

APPENDIX

THE ROLE OF FLUID CONSTITUENTS AND CONTAMINANTS IN CAUSING RESPIRATORY DISEASE AT POWERTRAIN LIMITED

HOW RESPIRATORY HEALTH MAY BE AFFECTED BY EXPOSURE

The way in which respiratory disease was initiated or exacerbated by exposure to metalworking or wash fluid mist at Powertrain Limited may have been as follows:

- there may have been a straightforward effect between a causative substance or agent (including biological agents) and disease
- there may have been a synergistic effect between causative substances or agents; a number of substances or agents may have combined to have an effect on respiratory health,
- one predominant substance or agent may have caused the initial harm in an individual case, sufficient to make that person susceptible to other substances or agents, which may have had an effect at levels below those normally considered to be harmful to a healthy individual,
- symptoms or disease existing before exposure may have been exacerbated by exposure in the ways outlined above

The tables below summarise the role constituents, contaminants and agents in metalworking and wash fluids may have played in the respiratory diseases diagnosed at Powertrain Limited.

CONSTITUENTS OR CONTAMINANTS, WHICH MAY HAVE PLAYED A PART IN CAUSING OR EXACERBATING SYMPTOMS OF BOTH EXTRINSIC ALLERGIC ALVEOLITIS(EAA) AND OCCUPATIONAL ASTHMA(OA)

Constituent or Contaminant and links to respiratory disease	Quantities found or identified in metalworking or wash fluids/mists	Comment
Bacteria - linked to both occupational asthma (OA) and extrinsic allergic alveolitis (EAA).	In 2004 high bacteria levels were counted in fluid samples from a number of washing machines and small sumps belonging to stand – alone metalworking machines. Two of these washing machines 38969 and 700315 were capable of expelling large quantities of contaminated mist in the area where most of those diagnosed with disease were working when they first became breathless	<p>Some workers diagnosed with EAA demonstrated a serological¹ response both to a crude metalworking fluid extract, taken in April 2004, from the large Mayfram sump, and to predominant bacteria, <i>Ochrobactum anthropi</i> and <i>Acinetobacter sp</i>², present as DNA fragments in the sump.</p> <p>In 2005 Two workers diagnosed with EAA have demonstrated adverse respiratory effects when challenged with samples of fluid from the Mayfram sump taken by HSE in September 2004.</p> <p><i>Ochrobactum anthropi</i> has been linked to an outbreak of EAA in a car component factory in the USA³.</p>
Constituent or Contaminant and links to respiratory disease	Quantities found or identified in metalworking or wash fluids/mists	Comment
Endotoxin - linked to short term	In 2004 high endotoxin levels were recorded	May have had a role in some of the disease

¹ Sera were taken from those diagnosed with EAA.

² HSL Report dated 9 September 2004 “Results of bacterial identifications from environmental sampling” 12 August 2004.

³ Project Sensor News Volume 16, No 1, winter 2004 – 5, Michigan State University, College of Human Medicine, 117 West Fee Hall, East Lansing, MI 48824

health effects and exacerbation of pre – existing asthma	in samples taken by HSL from a number of machines and locations ⁴ . These were frequently the same locations where high levels of bacteria had been recorded e.g. in and around 38969 (camshaft wash)	diagnosed. As they were found in wash 39869 they may have been spread over considerable area.
Fungi – linked to extrinsic allergic alveolitis and other respiratory conditions, but limited evidence of any link to occupational asthma	At all times, generally low levels of common fungi were found in all sumps and washing machines, although in August 2004 moderate levels were found in air in various parts of the factory (for example, on 12 August 2004 1.4×10^3 were found in air near washer 700315, and 1.2×10^3 in air in CPK 24 at the other end of the factory)	May have had a role in some respiratory disease.

⁴ See HSL Report dated 19/8/04

Constituent or Contaminant and links to respiratory disease	Quantities found or identified in metalworking or wash fluids/mists	Comment
<p>Cobalt - linked to hardmetal disease, a severe lung disease, and asthma, both normally from exposure to cobalt dust. There was no exposure to cobalt dust at Powertrain Limited, but it is possible there was some cobalt in metalworking and wash fluids from the metals being machined or metalworking tools used</p>	<p>A number of samples⁵ of fluids were taken from metalworking and washing machine sumps; generally levels were found < 0.1mg/l (or below the detection limit)</p> <p>Concentrations of cobalt in air sampled⁶ were below 0.01mg/m³</p> <p>Levels of cobalt in urine from those diagnosed with respiratory disease was not consistent with occupational exposure⁷</p>	<p>Respiratory disease from exposure to cobalt is normally associated with exposure to cobalt dust in the hard metal and diamond polishing industries</p> <p>The Occupational Exposure Standard (OES)⁸ was 0.1mg/m³ (8 hr time weighted average)</p>
<p>Other metals – including other hard metals, Iron, Chrome, Manganese and Nickel - either as constituents of metals being machined or metalworking tools used – linked to a variety of health effects on the skin and lungs, but not EAA or OA</p>	<p>Concentrations of these metals in air were sampled⁹ at very low exposures, generally <0.01</p>	<p>Such exposures are not generally associated with any health effect, and were always below any Maximum Exposure Limit (MEL)¹⁰ or OES</p>

⁵ See HSL Environmental Monitoring Requests - samples collected on 12/8/04, 16/8/04, 23/8/04, and 14/9/04

⁶ See HSL Environmental Monitoring Request – samples collected on 25/1/05

⁷ See letter from University of Surrey, dated 26 July 2005

⁸ Occupational Exposure Standards (OESs) were in force at the time of the outbreak and represent concentrations of hazardous substances in air at which there is no indication of risk to the health of workers exposed by inhalation day by day. OESs have now been replaced by Workplace Exposure Limits (WELs). The actual levels at which all relevant OESs and WELs were set remained unchanged over the period of the outbreak.

⁹ See Environmental Monitoring Request – samples collected on 25/1/05

¹⁰ Maximum Exposure Limits (MELs) were in force at the time of the outbreak for substances which may cause the most serious health effects, such as occupational asthma, and for which “safe levels of exposure” cannot be determined. A MEL is also set for substances, for which although safe levels may exist, it is not reasonably practicable to reduce to those levels. MELs have now been replaced by WELs.

Constituent or Contaminant and links to respiratory disease	Quantities found or identified in metalworking or wash fluids/mists	Comment
<p>Mycobacteria – these have been linked to outbreaks of EAA in the United States have been found in metalworking fluids after large outbreaks of EAA in the USA</p>	<p>No Mycobacteria were detected in HSL samples¹¹ taken from sumps</p> <p>HSL cultured Mycobacteria for precipitin tests involving sera from those diagnosed</p>	<p>No significant reactions were recorded between sera and Mycobacteria</p>
<p>Tramp oil – consists of oils, such as machine hydraulic and lubricating oils, which leak into metalworking fluid. At Powertrain Limited over the period of the outbreak hydraulic and lubricating oils were highly refined mineral oils, with an exposure guidance value of 3mg/m³. Exposure to mineral oil mist alone has been linked to respiratory irritation, shortness of breath, coughing and tachypnea, but not occupational asthma or extrinsic allergic alveolitis. Tramp oil may form mineral</p>	<p>Between October 2003 and February 2004 concentrations of mineral oil mist¹² in air of between 1 and 4 mg/m³ and an average concentration of just above 1 mg/m³ were recorded. Personal samples taken over the same period indicated exposures of between 1 – 1.7 mg/m³, with an average exposure of 1.3 mg/m³. These levels were recorded after the outbreak had peaked and action taken to reduce tramp oil.</p> <p>The hydraulic oil in all systems was changed in April 2003, which resulted in increased levels of tramp oil.</p>	<p>It may be expected that levels of exposure to mineral oil over the period of the outbreak were somewhat higher than those after steps had been taken to reduce the amount of tramp oil in the metalworking fluid. No direct link between such exposure and either occupational asthma or extrinsic allergic alveolitis has been demonstrated either in this outbreak or others.</p> <p>Onsets of breathlessness peaked in March 2003</p>

¹¹ See HSL Reports dated 17/11/03 and 4/5/04

¹² At the time of the outbreak, the guidance value for exposure to mineral oil, or neat oil, mist was 3mg/m³. This value is not based on any possible health effects at this level of exposure, but like the water – mix guidance value, represents good practice.

oil/water emulsions, which may easily become microbiologically contaminated and support the proliferation of microorganisms.

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CONSTITUENTS OR CONTAMINANTS, WHICH MAY HAVE PLAYED A PART IN CAUSING OR EXACERBATING SYMPTOMS OF OCCUPATIONAL ASTHMA (OA)

Generally these are constituents, which have been linked to occupational asthma, but not extrinsic allergic alveolitis. There is no pattern in the use of particular fluids, or additives, such as biocides, or changes in them or of them which correspond to patterns of disease onset.

Constituent or Contaminant	Quantities found or identified in metalworking or wash fluids/mists	Comment
<p>Cases of occupational asthma have been linked to ethanolamines, including mono- and tri-ethanolamine¹³.</p>	<p>Monoethanolamine present as 33.1% by weight of [REDACTED], which is used at 1.5% concentrate with [REDACTED] (concentrate at 8%) and water (at 90.5%) in large sumps.</p> <p>Monoethanolamine present as 3% by weight in [REDACTED], which is used in small sumps at 4 – 10 % concentration in water.</p>	<p>Amount in mist would be extremely low.</p> <p>[REDACTED] used since 1992 (diethanolamine removed 08/02).</p> <p>[REDACTED] used unchanged since 1992 (apart from mineral oil change - when?)</p> <p>Few onsets of breathlessness reported by workers using machines with small sumps.</p> <p>[REDACTED] in use since 1994 (diethanolamine removed 08/02).</p> <p>[REDACTED] used since 1994 (06/03)</p>

¹³ *American Review of Respiratory Disease* 115(5): 867-71, 1977 May, *Allergy* 1994; 49:877-881: 12 cases 1990 - 2005

	<p>Monoethanolamine present as 10.40% by weight in [REDACTED], a wash fluid for cast iron, used at 2% concentrate to 98% water.</p> <p>Monoethanolamine present as 1.75% by weight in [REDACTED], a wash fluid for aluminium, used at 2% concentrate to 98% water.</p> <p>Monethanolamine present in [REDACTED], a wash fluid, used for aluminium components, at 2 – 5%.</p>	<p>sodium omadine and chelating agent removed to prevent discolouration; Jan 04 chelating agent added).</p> <p>[REDACTED] used since 1998 (diethanolamine removed in August 2002).</p> <p>[REDACTED] only used between start and end of 2003, in aluminium washers, the distribution of which does not reflect the distribution of the onset of disease.</p>
Triethanolamine - cases of asthma linked to ethanolamines, including mono- and tri-ethanolamine ¹⁴ .	Present in [REDACTED] at 10.48%.	[REDACTED] used since 1994 (06/03 sodium omadine and chelating agent removed to prevent discolouration; Jan 04 chelating agent added).
Triazine biocide – has potential to cause asthma.	Removed from [REDACTED] in 1999.	Removed from [REDACTED] in 1999. No cases of asthma reported but a derivative linked to an outbreak of asthma at a plastics factory in very low concentrations ¹⁵ .

¹⁴ *American Review of Respiratory Disease* 115(5): 867-71, 1977 May, *Allergy* 1994; 49:877-881: 12 cases 1990 - 2005

¹⁵ *Toxicological sciences* 2003; 76: 338-346

Constituent or Contaminant and links to respiratory disease	Quantities found or identified in metalworking or wash fluids/mists	Comment
<p>Tolytriazole – biocide suspected of causing sensitisation but no cases of occupational asthma have been linked to exposure.</p>	<p>Present in [REDACTED] at concentration of 0.25%, in [REDACTED] at 0.05% and in [REDACTED] at 0.08%</p>	<p>[REDACTED] used since 1992 (diethanolamine removed 08/02).</p> <p>[REDACTED] used since 1998 (diethanolamine removed in August 2002).</p> <p>[REDACTED] in use since 1994 (diethanolamine removed 08/02).</p> <p>Amount in mist would be extremely low. Would be present in mist at low concentrations <0.001mg/m³ at the guidance value for metalworking fluid concentrate (1mg/m³). Exposures at Powertrain were generally below this value.</p>

Constituent or Contaminant and links to respiratory disease	Quantities found or identified in metalworking or wash fluids/mists	Comment
<p>Sodium Polyacrylate - polyacrylates have been linked to occupational asthma</p>	<p>Present at 0.6% by weight in [REDACTED]</p>	<p>[REDACTED] used since 1992 (diethanolamine removed 08/02).</p> <p>Polyacrylates named as suspected agents in 2 cases in nappy factory but kind of polyacrylate not named.</p> <p>About 50 cases due to monomeric acrylates e.g. cyanoacrylates, methacrylates in the last 15 years</p>
<p>Tall Oil – suspected to be a sensitiser</p>	<p>Present at 10.2% by weight in [REDACTED]</p>	<p>[REDACTED] in use since 1994 (diethanolamine removed 08/02).</p> <p>Would be present in mist at low concentrations <0.1mg/m³ at the guidance value for metalworking fluid concentrate (1mg/m³). Exposures at Powertrain were generally below this value</p>
<p>Formaldehyde¹⁶ released by biocides in use. May cause sensitisation by inhalation and skin contact</p>	<p>Very low concentrations of between 0.0130 and 0.1122 mg/m³ were measured¹⁷ at points around the factory in August 2004.</p>	<p>No new biocides have been introduced since 2000, with no changes in formulation since 2002.</p> <p>Formaldehyde had a MEL of 2ppm/2.5mg/m³ during the period of the outbreak.</p>

¹⁶ Formaldehyde is under review by HSE.

¹⁷ HSL Sample Numbers 03500/04 to 0309/04 taken on 23/8/04