



**Mine Managers
Association of Australia**

Presentation

Diesel Particulate Matter

Thursday 11 June 2015

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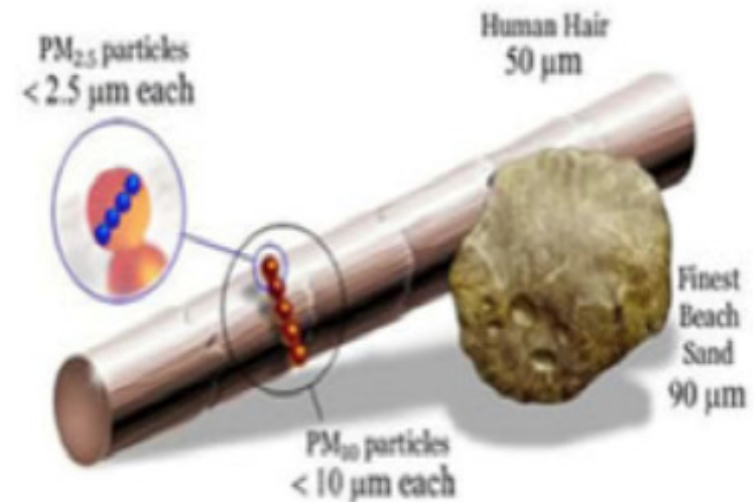
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Diesel Particulate matter

- What
- Why
- How
- Way forward
- Solutions

What is diesel fine particulate?

Fine particles 2.5microns or less in diameter



Diesel Particulate Matter

- What do you know of DPM?
- What are the consequences?
- How can they be controlled?

- Drivers, rail workers and miners

*Includes benzo[a]pyrene, coal-tar pitch, creosotes, cyclopenta[cd]pyrene, dibenz[a,l]pyrene, frying emission from high temperatures, mineral oils (treated or mildly treated), soots.

†Fission products including strontium-90, ionising radiation (all types), neutron radiation, phosphorus-32 as phosphate, radioiodines including iodine-13, internally deposited α - and β -emitting radionuclides, x- and γ -radiation, and radium-224, radium-226, radium-228, thorium-232 and their decay products.

‡Includes benzal chloride, benzotrichloride, benzyl chloride and benzoyl chloride.

§Includes 3,4,5,3',4'-pentachlorobiphenyl (PCB-126).

Estimated prevalence of exposure to occupational carcinogens in Australia (2011–2012)

Renee N Carey,¹ Timothy R Driscoll,² Susan Peters,¹ Deborah C Glass,³ Alison Reid,¹ Geza Benke,³ Lin Fritschil

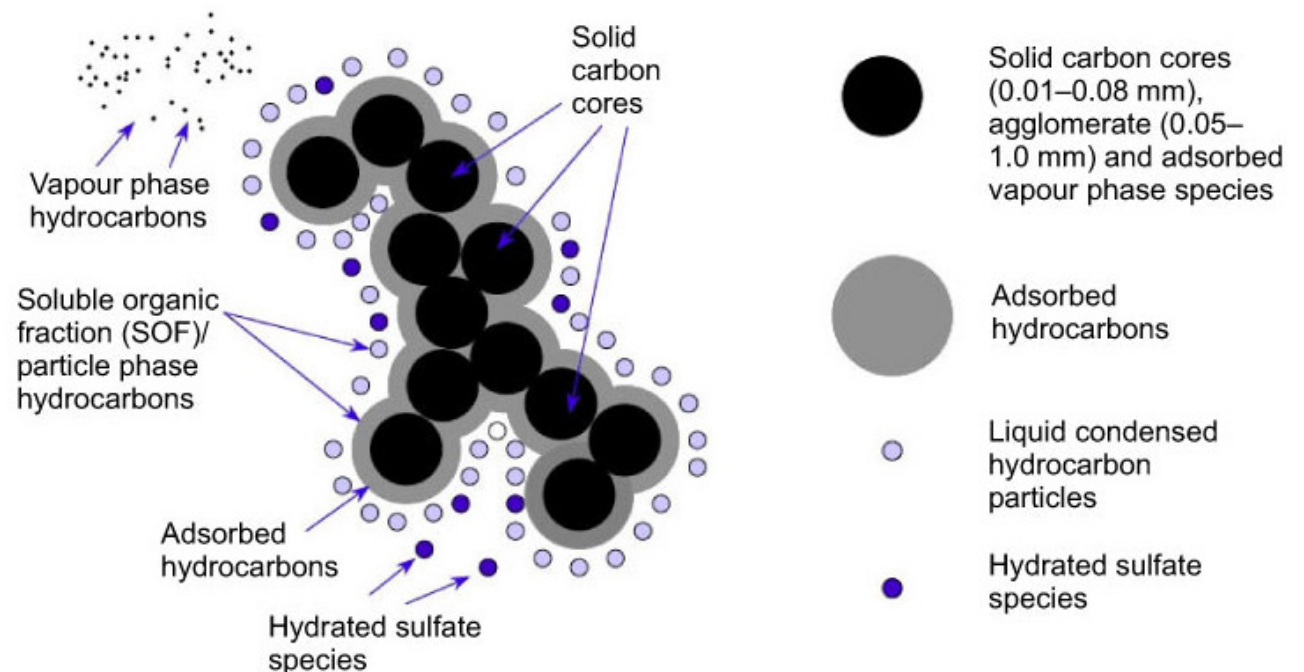
Table 1 The list of carcinogens as prioritised by Fernandez *et al*³³

Agent group	Agent
Combustion products (3)	Diesel engine exhaust Environmental tobacco smoke Polycyclic aromatic hydrocarbons (PAHs)*
Inorganic dusts (2)	Asbestos Crystalline silica dust
Organic dusts (2)	Leather dust Wood dust
Metals (7)	Arsenic and inorganic arsenic compounds Beryllium and beryllium compounds Cadmium and cadmium compounds Chromium (VI) compounds Cobalt metal and tungsten carbide Inorganic lead compounds Nickel compounds
Radiation (4)	Artificial ultraviolet radiation (UVA, UVB, UVC) Ionising radiation† Radon-222 and its decay products Solar radiation
Other industrial chemicals (19)	Acid mists, strong inorganic Acrylamide α -chlorinated toluenes‡ Benzene 1,3-butadiene Diethyl sulfate Dimethyl sulfate Epichlorhydrin Ethylene oxide Formaldehyde Glycidol 4,4'-methylenebis (2-chloroaniline) (MOCA) <i>N</i> -nitrosodimethylamine and <i>N</i> -nitrosodiethylamine <i>ortho</i> -Toluidine (2-aminotoluene) Polychlorinated biphenyls (PCBs)§ Styrene-7,8-oxide Tetrachloroethylene (perchloroethylene) Trichloroethylene Vinyl chloride

➤ What?

➤ **Diesel exhaust as a carcinogen**

- Complex mixture –particulate and gas phase
- Like other combustion mixtures (tobacco smoke)
- DPM is a component of ambient PM2.5, generally about 6-10% of PM2.5 although may be up to 36%



Diesel Particulate Matter

➤ contains

Contaminant	Note	Particulate extract mass concentration
<u>acetaldehyde</u>	<u>IARC Group 2B carcinogens</u>	
<u>acrolein</u>	<u>IARC Group 3 carcinogens</u>	
<u>aniline</u>	<u>IARC Group 3 carcinogens</u>	
<u>antimony</u> compounds	Toxicity similar to arsenic poisoning	
<u>arsenic</u>	<u>IARC Group 1 Carcinogens, endocrine disruptor</u>	
<u>benzene</u>	<u>IARC Group 1 Carcinogens</u>	
<u>beryllium</u> compounds	<u>IARC Group 1 Carcinogens</u>	
<u>biphenyl</u>	It has mild toxicity.	
<u>bis(2-ethylhexyl) phthalate</u>	<u>endocrine disruptor</u>	
<u>1,3-Butadiene</u>	<u>IARC Group 2A carcinogens</u>	
<u>cadmium</u>	<u>IARC Group 1 Carcinogens, endocrine disruptor</u>	
<u>chlorine</u>	Byproduct of Urea injection	
<u>chlorobenzene</u>	It has "low to moderate" toxicity.	
<u>chromium</u> compounds	<u>IARC Group 3 carcinogens</u>	
<u>cobalt</u> compounds		
<u>cresol</u> isomers		
<u>cyanide</u> compounds		

Diesel Particulate Matter

➤ contains

Contaminant

Note

Particulate extract mass concentration

[dibutyl phthalate](#)

[endocrine disruptor](#)

1,8-dinitropyrene

Carcinogen [[citation needed](#)]

[dioxins](#) and [dibenzofurans](#)

[ethylbenzene](#)

[IARC Group 1 Carcinogens](#)

[formaldehyde](#)

[endocrine disruptor](#)

inorganic [lead](#)

[manganese](#) compounds

[IARC Group 3 carcinogens](#)

[mercury](#) compounds

[methanol](#)

[methyl ethyl ketone](#)

[IARC Group 2B carcinogens](#)

[naphthalene](#)

[IARC Group 2B carcinogens](#)

[nickel](#)

One of the strongest carcinogens known

0.6 to 6.6 ppm

[3-Nitrobenzanthrone](#)

[4-nitrobiphenyl](#)

2.2 ppm

[phenol](#)

[phosphorus](#)

[polycyclic organic matter](#),

including [polycyclic aromatic](#)

[hydrocarbons](#) (PAHs)

[Pyrene](#)

3532–8002 ppm

[Benzo\(e\)pyrene](#)

487–946 ppm

[Benzo\(a\)pyrene](#)

[IARC Group 1 carcinogen](#)

208–558 ppm

[Fluoranthene](#)

3399–7321 ppm

[propionaldehyde](#)

[selenium](#) compounds

[styrene](#)

[IARC Group 2B carcinogens](#)

[toluene](#)

[IARC Group 3 carcinogens](#)

[xylene](#) isomers and mixtures:

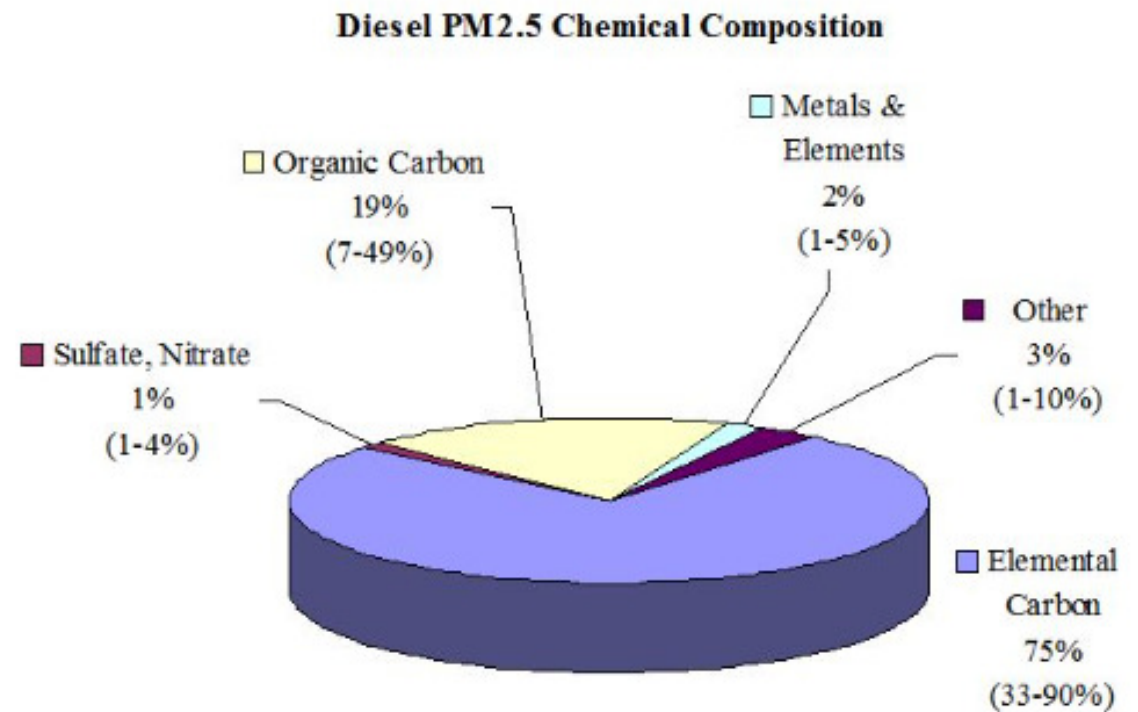
o-xylenes, m-xylenes, p-

[IARC Group 3 carcinogens](#)

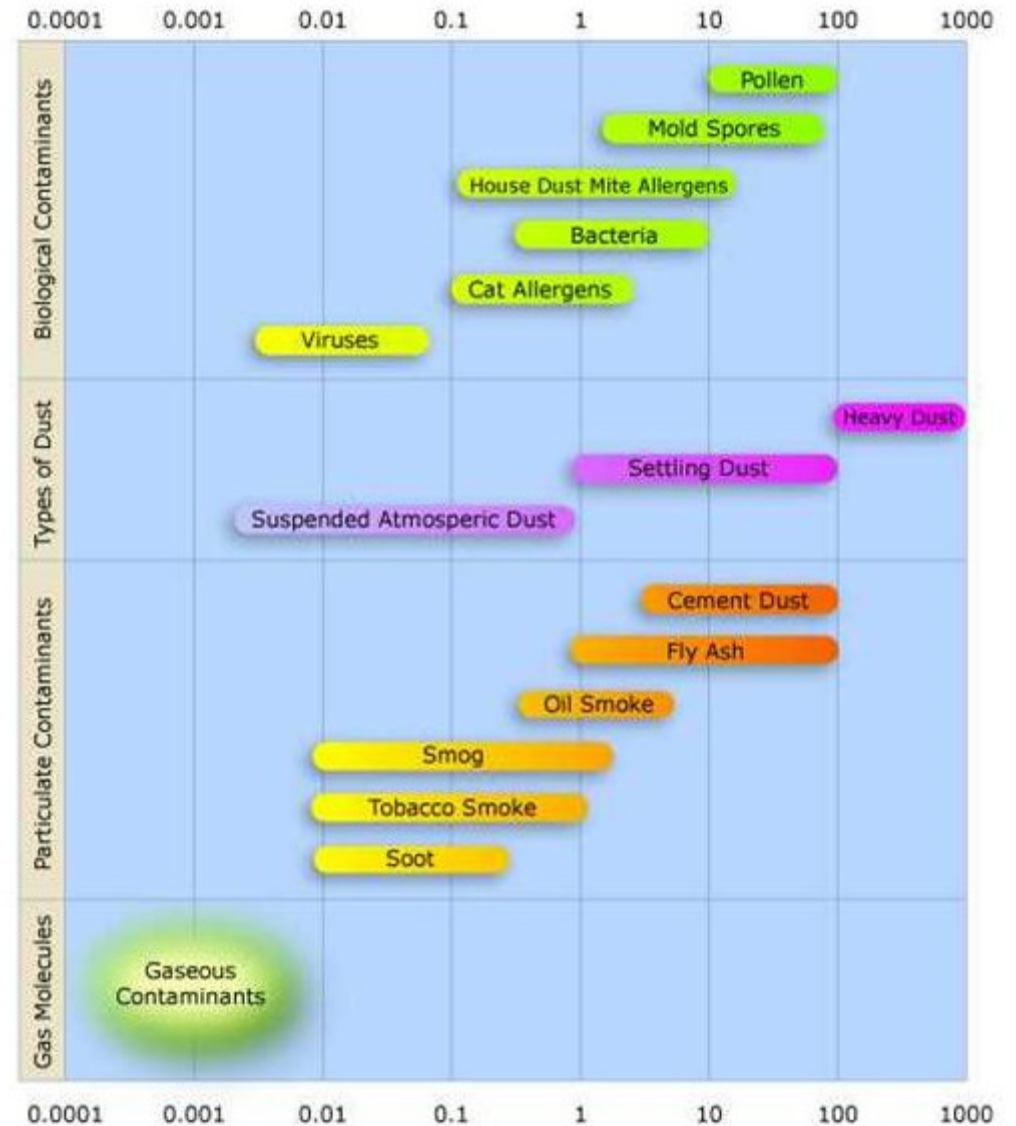
xylenes

- Emissions are complex
 - Fuel
 - type and age of engine
 - tuning and maintenance
 - emissions control system
 - Use

- Many benefits to using monitoring and controls



- Studies adjusted for tobacco
 - showed positive trends for lung cancer risk
 - 2-3 fold increased risk in highest cum or average exposure categories
 - 40% increased risk in workers based on work history and history of dieselization,
 - 70-80% increased risk with duration but not cumulative exp.

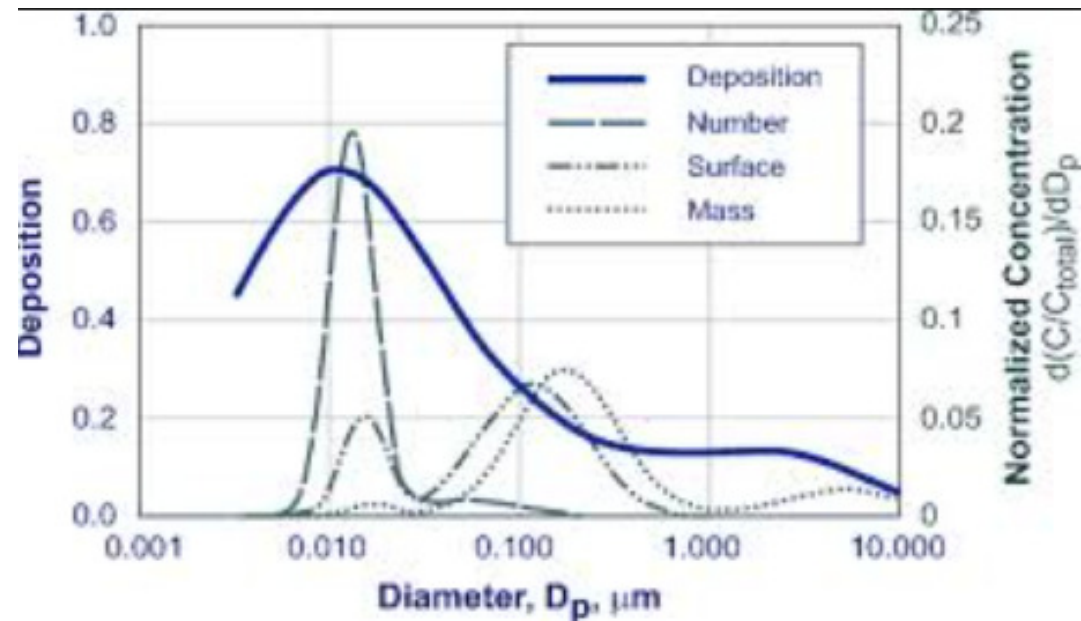


➤ Study-

- 15-40% increase in risk in workers w/ regular exposure
- increased risk with longer duration of employment
doubling of risk at 20 years

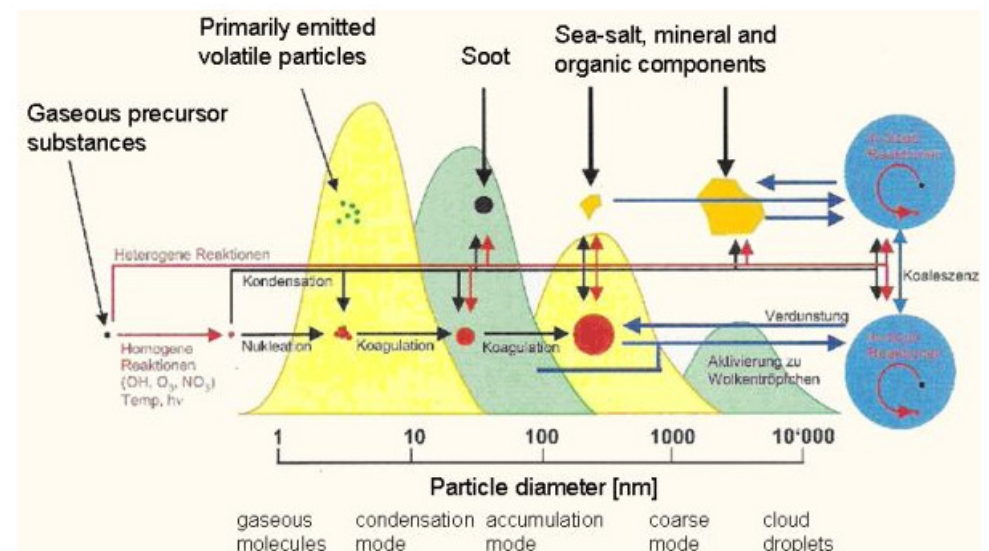
- Bladder cancer
- Cardiovascular disease
- Heart attacks
- Strokes
- Tooth decay
- Lung cancer
- Respiratory disease
- Mouth cancer

- Modes of absorption



The risk of developing lung cancer from DPM increases with every small increase in particulate matter. An increase of $10\mu\text{g}/\text{m}^3$ in $\text{PM}_{2.5}$ equates to a 40 per cent increase in the life time risk of developing lung cancer. *

Long-term exposure to the current advisory level of $\text{PM}_{2.5}$ of $8\mu\text{g}/\text{m}^3$ equates to smoking 2.4 cigarettes daily.*



*from the American Cancer Prevention II Study2 (NSW Coal Mining Benchmarking Study Consultation, Clare Walter).

- Solutions
 - Controls
 - Total mass vs particle size

 - Filtration
 - PPE
 - Engine modification
 - Regulation (WA, Qld)
 - Monitoring
 - Cross detection

 - Do we need to reinvent the wheel
 - Value proposition
 - Diesel tag boards
 - Fuel optimisation
 - Ventilation optimisation
 - Reducing risk





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**Thank you.
Questions?**

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