The Lead Education and Abatement Design Group
Working to eliminate lead poisoning globally and to protect
the environment from lead in all its uses: past, current and new uses
ABN 25 819 463 114

Fully Referenced Expanded Version of "New strategies needed to cut lead pollution"

Guest Article, Science and Technology Column, Canberra Times, Thursday 25th January 2001

Lead - From The Petrol Bowser To Blood And Bone

by Elizabeth O'Brien, National Coordinator of The LEAD Group and
Mariann Lloyd-Smith, Coordinator of the National Toxics Network

A RESPONSE TO: "Lead may be dead but we've been had"

As the Australian government moves to regulate new petrol additives, it is an appropriate time to review the petrol policies of the past, in particular, the reduction of lead in petrol. The decisions in 1993 to both reduce lead in petrol and add a price differential of 2 cents (CEPA, 1993) were not popular with old car enthusiasts and still have their critics today. Yet, lead from petrol is found in the dust of people's homes, in ceilings, wall cavities, under the floor and in the carpet. Lead from petrol contaminates the environment and is in storm water, soil, sediments, rivers, lakes, the ocean, plants and animals. In Kalgoorlie, it's estimated 3700 kilograms of lead is washed off the road into the environment every year (NPI, 1998-9).

Simon Grose's article "Lead may be dead but we've been had" [Canberra Times 3rd January 2001 - which is published (without graphs) on their website http://canberra.yourguide.com.au] could leave the readers with a notion that the removal of lead from petrol was an expensive and wasteful exercise. It would also give the uninformed the impression that the driver of every pre-1986 car that remains on the road after 2004 will be forced to add a mock-lead additive at the pump, whereas the vast majority of these drivers will simply be filling up with unleaded. The article also reinforced the myth that a 2 cent price differential between unleaded and leaded petrol was designed to make people sell their pre-1986 car and buy a newer one, when it was clearly designed to get these drivers to switch to using unleaded fuel (CEPA, 1993).

The Lead Roundtable Agreements

Actually, the price differential that made leaded petrol 2 cents per litre dearer in 1993, was designed to encourage the drivers of certain car models (nominated by the manufacturers as either originally designed to run on unleaded petrol or at least capable of doing so), to start using the unleaded petrol that they could have been using since 1985. Additionally, any driver of a car that needed lead as a valve lubricant could have been encouraged by the levy to replace soft valves in their engine for hardened valves - thus enabling their vehicle to run on the cheaper unleaded petrol. And for other old vehicles that were not on "the [AIP, 1992] list" of models that could use unleaded or that needed the higher octane of leaded petrol, the NSW EPA (Environment Protection Authority) published (1994) a fact sheet on how to experiment with using at least some of the cheaper unleaded petrol in each tank-full.

Simon Grose's article failed to acknowledge the other major decision made at the Lead Roundtable - that is, that the amount of lead added to petrol would also be reduced in stages. The combined effect of the two policies - that leaded petrol contained less lead and was more expensive - resulted in a halving of the amount of lead used in Sydney petrol by 1996 (from 1993 levels). Interestingly, a blood lead study of 9-48 month old children in inner Sydney in 1992 found that 50% of these children were lead poisoned (Fett *et al* 1992) and a follow-up study in 1996 found that the rate of poisoning had halved - down to 25% of 9-60 month old children within 10 kms of the Sydney CBD (Mira *et al* 1996). This is using the

The LEAD Group Inc. PO Box 161 Summer Hill NSW Australia 2130
Phone: (02) 9716 0966 Email: www.lead.org.au/cu.html Web: www.lead.org.au

current US definition of lead poisoning ie a blood lead level above 10 micrograms per decilitre. It is the Australian goal that all Australians have a blood lead level below 10 micrograms per decilitre (µg/dL).

The 1998 report by the global Inter Organisation Programme for Sound Management of Chemicals (IOMC, 1998, pp3-4), which includes the World Health Organisation, confirmed that lead can damage the nervous system, has adverse reproductive affects, impairs the functioning of the immune system and can cause cancer.

The US EPA (Environmental Protection Agency) has estimated that 4-5 million tons of lead have been deposited in the environment in the United States since the introduction of leaded petrol in the 1920s. In Europe, estimates of lead emissions from petrol have tracked a reduction from 64,000 tons in 1985 to 32-54,000 tons in 1990 (IOMC, 1998, p22). In Australia, there are no national estimates of lead emissions however, Western Australian regulators reporting to the 1998-99 National Pollutant Inventory (NPI) stated that over 43,000 kilograms of lead compounds were released to Perth's air shed from automobiles.

Octel Ltd, the largest manufacturers of lead for petrol, have estimated that, over 50,000 km of driving, about 73% of total lead input will be emitted, so around one quarter remains in the car and can be released to the environment during maintenance of the engine or exhaust system or if the car is burned, dumped or recycled.

Lead - from the air - into our blood

The particles of airborne lead from traffic are extremely small and are inhaled deep into the lungs (Cribb, 1994). An abundance of studies has shown that lead in all forms (including from vehicle exhausts) is both inhaled into the lungs and absorbed. Though it's a long quote, it's worth reading the following from NRC (1993, p144-6):

"Humans absorb lead predominantly through the gastrointestinal and respiratory tracts…

"Inhaled lead is deposited in the upper and lower reaches of the respiratory tract. Deposition in the upper portion leads to ciliary clearance of the lead, swallowing, and absorption from the intestine. Smaller lead particles, especially those less than 1 um in statistically averaged diameter, penetrate the lower, pulmonary portion of the respiratory tract and undergo absorption from it.

"Human studies (Chamberlain, 1983; EPA, 1986a) have shown that about 30-50% of inhaled lead is retained by the lungs (the range reflects mainly particle size and individual breathing rate). These studies have used unlabelled lead aerosol (Kehoe, 1961a,b,c), radio labelled oxide aerosol (Chamberlain et al, 1978), lead fumes inhaled by volunteers (Nozaki, 1966), ambient air lead around motorways and encountered by the general population (Chamberlain et al, 1978; Chamberlain, 1983), lead salt aerosols inhaled by volunteers (Morrow et al, 1980), and lead in forms encountered in lead operations, fumes, dusts, etc. (Mehani, 1966). Most (over 95%) of whatever lead is deposited in the human pulmonary compartment is absorbed (Rabinowitz et al, 1977; Chamberlain et al, 1978; Morrow et al, 1980). Thus, the overall rate of uptake is governed by lung retention (ie, 30-50%). Uptake occurs rapidly, generally in a matter of hours.

"Evidence of complete and rapid uptake can be gleaned from analysis of autopsy lung tissue (Barry, 1975; Gross et al, 1975). The chemical form of inhaled lead appears to have little effect on uptake rate (Chamberlain et al, 1978; Morrow et al, 1980)."

Having been one of the instigators (O'Brien, 1992; Gordon 1992; Greenpeace 1992) and also a community representative at Ros Kelly's Lead Roundtable, one of the present writers, Elizabeth O'Brien, can vouch for the fact that the 1992 Sydney blood lead study was brought to the attention of Ros Kelly. But no blood lead studies were actually considered at the Roundtable (CEPA, 1993a). Instead, the conclusions of the review of 600 lead studies, by the International Program on Chemical Safety (IPCS) of the World Health Organisation (WHO, 1992) and the directive of the National Health and Medical Research Council (NHMRC, 1993) were accepted as the starting point. As Ros Kelly (1993) said in her opening speech, "The purpose of our meeting today is to talk about how we, as a nation, can reduce the amount of lead in petrol and increase the use of unleaded petrol. In this way, we can begin to solve the very serious problem we have of a large number of children in Australia being adversely affected by lead." The graph showing the lock step reduction of US blood lead and petrol lead levels (Annest, 1983 - see Figure 2 at www.princeton.edu/~vmthomas/pb_elim/pb-elimination.html) was not actually considered at the Roundtable meeting at all, though it was one of the 600 studies reviewed by WHO.

The price differential was regarded as a fair and equitable move for the government to make because it had been shown in a number of OECD countries that a price differential led to a more rapid phase-out of leaded petrol. The OECD had stated in 1992 that: "because the phasing out of leaded gasoline has led to dramatic decreases in atmospheric lead levels, it is clearly the most important single measure for lead risk reduction. Ros Kelly herself noted (as did the CEPA Options Paper, 1993) that though people who owned older cars would be the hardest hit by the price differential, as the lowest socio-economic groups are also the most likely to be lead poisoned, the poorest people in the community would have the most to gain from the new levy, in terms of reduced lead pollution.

The mixture of stakeholders at the Roundtable all understood the logic that if you add lead to petrol, it will raise air lead levels, everyone breathes, so blood lead levels will be raised throughout the community - we can call this the baseline

The LEAD Group Inc. PO Box 161 Summer Hill NSW Australia 2130
Phone: (02) 9716 0966 Email: www.lead.org.au/cu.html Web: www.lead.org.au

blood lead level. Then if you add on to that lead from any other of a range of sources, some people in the population will have a high blood lead level. So public health policies are currently ensuring throughout the world that the baseline (the lead contributed to blood by lead from petrol) is as low as possible - because eliminating lead from petrol is one of the cheapest and most cost effective ways of reducing the number of people with high blood lead levels. That's why, to our shame, 55 countries will have eliminated lead from petrol before Australia does, that is, by 1st January 2002 (LEAD Group, 2000).

Problems with the lead industry graph

Simon cited a graph of hand-picked blood lead studies that the lead industry research arm - International Lead Zinc Research Organisation (ILZRO) submitted only for the final version of the OECD lead policy development process. This version was published in 1993 but two earlier drafts, in 1991 and 1992 did not include the ILZRO information so the material was never reviewed by government and environment group reviewers (such as The LEAD Group Inc) before it was published in the OECD monograph in 1993. It has since been thoroughly criticised by a Princeton University researcher, Valerie Thomas, in an extensive article available on the web at www.princeton.edu/~vmthomas/pb_elim/pb-elimination.html (where both the graphs that Simon Grose published in his article in the Canberra Times, can be found.)

The 36 studies graphed by ILZRO were dated between 1933 and 1985, showing a steady decline in the lead levels in human blood streams, at the same time as lead began to be added to petrol in 1925 peaking in 1970. Only three of the 36 carefully selected US studies were included in the 1992 WHO (World Health Organisation) review of blood lead studies which referenced over 600 mostly US studies. It is important to question how the industry determined which studies to include and which to leave out, rather than trust the industry graph without question. The lead industry graph plotted mean blood lead levels from the different studies whether there were 10 people in the study or 500, whether they were lead workers or slum children.

It makes sense that if you plot workers blood lead levels from various studies on a graph, you will see a decline over time - if you didn't, there would be an outcry about the inability of Occupational Health and Safety Regulations to protect workers. And if you plot the blood lead levels of smelter and mining town communities, you would similarly expect to find a decline over time as ways of protecting these communities from lead have been developed. Then if you take into account that legislation reducing lead in various consumer products in the US has contributed to less lead being available in newly purchased products for children eg toys, cot paint, house paint, drink and food cans, ceramics and art materials, you would also expect a decline in blood lead levels found in these studied populations. Is it so hard to comprehend a rising blood lead level in the general population up to 1970 due to lead in petrol throughout a period of declining blood lead levels for workers, smelter communities and people exposed to particular consumer products?

A more comprehensive plot of all available studies would possibly show these conflicting trends (blood lead levels from petrol lead going up to the peak of lead petrol usage in 1970 while blood lead levels from other sources were coming down). Such a graph would always have the problem though, of appearing to compare non-comparable study groups and comparing data from a period of extremely high lead contamination levels to data with relatively uncontaminated sampling and analysis techniques from the last quarter century. As Thomas (1995) says:-

"By the mid-1970s, procedures for contamination avoidance and quality assurance had been widely adopted, and the trend in the more recent data in Figure 3 [the ILZRO graph] can be interpreted as a true reduction in blood lead levels in the United States. However, the trend in the data up to the 1960s reflects improved measurements and cannot be interpreted as a reflection of the true values."

Lead contamination of blood samples typically occurred through lead contamination of skin, glassware, detergents, swabs etc. Therefore, any comparison of blood lead levels over such a long period of time when sample contamination decreased drastically will show a decrease in blood lead levels.

There are many more studies than those graphed, which report on US blood lead results in the period. For instance, not one of the 65 blood lead studies comprehensively reviewed in the first draft of the OECD lead document (1991, *Appendix H - "Lead Occupational Exposure Findings, by Reference"*) was included even though most of them were US studies. Only three of the 36 ILZRO selected studies were included in the IPCS review (1992) by the World Health Organisation which referenced over 600 studies, again, mostly US studies.

It would be interesting to know how many of the graphed studies were funded by ILZRO. According to the OECD Lead monograph (1993, p227) *"Annual ILZRO expenditures for the conduct of lead health-related research will typically range between [US] $400,000 and $600,000."* Industry money had been used before to criticise the US leaded petrol phase-out policy. For instance, Needleman (1992, p 278) refers to a classic example about a report written by a man called Tozzi:

"Tozzi had a reputation with environmental managers as fair minded and hence was usually taken more seriously than were direct representatives of industry. He had been involved in earlier lead analyses in OMB [US Federal Office of Management and Budget] and after he left government in early 1984 he established his own consulting service and was hired by the Lead Industry Association to press its case.

The LEAD Group Inc. PO Box 161 Summer Hill NSW Australia 2130
Phone: (02) 9716 0966 Email: www.lead.org.au/cu.html Web: www.lead.org.au

"Tozzi proceeded to do so with a report that the EPA's [US Environmental Protection Agency's] cost/benefit analysis was seriously flawed and that a more proper study would indicate that "benefit represent only a fraction of the costs" - benefit of $559 million and costs of $9,922 million, much reverse of the EPA figures. Embedded in this analysis was major objection both to the EPA conclusions about the health effects of lead and the damage from lead to automobile engines. A comment from one EPA staffer reflected the agency's reaction: "It just goes to show that for the right amount of money you can make the numbers say anything."

The implication from Grose's use of the ILZRO graph is that the populations sampled in the blood lead studies were representative of the general population. However, until it was recognised that leaded petrol emissions were lead poisoning the whole population, only populations who were exposed to particular sources of lead were tested, as Smith (1989, p37) confirms: *"Most of the early lead studies were of social disadvantaged populations, either living in close proximity to industrial premises, or in inner-city slum areas."* As can be seen from the titles of the studies included by ILZRO, some of the studies were of workers, who always have higher blood lead levels than the general population, for example:

"Lead Exposure Among Decorative and House Painters",

"Relationship of Biological Indices of Lead Exposure to the Health Status of Workers in a Secondary Lead Smelter", and

"Lead Exposure in Stained Glass Workers".

The issue has been raised that the ILZRO graph indicates that blood lead levels are independent of the amount of lead used in petrol, yet half of the ILZRO graph (the post-1970 studies) confirm the downward trend in blood lead levels in the general population as lead was phased out of petrol and during the period when contamination of blood samples was being controlled. So the only part of the ILZRO "trend" graph that conflicts with the correlation found in the analysis of the National Health And Nutrition Examination Survey (NHANES) studies (Annest *et al*, 1983), between blood lead levels and the amount of lead used in petrol is the period from 1935 to 1970 (when the tonnage of lead used in petrol reached its peak). The pre-1970 dot points on the graph came from just 14 studies (or 13 if the Kehoe "study" is not a separate study [see below]) and involved as few as 10 people's blood lead results per study.

Look for yourself at the ILZRO graph of blood lead study results (the little circles) and of the lead used in petrol in the US over a similar period (Figure 3 at www.princeton.edu/~vmthomas/pb_elim/pb-elimination.html). Notice how few of the graphed blood lead studies you would have to exclude (as being invalid for the above reasons) - basically the first 6 little circles from the earliest studies at the top left of the graph - to make the "downward trend" between the mid 1930s and the mid 1950s, not a trend at all.

Notice that one little circle "carries" the trend from the mid 30s to the mid 50s. The 1946 reference appears to be the same results as have already been plotted at 1935. The reference list reveals that the 1935 study and the 1946 study both had 30 participants with a mean blood lead level of 27 µg/dL. The researchers for the 1935 study were Kehoe, Cholak and Story. The 1946 study was a conference paper by Kehoe. It seems highly likely that Kehoe was presenting the 1935 results at a 1946 conference and ILZRO counted them twice. Then look at the way ILZRO has turned their series of chosen dots into an unjustified "trend line" and laid the dubious blood lead graph over the petrol lead graph. How easy this makes it to not question the accuracy of the early studies and to forget the missing hundreds of blood lead studies from the period which were excluded for no stated reason.

The ILZRO graph is often used without reference to its source and without commenting on the highly questionable uses it has been put to, for example, by an important Australian authority, in a successful attempt to convince the Australian government that international pressures were threatening Australia's lead industry. ABARE (Australian Bureau of Agricultural and Resource Economics) used the graph in a 1994 "research report" on the implications of the OECD lead strategy for Australian lead exports. It was the only blood lead graph reprinted from the OECD lead monograph, from a choice of many others provided by national governments. As the NHANES (Annest) graph from the US was not included, the ABARE authors (Cox *et al*) were able to cast doubt on the general trend of reduced blood lead levels as lead in petrol was reduced. Our national resources research institution only used this industry-devised graph, **and did not include a reference source for it.** There follows, an extract from the ABARE Acknowledgments and some pertinent quotes from the report:

In 1992-3, lead exports from Australia were valued at $408 million, making Australia the world's largest exporter of lead.

Acknowledgments

Preparation of this report was assisted by funding provided by MIM [Mt Isa Mines] Holdings Ltd…. The authors would like to acknowledge the comments and assistance provided by… David Hughes from MIM.

Policy Responses

…in many countries, policies implemented and designed to increase the use of unleaded petrol and reduce exposure to lead risks have sometimes been credited with apparent reductions in blood lead levels. Analysis of statistics from the

The LEAD Group Inc. PO Box 161 Summer Hill NSW Australia 2130
Phone: (02) 9716 0966 Email: www.lead.org.au/cu.html Web: www.lead.org.au

1970s tends to indicate this correlation in the United States. However, when a longer time series of data is considered (figure E [figure E is the ILZRO graph]), it becomes apparent that there has been a downward trend in blood lead levels since the 1930s. At the same time, use of lead in petrol rose substantially from 1930 to its peak in the early 1970s. This suggests that blood lead levels are not solely related to the amount of lead used in petrol, but rather are likely influenced by a variety of the exposure pathways already outlined… This scientific uncertainty highlights the difficulty of ensuring that the economic costs of policies to constrain or ban particular uses of lead are exceeded by the health benefits.

Assistance from the lead mining industry to write a government report, and the use of only an industry-generated graph, has resulted in this instance in doubt being cast on the benefits of any constraint or ban on any particular use of lead.

It is interesting to compare the above evidence to a statement made by R. D. Greenway (1998): "The authorities in Australia have used every trick imaginable to support unleaded petrol, even to doctoring graphs and charts." And then to compare that statement to the more recent accusation of a trick (following).

Lead in blood in the general population - the NHANES studies

The study cited in the Canberra Times article as a "trick" is a far more honest study than the lead industry graph. The 1976-80 NHANES (National Health And Nutrition Examination Survey) US study measured blood lead levels in nearly 10,000 people, this is nearly **twice** the total number of people blood lead tested in all 13 of the pre-1970 studies put together, for the ILZRO graph. Because so many people were involved in the NHANES study, numbers in most of the sub-groups are large enough to make the results statistically significant. Over the four years of the survey, the levels of lead in people's blood dropped significantly and almost exactly in step with the decline in the amount of lead added to petrol, following initiatives to encourage cars to run on unleaded petrol begun in 1975.

As opposed to the industry graph, the NHANES evidence is especially reliable and convincing since the correlation between lead levels in people's blood and the amount of lead added to petrol is very close and the correlation held in almost every case when the sample was sub-divided into groups defined by age, sex, race, family income, season, region and type (urban or rural) of residence.

Also, a careful control programme showed that the trends were not due to changes in laboratory practice. Throughout the four years of the survey, there were no chronological trends in blind controls that were analysed.

To put paid to the suggestion "that airborne lead from car emissions was not a major source of lead in human blood" the NHANES follow-up to the 1976-80 study provides compelling evidence of the huge impact of lead from petrol, as the following list of results indicates (Pirkle *et al*, 1994):

The mean blood lead level of persons aged 1 to 74 years dropped 78%, from 12.8 to 2.8 µg/dL. Mean blood lead levels of children aged 1 to 5 years declined 77% [13.7 to 3.2 µg/dL] for non-Hispanic white children and 72% [20.2 to 5.6 µg/dL] for non-Hispanic black children. The prevalence of blood lead levels 10 µg/dL or greater for children aged 1 to 5 years declined from 85.0% to 5.5% for non-Hispanic white children and from 97.7% to 20.6% for non-Hispanic black children. Similar declines were found in population subgroups defined by age, sex, race/ethnicity, income level, and urban status.

The NHANES follow-up study estimated as of July, 1994 that 210,000 children under age six in the United States had levels of 20 ug/dL or higher [twice the Australian goal], which is a 96 % drop from the 4.7 million estimate from 1980. The Centers for Disease Control has attributed the drop to the elimination of lead from gasoline and solder on food cans (Brown, 1996).

In 1996 the national blood lead survey estimated that there were 75,000 1-4 year old children in Australia above the Australian blood lead goal (Donovan, 1996; Gilchrist and Beale 1996). Unfortunately for all children, there is no safe level of exposure to lead as no threshold level has been found. Changes in blood enzymes and disruption to children's neurobehaviour and IQ are evident at levels below the Australian goal. In the US, recent research into the effects of lead at even lower levels has prompted a call to halve the "acceptable" level to 5 µg/dL. The renowned lead researcher, Professor Herbert Needleman, (Professor of Pediatrics and Psychiatry at the University of Pittsburgh) has demonstrated a strong correlation between the levels of lead in the bones of youths and their delinquent behaviour. Moss *et al* (1999) used NHANES data to conclude that for every 5 ug/dL increase in blood lead level, children show an 80% increase in the number of dental caries. The social implications of effects of lead on behaviour may be even more profound than those on intelligence. New York researchers, Mendelsohn *et al*, in 1998 demonstrated adverse behaviour changes in 1 to 3 year olds with "low" blood lead levels, when compared to children with very low levels. And Lanphear found cognitive impairment, affecting maths ability and especially affecting reading ability, in children with levels as low as 2.5 µg/dL (Tanner, 2000).

During the slow lumbering phase-out of leaded petrol in Australia, air lead levels have been gradually reduced and blood lead levels have fallen as a result. Isotopic research in the early and late nineteen-nineties determined that the contribution from petrol to lead in air in Sydney and Melbourne remained constant at 90%, but the air lead level had been reduced by 75% in that time (Chiaradia *et al*, 1997). It is expected therefore that there are no longer 75,000 lead

The LEAD Group Inc. PO Box 161 Summer Hill NSW Australia 2130
Phone: (02) 9716 0966 Email: www.lead.org.au/cu.html Web: www.lead.org.au

poisoned pre-schoolers and the government appears to be so confident of this that there is no intention to carry out the planned follow-up to the national blood lead survey of children.

The Grose article refers to an ad hoc 1993 Victorian study, which supposedly indicated that only 3 children were above the Australian goal of 10 µg/dL. In fact the study states that over 8% of the under 5's, the highest risk category, had a lead level above the Australian goal. The researchers in this study also acknowledged that the reduction in lead levels seen since 1979 was attributable to better food processing and the reduction of lead in petrol in Victoria. Victorian petrol has since 1983 had the lowest lead content of any petrol in Australia.

In reality it happens rarely if at all, that a study has the capacity to show blood lead levels in the same population (the general population) under the influence of just one variable - lead from petrol. It happened once in Italy, according to New Scientist: "In [an] Italian study (in Turin and Piedmont), lead from the Broken Hill mine in Australia was put in petrol sold in the area for almost two years between 1977 and 1979. This lead has a different ratio of the isotopes lead-206 and lead-207 from lead from other sources. So researchers could find out how much of the lead in people's bodies came from this source merely by measuring changes in the isotopic ratios of the lead in their blood. They found that the ratio characteristic of Broken Hill lead dropped by 30% for people in Turin after 1979, suggesting that lead from petrol makes up a similar percentage of the total burden of lead in the body."

It should be noted that the above estimate as to the contribution of lead from petrol to lead in blood was made in an era where many other sources of lead were less controlled than they are now in people's workplaces, hobbies and homes. A more recent analysis by Thomas *et al* (1999) of blood lead studies in 17 locations on 5 continents which compared population blood lead levels before and after changes in use of petrol has concluded that:-

"As GPb [lead in gasoline] is reduced to zero, blood lead levels across locations converge to a median of 3 µg/dL. This convergence of BPb [blood lead] levels occurs at different times for different locations and corresponds to the timing of gasoline lead reductions. For those [eleven] locations with available air lead data, air lead concentrations converge to [less than or equal to] 0.2 µg/m^3 [which compares to Australia's plan to achieve less than 0.5 µg/m^3 by 2008] as GPb is reduced to zero. Together, these features indicate that gasoline lead levels have been a major causal factor in the observed reductions in population blood lead levels at these locations and show that BPb levels of about 3 µg/dL are widely achievable."

In 1993, Julian Cribb reported an estimate that reducing lead in petrol would save more people's lives (from fatal heart attacks and strokes) than the road toll each year.

It is sobering to consider that 55 countries will have eliminated lead from petrol before Australia does by 1st January 2002.

Lead is not dead

Do we have a lead-free future? Absolutely not! With the car population increasing at a rate twice as fast as the rate of human population growth, the global tonnage of lead mined and smelted increases every year, largely to keep up with the demand for lead acid batteries. So communities around lead mines and smelters will continue to be impacted by the lead we all want to be able to drive around in our cars.

Now that the end of one of the most dispersive sources of lead is close, we need to look at where all the lead from petrol ends up - in soil, ceiling dust, wall and window cavity dust, underfloor cavity dust, stormwater, sewage, sediments, rivers, lakes, the ocean, plants and animals - (mainly stored in bone). And we need to look at who is most at risk of being lead poisoned from this contamination.

So unfortunately, lead in air or blood is not the end of the story. Renovators can release huge amounts of lead by dry sanding or heat gunning old paint but demolition of ceilings or walls in highly trafficked areas will also release some lead because wall and ceiling and under-floor cavities in buildings are just a repository for all the air pollution fall-out that has occurred during the life of the building. This makes the children of renovators or those living in old houses especially at risk of lead poisoning in the future. Most inner city residential soil samples exceed the acceptable level of lead in soil of 300 parts per million (Fett *et al*, 1992). So unless you are "lucky" enough to have a federal government funded clean out of your ceiling cavity (prior to putting in noise insulation for an Aircraft Noise Insulation Project), then you will have to pay for the clean-up of lead contamination yourself. And for parents of young children, constant vigilance is required to prevent lead poisoning.

Lead and aging - from bones back into blood

Yet, the position could be even worse for all those of us who were around during the greatest period of lead poisoning of the general population. Following absorption of lead into the bloodstream, the body stores lead in bone and as we age - or during pregnancy and breastfeeding (Gulson *et al* 1997; Gulson *et al* 1998) the bone lead stores can be returned to the blood enabling the lead to do more damage (Balzer, 2000). Lead released from the bones adds to the lead currently being absorbed from the environment and recirculates via the blood stream for a second round of negative impacts on hearing,

The LEAD Group Inc. PO Box 161 Summer Hill NSW Australia 2130
Phone: (02) 9716 0966 Email: www.lead.org.au/cu.html Web: www.lead.org.au

balance, memory, blood pressure, libido, sperm production, haem synthesis, vitamin D metabolism, kidney function etc. Lead speeds up brain aging (McKinney, 2000; Schwartz *et al*, 2000) and has recently been found to be associated with Alzheimer's disease (American Academy of Neurology, 2000; CNN.com, 2000).

With so many people having higher blood lead levels in the past than today, it is little wonder that we associate aging with many of these effects of lead poisoning - poor memory, falls (from loss of balance), loss of libido, strokes and heart attacks (from high blood pressure), tooth decay, Alzheimer's disease. It is fair to say that all these effects of lead add up to a reasonable description of what we think of as "normal" aging and it is certainly time that we measured blood lead levels in older people who display these symptoms before discounting their symptoms as just "a natural part of getting old". This is such an important issue that the Lead Advisory Service Australia recently created an information pack on "Lead and Aging", available by phoning 1800 626 086.

Reduced vehicle maintenance costs with lead phase-out

One completely neglected issue is that there are economic benefits of reducing lead in petrol in terms of reduced maintenance costs for the vehicle. In 1985 the US EPA published a cost benefit analysis of a stepped phase-down of the level of lead in leaded petrol (with steps to occur by July 1985 and by January 1986) which estimated the total maintenance benefits of the phase-out as (in 1983 US$) $252 million in 1985, rising to $933 million in 1986. The analysis (Schwartz *et al*, 1985) included the following information on maintenance issues affected by lead or the scavengers that are always included in leaded petrol in an attempt to overcome some of these problems:

Reducing lead in gasoline can result in less frequent replacement of exhaust systems and spark plugs and less frequent oil changes…

Vehicles experience fewer exhaust system failures using unleaded gasoline than leaded because of the difference in acidity in exhaust gas concentrates…

This higher acidity accelerates corrosion in mufflers and tailpipes…

The corrosive effects of lead and its scavengers also reduce the useful life of spark plugs…

The combustion products that deposit on engine surfaces cause corrosion and rusting. Engine oil accumulates much of the debris from this corrosion, as well as some portion of the gasoline lead. According to at least one estimate, up to 10 percent of the lead in gasoline ends up in the used oil, comprising up to 50 percent of the weight of engine oil sludge….

The evidence indicates that there is a relationship between lead additives and oil change intervals shown through reduction in engine and engine-parts wear (from reduced abrasive lead particles or reduced rust), oil degradation, and general engine and engine-part cleanliness (eg lack of deposits and sludge). One indication of this relationship is the fact that manufacturers' recommended intervals between oil changes have more than doubled since the introduction of unleaded gasoline…

Call for a new national lead strategy

It is still the best public health policy to remove lead from petrol even if some people have high blood lead levels due to paint or other sources – there is wisdom in taking the lead out of petrol as a first step to reducing the baseline level of lead in blood, to which all other sources are added. What remains to be done in Australia is to lower the goal for blood lead levels, eliminate lead poisoning and clean up the lead contamination of our environment. It would certainly be a fair and equitable tax if the 2c/litre levy was used to do this. Up to the beginning of 2000, the total income from this levy was in excess of $725 million. Around 40% of the children in lead smelter and mining towns in Australia are still lead poisoned and in South Australia and NSW they are receiving some state government assistance (a total of around $50 million) to clean up the contamination that industry continues to cause.

Unknown numbers of adults and children elsewhere are lead poisoned yet the federal environment minister contends that the $15,000 annual grant provided to The LEAD Group to run the Lead Advisory Service Australia is an appropriate level of funding to cover the annual call rate of over 5,500 calls handled by the service (Hill 2000; LEAD Group, 1996).

For information and referral about all lead hazards phone the Lead Advisory Service Australia [LASA] (staffed by dedicated volunteers due to insufficient government funding) - Freecall 1800 626 086.

ENDNOTES - Leaded petrol phase-out helped reduce benzene emissions

In the last paragraph of the Canberra Times article, the issue of benzene in vehicle emissions was mentioned:- "many of our post-1986 cars have inefficient catalytic converters, causing our unleaded emissions to contain high levels of benzene". A fuller account of the benzene issue is called for, but briefly no matter how "high" the levels of benzene are currently, the levels are lower now than during the reign of leaded petrol:

Lead in petrol prevents the use of catalytic converters as the lead poisons the catalytic converter. Catalytic converters reduce more than just benzene emissions.

The LEAD Group Inc. PO Box 161 Summer Hill NSW Australia 2130
Phone: (02) 9716 0966 Email: www.lead.org.au/cu.html Web: www.lead.org.au

In 1996 the CSIRO reported that over the whole fleet (including poorly performing cars) catalytic converters reduce aromatic emissions of benzene on average by 70 per cent

Valerie M Thomas (1995) has reported that:-

"Octel, the manufacturer of TEL [tetra ethyl lead - the lead additive in leaded petrol], has made the benzene emissions of unleaded gasoline the focus of its international effort to market leaded gasoline. According to John Little, Managing Director of Octel, "We have launched a worldwide effort to promote the dangers of using unleaded gasoline, particularly in cars that are not equipped with catalytic converters…For the past five years we have been visiting developing countries to promote the use of leaded gasoline and to warn against the use of unleaded in non-catalyzed cars". This corporation has actively campaigned in the United Kingdom, Israel, Egypt, Hong Kong, Italy, the Philippines, New Zealand, Australia, and elsewhere. Octel claims that use of unleaded gasoline in cars without catalytic converters may increase exposure to benzene. Based on this claim, Octel argues that only cars with catalytic converters should use unleaded gasoline."

The levels of benzene in unleaded and leaded petrol in Australia are essentially the same. Leaded petrol is basically unleaded petrol plus lead (NRMA, 1996). Yet the 1996 CSIRO report showed that using Australian unleaded petrol compared to using leaded petrol in pre-1986 cars even without catalytic converters reduced the volume of emissions of benzene on average by 30 per cent. The reduction of benzene and other aromatic emissions from low octane unleaded fuel may be the result of the more efficient combustion of petrol in the absence of lead.

So in stark contrast to the policy of Octel to promote the dangers of unleaded petrol in regard to benzene emissions in Australia (Gidlow, 1995; Associated Octel, 1995a,b,c&d), Australia has seen an excellent reduction in the total estimated benzene emissions (AIP, 1994) from our car fleet over the period of the phase-down of leaded petrol - both due to more drivers using unleaded petrol in cars without catalytic converters and the fact that all new cars since 1986 have had catalytic converters.

Up to 20% of benzene emissions from vehicles are due to fuel evaporation (AIP, 1995) and since these emissions don't pass through the catalytic converter, evaporative emissions are the same regardless of the efficiency or presence of a catalytic converter (Thomas, 1995)

A World Bank report from 1998 states that "the magnitude of health impacts caused by benzene exposure should be compared to those of lead exposures. [The US EPA] estimated that 47 cases of deaths from leukemia could be attributed to the exposure from gasoline. For comparison, the annual number of deaths avoided by the reduction of lead in gasoline (only one of the positive impacts of reducing lead), has been estimated between 4,000 and 5,000." (Lovei, 1998)

There are far greater concerns about benzene emissions from non-vehicle sources. The exposure of smokers to benzene, for example, exceeds the exposure of non-smokers nearly 10 times (Lovei, 1998)

REFERENCES:

1. AIP (Australian Institute of Petroleum Ltd), *"Estimated Relative Benzene Exhaust Emissions from Australian Car Fleet"*, Fax sent to Elizabeth O'Brien in 1994 by AIP, Melbourne
2. AIP, *FACTSHEET* "*Benzene in Petrol*", (Available at www.aip.com.au - Education site, On-line resources, Petroleum Topics) 1995, Melbourne
3. AIP, *Pre-1985 Cars Suited to Unleaded Petrol ["The List"] - Supplement to AIP News,* July-August 1992, Melbourne
4. American Academy of Neurology, *MEDIA RELEASE: On-the-Job Lead Exposure Could Increase Alzheimer's Risk*, 3rd May 2000
5. Annest, JL, *GRAPH: Change in Blood Lead Levels in Relation to a Decline in Use of Leaded Gasoline, 1976-1980*, from *Trends in the blood lead levels of the US population,* in "Lead versus Health" edited by M Rutter and RR Jones, John Wiley and Sons, Chichester and New York, pp33-58June 1983
6. Annest, Joseph L; Pirkle, James L; Makuc, Diane; Neese, Jane; Bayse, David; & Kovar, Mary Grace, *Chronological Trend In Blood Lead Levels Between 1976 And 1980,* The New England Journal Of Medicine Vol 308 No 23, 9th June 1983
7. Associated Octel, *Associated Octel: Fuel Composition Analysis and Information*, 1995, South Wirral, UK
8. Associated Octel, *NEWSLETTER: Petroleum, Air Quality and Health - Firm Evidence of unleaded's greater carcinogenic content*, 1995, South Wirral, UK
9. Associated Octel, *PAMPHLET: Petrol - Facing Reality*, 1995, South Wirral, UK
10. Associated Octel, *PAMPHLET: Petrol and the Air You Breathe*, 1995, South Wirral, UK
11. Balzer, Dr Ben, *Lead Poisoning - [PowerPoint Presentation]* on The LEAD Group's website at www.lead.org.au/bblp/sld012.htm September, 2000, Sydney

The LEAD Group Inc. PO Box 161 Summer Hill NSW Australia 2130
Phone: (02) 9716 0966 Email: www.lead.org.au/cu.html Web: www.lead.org.au

12. Brown, Craig (1996) *"Question: Will Lead-Paint Litigation Be as Big as Asbestos? Answer: We Can Only Hope it Will Be That Small"* in *For the Record* published by Luce, Forward, Hamilton and Scripps, Vol 11, No 1, Spring 1996
13. CEPA (Commonwealth Environment Protection Authority), *Lead Roundtable [Agreements] - 29 July,* 1993, Canberra
14. CEPA (Commonwealth Environment Protection Authority), *Roundtable Conference on Lead - First Meeting - Lead in Petrol: Options Paper - 29 July*, 1993a, Canberra
15. Chiaradia, Massimo; Gulson, Brian L; James, M; Jameson, CW; and Johnson, D, *Identification Of Secondary Lead Sources In The Air Of An Urban Environment*, Atmospheric Environment Vol 31 No 21, August 1997
16. CNN.com, *Lead Exposure, Inactivity Linked To Alzheimers*, 4th May 2000, www.cnn.com
17. Cox, Anthony; Beil, Stuart; and Neck, Moston, *"The OECD Risk Reduction Strategy for Lead: An Economic Perspective - ABARE [Australian Bureau of Agricultural and Resource Economics] Research Report 94.12"*, Commonwealth of Australia, 1994, Canberra
18. Cribb, Julian, *Death Comes in an Invisible Chemical Soup* in LEAD Action News Vol 2 No 4 p4 Spring, 1994, published by The LEAD Group Inc., Sydney
19. Cribb, Julian, *Toxic Lead Deaths Overtake Road Toll*, The Australian, 8th Sept 1993. Reprinted in LEAD Action News, vol 3 no 3, Winter, 1995, published by The LEAD Group Inc., Sydney
20. Donovan, John, *Lead in Australian Children - Report On The National Survey Of Lead In Australian Children,* AIHW (Australian Institute of Health & Welfare), 1996, Canberra
21. EPA (Environment Protection Authority) NSW, *FACTSHEET: Unleaded Petrol and Pre-1986 vehicles*, 1994, Sydney
22. Fett MJ; Mira M; Smith J; Alperstein G; Causer J; Brokenshire T; Gulson B; Cannata S, *Community Prevalence Survey Of Children's Blood Lead Levels And Environmental Lead Contamination In Inner Sydney,* MJA [Medical Journal of Australia], Vol 157, 441-445, 5th October 1992
23. Gidlow, Dr David, Company Medical Officer, Associated Octel, *Gasoline Composition: No Such Thing as "Green" Fuel* letter to Consumer's Health Forum of Australia, March 24, 1995, South Wirral, UK
24. Gilchrist, Gavin and Beale, Bob, *Lead Damaging IQ's of 75000 children,* Sydney Morning Herald, 29th March 1996, Sydney
25. Gordon, Theresa, No-LEAD, *Letter to Environment Minister Ros Kelly seeking a national lead strategy and international cooperative lead risk reduction strategy,* 10th May, 1992, Newcastle NSW
26. Greenpeace Australia Ltd, *Briefing Notes - LEAD IN AUSTRALIA: The Poisoning of Our Children - The need for urgent coordinated activity by the Australian Federal government,* May 1992, Sydney
27. Greenway RD, *Leaded vs Unleaded* in "Pacific Ultralights Monthly" magazine, early 1998
28. Gulson, B.L., Jameson, C.W., Mahaffey, K.R., Mizon, K.J., Korsch, M.J., Vimpani G. *Pregnancy increases mobilization of lead from maternal skeleton.* J. Lab Clin Med., 130, 51-62. (MRF/926) 1997
29. Gulson,B.L., Jameson, C.W., Mahaffey, K.R., Mizon, K.J., Korsch, M.J., Cameron, M.A., Vimpani, G., Eisman, J.A. *Mobilisation of lead from the skeleton during the post-natal period is larger than during pregnancy.* J Lab Clin Med., 131, 324-329. (MRF/955) 1998
30. Hill, Senator Hon. Robert, *LETTER: $15,000 Grant is Appropriate Funding Level for the Lead Advisory Service Australia*, 1st December 2000, Canberra
31. ILZRO (International Lead Zinc Research Organisation Inc.), *Figure 57 - Blood Lead Levels United States - blood lead values taken from literature referenced in Appendix A: US Blood Lead Literature Data 1935 - 1990, from "Risk Reduction Monograph No. 1: Lead"*, 1993, Research Triangle Park, North Carolina
32. ILZRO, *Lead in Gasoline - Environmental Issues*, 1991, Research Triangle Park, North Carolina
33. IOMC (Inter-Organisation Programme for Sound Management of Chemicals for the United Nations Environment Program, UNITAR, UNICEF, WHO, FAO, UNIDO & OECD), *Global Opportunities for Reducing the Use of Leaded Gasoline*, 1998
34. Kelly, Ros, Minister for the Environment, Sport and Territories, *Roundtable Conference on Lead in Petrol - Opening Address - Canberra 29 July 1993*
35. LEAD Group, The, *MEDIA RELEASE: Green Games Sham - Visitors Will Breathe Leaded Air - Why? [Including List of 55 Countries that will Ban Leaded Petrol Before Australia Does]*, 30th August 2000, Sydney
36. LEAD Group, The, *MEDIA RELEASE: Helping At Least 75,000 Lead Poisoned Australian Children Not Worth $150,000 To The Federal Government,* 31st May 1996, Sydney
37. Lead Roundtable Agreements - 29th July 1993, Parliament House, Canberra.
38. Lovei, Magda (1998) *"Phasing Out Lead From Gasoline"* World Bank Technical Paper No. 397 - Pollution Management Series, The World Bank, 1998, Washington, DC

The LEAD Group Inc. PO Box 161 Summer Hill NSW Australia 2130
Phone: (02) 9716 0966 Email: www.lead.org.au/cu.html Web: www.lead.org.au

39. McKinney, Merritt, *Lead Exposure Speeds Up Brain Aging*, Reuters Health - 24th October 2000 www.brain.com/about/article.cfm?id=17411&cat_id=31
40. Mendelsohn, A; Dreyer, B; Fierman, A; Rosen, CM; Legano, LA; Kruger, HA; Lim, SW; and Courtlandt, CD, *Low-Level Lead Exposure And Behavior In Early Childhood*, Pediatrics Vol. 101 No. 3, March 1998 - www.pediatrics.org/cgi/content/full/101/3/e10
41. Mira, Michael; Bawden-Smith, Jason; Causer, Jane; Alperstein, Garth; Karr, Margaret; Snitch Peter; Waller, Graeme & Fett, Michael, *Blood Lead Concentrations Of Preschool Children In Central And Southern Sydney*, MJA, Vol 164, 1st April 1996
42. Moss, Mark E; Lanphear, Bruce P; and Auinger, Peggy, *Association Of Dental Caries And Blood Lead Levels*, JAMA Vol. 281 No 24 p 2294 -2298, 23rd June 1999
43. Needleman, Herbert L; Riess, Julie A; Tobin, Michael J; Biesecher, Gretchen E; & Greenhouse, Joel B, *Bone Lead Levels And Delinquent Behaviour,* JAMA [Journal of the American Medical Association] Vol 275, No. 5. 2nd July 1996
44. Needleman, Prof Herbert (editor), *Human Lead Exposure*, CRC Press, 1992, Florida
45. NHMRC (National Health and Medical Research Council), *Summary Statement Of The 115th Session Of The NHMRC, 2 June 1993 regarding revision of the 1987 (103rd session) Guidelines for lead in Australians*, 1993, Canberra
46. NPI (National Pollutant Inventory) 1998-99 http://www.environment.gov.au/npi Canberra
47. NRC (National Research Council), *Measuring Lead Exposure in Infants, Children, and Other Sensitive Populations,* National Academy Press, 1993, Washington, DC
48. NRMA (National Roads and Motorists Association), *Unleaded Petrol - Is it Dangerous? in* "Open Road", May - June 1996, p39, Sydney
49. O'Brien, Elizabeth, The LEAD Group Inc. *Letter to Environment Minister Ros Kelly seeking a national strategy to eliminate childhood lead poisoning,* 19th May, 1992, Sydney
50. OECD (Organisation for Economic Cooperation & Development), *RESTRICTED Draft Co-Operation on Existing Chemicals: Risk Reduction Lead Country Report On Lead*, 21st May 1991, Paris
51. OECD, *RESTRICTED Draft Risk Reduction Strategies for Lead*, 10th November 1992, Paris
52. OECD, *Risk Reduction Monograph No. 1: Lead*, 1993, Paris
53. Pirkle, MD, James L. PhD; Brody, Debra J. MPH; Gunter; Elaine W; Kramer, Rachel A. ScD; Paschal, Daniel C. PhD; Flegal, Katherine M. PhD, MPH; Matte, Thomas D. MD, MPH (1994), *The Decline in Blood Lead Levels in the United States - The National Health and Nutrition Examination Surveys (NHANES),* p284 JAMA (Journal of the American Medical Association), July 1994 - Vol 272, No. 4.
54. Schwartz, BS; Stewart, WF; Bolla, KI; Simon, D; Bandeen-Roche, K; Gordon, B; Links, JM; & Todd, AC, *Past adult lead exposure is associated with longitudinal decline in cognitive function*, Neurology 55, October 2000
55. Schwartz, Joel; Pitcher, Hugh; Levin, Ronnie; Ostro, Bart; Nichols, Albert L, *Costs And Benefits Of Reducing Lead In Gasoline: Final Regulatory Impact Analysis*, US EPA (Environmental Protection Agency), February 1985, Washington DC
56. Tanner, Lindsey, *Lead Standards May Be Too High - Studies Say Exposure May Be Worse Than We Thought*, Spokesman Review, Associated Press, 28 May 2000
57. Thomas, Valerie M, Center for Energy and Environmental Studies, Princeton University, Princeton, New Jersey, *The Elimination of Lead in Gasoline*, Annu. Rev. Energy Environ, 1995, 20:301-24, Annual Reviews Inc www.princeton.edu/~vmthomas/pb_elim/pb-elimination.html
58. Thomas, Valerie M; Socolow, Robert H; Fanelli, James J; and Spiro, Thomas G, *Effects Of Reducing Lead In Gasoline: An Analysis Of The International Experience*, Environmental Science & Technology Vol 33 N0 22 pp3942-7, 1999
59. WHO (World Health Organisation), *IPCS (International Program on Chemical Safety) - Environmental Health Criteria for Inorganic Lead - First Draft,* November 1992, Geneva.

The LEAD Group Inc. PO Box 161 Summer Hill NSW Australia 2130
Phone: (02) 9716 0966 Email: www.lead.org.au/cu.html Web: www.lead.org.au