehicles running, would result in DP exposures that would require control. Good flow-through ventilation will eliminate this problem.

9. *Does Fuel Quality Impact on Emission Levels ?*

The quality of the diesel fuel influences gaseous and DP emissions, however, the relationships are complex. A well-formulated lower-emission fuel can have a significant effect on DP emissions. Use of low sulphur diesel fuel (<0.05% sulphur) not only reduces the level of DP emissions but has been demonstrated to reduce objectionable odours associated with diesel use.

10. *What Other Factors Govern Emission Levels ?*

Engine emissions are governed by engine design, work practices, duty cycle and maintenance. Diesel engine maintenance is the cornerstone of a diesel emission control program. The use of exhaust after-treatment technology is highly effective in reducing DP emissions into the mine atmosphere. There is no single control strategy that is a solution to all problems.

11. *Do Water Scrubbers Remove DP from Engine Exhaust ?*

Water scrubbers are basically a safety device used on diesel equipment in underground mines. Water scrubbers perform three functions: cool exhaust gases to safe temperatures, arrest sparks and arrest flames. Although not intended as an emission control device, water scrubbers remove up to 20% of DP from an engine's exhaust. Because water scrubbers cool the exhaust gases, the equipment can be fitted with high-efficiency disposable exhaust filters that reduce DP.

12. *Can Disposable Exhaust Filter Systems Collect DP ?*

Exhaust filtration devices capture DP from the exhaust before it enters the mine atmosphere. Disposable exhaust filters can remove up to 85% of the DP. The filter is placed downstream of the water scrubber and captures DP from the exhaust stream. The filter is disposed-of after being loaded with DP.

13. *What is Dry Systems Technology ?*

An alternative to water scrubbers for achieving the exhaust gas cooling, spark arresting and flame arresting requirements is the Dry Systems Technology (DST). With this technology the exhaust gas does not come into direct contact with cooling water but is indirectly cooled by a tube or shell water-cooled heat exchanger. Spark and flame arrest are provided by mechanical means. The DST also includes a water-jacketed oxidation catalytic converter and a disposable exhaust filter to reduce emissions.

14. *Is Ventilation Important in the Control of Exhaust Emissions ?*

Ventilation is the primary means used to manage personal exposure to DP. As the air quantity increases, the DP concentrations decrease. It may be necessary to supply air quantities above those currently being used to significantly reduce DP concentrations, especially with multi-vehicle usage. Some operations have had success by the introduction of vehicle tag procedures based on statutory ventilation requirements that limit the number of vehicles in a panel or district. The use of multiple vehicles in the one heading can have a significant effect on the ventilation pattern in that heading. The vehicle exhaust location should be such that exhaust is directed away from the vehicle operator. The exhaust gas can be directed across the radiator, thus providing immediate dispersal by the radiator fan.

15. *Is Respiratory Protection Equipment Suitable for Use Against Exhaust Emissions ?*

The use of respiratory protective equipment should not be used as the primary method of control but can help to reduce personal exposure to DP until better controls can be implemented. Good occupational hygiene practice is to eliminate or minimise hazards before resorting to personal protective equipment. Using the correct respiratory protective equipment can help to protect a miner's health. Care has to be taken with facial fit and wear time. The normal P1 and P2 respirators used in mines for dust control will reduce exposure to DP.

16. *How Can Machine Operators Reduce Emissions ?*

Machine operators should carry out pre-start checks including a visual inspection of the machine. Operators should avoid unnecessary idling of the engine as it wastes fuel, increases emissions and may over-cool the engine. Avoid lugging the engine to low RPM, this affects the engine's ability to efficiently burn fuel and produces excessive DP emissions. Aggressive driving is a bad work practice and results in increased DP levels. Drive to the conditions, select the right gear and avoid over revving. Skilful driving by operators has been demonstrated to reduce DP levels.

17. *What is Management Doing to Reduce Emission Levels ?*

At some mines they have introduced a well-balanced maintenance programme including oil cleanliness controls, chemical decoking of engines and improved tuning to optimise engine performance. Underground diesel test stations have been introduced at several operations. These computerised facilities provide better management of gaseous and particulate emissions. In 1995 the NSW Minerals Council developed “Guidelines for Minimising Exposure to Diesel Emissions in Underground Coal Mines”. They were updated in 1999 via a task force involving membership from management, unions, OEM’s and technical specialists and are now called “Diesel Emissions in Underground Mines, Management and Control”. The industry, through ACARP and the JCB Health & Safety Trust, continues to fund research for improved diesel operations. This investment is underway to provide a means of lowering employee exposure to diesel emissions.

18. *Are There Any New Solutions on the Horizon ?*

Research in Australia and overseas suggests that newer engine technology is being developed which has the potential to reduce DP levels by 33-50% of the presently used engines. This technology is currently in operation in the metalliferous mining industry and ultimately will gain approval for use in the coal industry.

19. *Where Can I Get More Information ?*

Considerable information has been written on this topic however much of it is very technical and difficult to obtain. As a starting point, some information can be obtained from the Web Sites of the Joint Coal Board (www.jcb.org.au) and the NSW Minerals Council (www.nswmin.com.au). If you don’t have access to the Internet contact the local JCB office who will assist.