SHORT REPORT

Engine reconditioning workshops: lead contamination and the potential risk for workers: a pilot study

Matthew G James, Brian L Gulson

Abstract

Lead concentrations were measured in surface dust, airborne dust, air, and grinding material from five engine reconditioning workshops to evaluate the impact on blood lead concentrations (PbB) of 10 employees. Lead in the environmental samples ranged from trace amounts to extremely high concentrations (4667 mg/m^2). The highest concentrations in surface wipes were found in areas where engine deposits are removed from valves and valve seats. The amounts of lead in long term dustfall accumulation and static air filter samples varied with the position in the workshop and the amount of ventilation. In all but one workshop, the air lead concentrations exceeded Australian occupational guidelines of 150 µg Pb/m^3. PbB ranged from 4.5 to 25.3 µg/dl. There was an empirical relation between the cleanliness, work practices, ventilation of the workshops, lead concentrations in environmental samples and PbB. Office employees not directly exposed to the leaded dust had the lowest PbB. Those who smoked had the highest PbB. Several relatively inexpensive recommendations were made to the owners to minimise exposure of the workers and in most cases these have been implemented.

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Graduate School of the Environment, Macquarie University, Sydney 2109, Australia
M G James
B L Gulson

Correspondence to: Dr Brian L Gulson, Graduate School of the Environment, Macquarie University, Sydney 2109, Australia.

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Lead toxicity is a major public health concern and a primary environmental health issue. Industries that use lead in manufacturing or in the workplace—such as radiator repair workshops and car battery recycling operations—are legislated as lead industries to protect the workers from exposure to lead.[1 2] The engine reconditioning trade is not classified as a lead process and hence neither workplace nor employees are monitored for lead exposure and there are no regulations about working practices—for example, the mandatory use of properly fitting respirators. About 15% of the lead from leaded petrol is retained in the engine.[3] During engine reconditioning (valve grinding and valve reseating), metal grinding dust of variable particle size from the engine block is generated. Dispersal of lead dust particles throughout the workplace may pose a risk to the workers.

Engine reconditioning involves removal of the cylinder head from the vehicle, dismantling of the cylinder head including removal of the valves, a washing procedure to remove the deposits in the head, and grinding the valve seating in the head with a carborundum stone fitted to a drill (often powered by compressed air). Valves may be buffed with a bench grinder fitted with steel brushes and refaced (ground) on a valve facer fitted with a carborundum stone. These activities produce the bulk of the lead bearing dust as the other operations involve machines producing metallic particles, with cutting liquids an integral aspect of the process.

Methods

There are 94 registered engine reconditioning workshops in New South Wales in Australia. Environmental samples were collected from four workshops in the Sydney metropolitan area and another from a rural town. Blood sampling was only possible in the four Sydney workshops.

Environmental sampling comprised surface dust wipes, dustfall accumulation over 3 weeks,[4] airborne dust with personal air samplers in static mode, and sweepings.

Blood samples were collected by venepuncture from active workers as well as office employees (controls). All subjects gave written informed consent to blood sampling.

Solubility tests used a 2 hour reaction of dust with 0.1 M HCl at 38°C.[5]

Wipes of each hand from one employee were obtained after the head grinding process.

A questionnaire was administered to each subject who gave a blood sample. Questions were especially targeted towards high risk activities, personal hygiene, smoking, and the possibility of taking home lead.

Approval was granted from the Macquarie University ethics committee.

All sample preparation and digestion was performed in a clean room. Environmental samples were prepared by standard

Table 1 Personal information, blood lead concentration, and isotopic composition for employees

Workshop subject	*Sex*	*Age*	*Years in trade*	*Smoker*	*Wash before going home*	*Wear work clothes home*	*Blood lead (μg/dl)†*	*$^{206}Pb/^{204}Pb$*
A1	Male	43	29	No	Yes	Yes	9.5	16.97
A2*	Male	39	??	No	Yes	Yes	4.5	16.97
G1	Male	17	1	No	Yes	Yes	17.0	16.80
G2*	Female	48	15	Yes	No	Yes	5.1	16.76
G3	Male	24	9	Yes	Yes	Yes	10.6	16.92
G4	Male	45	20	Yes	Yes	Yes	25.3	17.23
NR1	Male	22	3	Yes	Yes	Yes	6.0	17.00
NR2	Male	35	15	Yes	Yes	No	9.0	17.06
NR3*	Male	50	20	No	Yes	Yes	5.9	16.98
P1	Male	50	30	No	Yes	No	14.5	16.81

*Office employee.
†Australian worksafe maximum is 50 μg/dl.

techniques—for example, acid digestion—and lead concentrations were measured on a Varian Liberty 220 ICP-AES. Lead isotope ratios and lead concentrations were analysed by isotope dilution thermal ionisation mass spectrometry.[4 5]

Results

Personal information about employees and PbB and isotope ratios are listed in table 1. A summary of the lead data for environmental samples is listed in table 2. Complete data sets are available from the second author.

ENVIRONMENTAL SAMPLES

Lead deposits on heads and valves were found to contain from 10% to 25% Pb; high concentrations were still present in head deposits after cleaning.

The lead concentration in dust on various surfaces was extremely high with overall lead concentrations showing the following pattern:

floor > general work benches > benches adjacent to grinders

The highest values of up to 1375 mg/m^2/30 days for dustfall accumulation were found in the grinding and sandblasting areas. In all but one workshop, airborne dust concentrations exceeded the Australian worksafe atmospheric exposure standard of 150 μg Pb/m^3 .[2]

BLOOD SAMPLES

Smokers had the highest, and office employees, the lowest PbB concentrations. The measured $^{206}Pb/^{204}Pb$ isotopic ratios in blood were within the range for the isotopic composition of petrol lead and particulates measured in Sydney from 1994 to the present with high volume air filters.[6] Ratios for the office workers were similar to those of the exposed employees and indicate that the source of lead in all employees from the one workshop was the engine reconditioning process, regardless of occupation.

LEAD DUST ON HANDS

The hands, washed before grinding the head, contained 21 500 and 38 000 μg Pb per wipe for the right and left hand respectively. These concentrations probably represent a minimum amount of lead dust as they were for only one operation.

Discussion

The amounts of lead present in engine deposits can be extremely high with values of almost 36% Pb found on a valve. Hence in the reconditioning process, the amount of lead in dust can also be extremely high. In the high risk areas—such as valve grinding and facing, up to almost 18% Pb was measured in the floor dust.

The environmental measures show that a considerable amount of lead rich dust of small enough particle size to be airborne (and hence inhaled) is generated during engine reconditioning; air filter measurements, for all but one workshop, showed air lead concentrations that exceeded Australian occupational standards.[2]

Ingestion is also a major route either during the reconditioning operations or through transfer from unwashed hands, through smoking, or food consumption. The very high concentrations of lead up to 38 000 μg Pb/hand on the hands of one worker undertaking the highest risk process of valve abrasion, is a potential source of ingested lead. These values are 50 times higher than for the boys living <1 km from a lead smelter in Belgium.[7]

Another potential route is by skin absorption,[8] especially during hot weather when there is maximum skin exposure and probably maximum sweat production.

Table 2 Lead concentrations of environmental samples

	Wipes		*Grindings*		*Petri dust*		*Air filters (8 h)*	
	Mean	*Range*	*Mean*	*Range*	*Mean*	*Range*	*Mean*	*Range*
Workshop identifier	*(mg/m^2)**		*(mg/g)*		*(mg/m^2/30 days)*		*(mg/m^3)†*	
A	115 (4)	22–227	1 (2)	0.017–2	47 (4)	6.0–84	2.5 (2)	2.0–3.0
G	320 (5)	25–1090	10 (3)	0.15–30	181 (4)	4.7–559	1.0 (3)	0.3–2
NR	55 (4)	11.0–98	13 (3)	0.24–38	4.0 (4)	1.6–10	0.3 (2)	0.3
P	207 (4)‡	27–411	41 (3)	0.02–121	31(4)	7.0–79	81 (2)	19–143
Q	2040 (4)	383–4667	236 (2)	179–292	162 (2)	10–313	0.0447 (2)	0.0024– 0.087

*US HUD recommended clean up level after lead paint abatement 1.1 mg/m^2.
†Australian worksafe maximum is 0.15 mg Pb/m^3 over 8 h.
‡Number of samples analysed.

In spite of the very high amounts of lead in the workshop environment and the soluble nature of the lead deposits, the PbB of the employees did not exceed the Australian occupational guidelines of 50 μg/dl. Although in some cases they did exceed the National Health and Medical Research Council (NH and MRC) goal for all Australians of 10 μg/dl.

There are other potential problems, which were not considered in this study. One is a possibility of the contamination of surrounding areas, as most of the ventilation systems from the workshops were external. Another is the potential of taking home leaded dust, as most workers did not change their clothes or shower before leaving the worksite.

In developed countries that have phased out leaded petrol—for example, the United States, Sweden, Japan), any potential contamination of engine reconditioning workshops would gradually diminish over time, and hence would not be classified as a lead industry. This, however, is not the case in many developing nations, where the overwhelming majority of motor vehicles are old and use leaded petrol.

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