REDUCTION OF LEAD IN THE CANADIAN ENVIRONMENT:

A Brief to the Royal Society of Canada
Commission on Lead in the Environment

Murray Klippenstein,
Toby Vigod,
Canadian Environmental
Law Association,
243 Queen St. W., 4th Floor,
Toronto, Ontario M5V 1Z4

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EXECUTIVE SUMMARY

1. There is a substantial amount of evidence pointing to physiological changes in children associated with blood lead levels below 20 ug/dL, a level once considered safe. These changes include: inhibition of ALA-D and inhibition of the addition of iron to porphyrin (both examples of interference with the production of heme for hemoglobin), interference with the activity of vitamin D, apparent interference with mental development, changes in reaction time, and changes in brain wave activity.

2. In view of these effects, priority should be given to reducing lead in the environment for a number of reasons. The most important reason is that some of these effects appear harmful. However, even where the evidence is not conclusive

1) it should be remembered that to this point, studies of lead have continually discovered new effects at lower levels
2) physiological changes known to be caused by lead should be presumed to be undesirable; to do otherwise uses humans as experimental subjects

3) the burden of proving the safety of low level lead should be on those proposing to discharge it into the environment

4) there should be a real margin of safety in what is considered an acceptable level of lead

5) it should be remembered that lead is increasing and accummulating in the environment.

3. Average Canadian blood lead levels appear at or near levels where physiological changes occur.

4. In view of the diverse sources of lead in the environment, an overall strategy is needed to reduce total emissions.

5. Gasoline is an important and probably the preeminent contributor to lead in humans. It is not clear that there will be any net costs to Canadian society from the total removal of lead from gasoline. There may in fact be net financial benefits. The federal government has the legislative authority under the Clean Air Act to remove lead from gasoline as a preventative measure. In view of the health effects discussed above this should be a priority.

6. Emission standards for secondary lead smelters under the Clean Air Act should be strengthened and set according to an

overall strategy, and extended to the most important lead emitters such as mining, milling, smelting, and refining.

7. Ontario ambient air standards for lead should be reviewed with an eye to revising them; unenforcable criteria should not be relied on as regulatory instruments.

8. Lead from soldered seam cans is a major contributor to dietary, and in turn total, lead intake by individuals. Present lead levels in canned food may be in violation of the Food and Drug Act and regulations. At any rate, authority exists under the FDA and the Hazardous Products Act to pass regulations limiting lead in canned food or to phase out solder seam cans, and the health concerns described earlier justify such an initiative.

I. INTRODUCTION

In 1978, the last year for which detailed information is available, 14.6 million kg of lead were pumped into the air Canadians breath.[1] In addition, it is estimated that the Canadian population eats nearly a tonne of lead every year.[2] The result is that Canadians carry in their bodies a total of more than 2.5 tonnes of lead.[3]

The Canadian Environmental Law Association (CELA) is a non-profit, public interest organization that has long been committed to a reduction of lead in the environment. In the early 1970s, CELA represented residents living near a secondary lead smelter in downtown Toronto and became aware of the serious adverse health impacts of lead emissions. CELA has also represented a citizens' group in Eastern Ontario, again concerned about lead, as well as other toxic emissions, from a scrap smelter. We have made various representations on behalf of our clients to the Ontario government over the years to lower the airborne lead criterion under The Environmental Protection Act.

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[1]Environmental Protection Service, "Control Options for Lead Phase-down in Motor Gasoline", Environment Canada, (February 1983), p. 4.

[2]Ibid, p. 12.

[3]Ibid, p. 13.

CELA also prepared a brief in relation to the phase-down of lead in gasoline under the Clean Air Act.

In this paper CELA will be outlining its position with respect to reform of regulation of lead from various sources. Particular emphasis will be placed on the regulation of lead levels in gasoline.

II. EVIDENCE OF ADVERSE HEALTH IMPACTS

It is clear that what is at issue in any consideration of lead in the environment is the health of Canadians. CELA believes that it is absolutely crucial to keep this goal--the protection and promotion of Canadians' physical wellbeing--front and center when considering the direction regulation should take.

Just as it is clear that the issue is the health of Canadians, there is no doubt that lead is a poison. The Socio-Economic Impact Analysis of Lead Phase-Down Control Options published by Environment Canada in February 1983 (SEIA) summarizes: "lead is particularly hazardous since it is cumulative and it produces many and severe toxic effects. Lead toxicity may be acute, chronic, or sub-chronic; carcinogenicity, teratogenicity, mutagenicity and reproductive damage potentials have been reported".[4] Children are particularly susceptible.

It is well established that lead causes clearly adverse physiological changes, both overt and asymptomatic, in both adults and children, at blood lead levels exceeding 40 ug/dL, and this paper will not be dealing with such levels. In 1978 the Centre for Disease Control established a blood lead level of 30 ug/dL as the criteria for undue lead exposure for young children, allowing a margin of safety below known unsafe levels . This paper will highlight the evidence relating to effects in humans of blood lead levels below these standards, which, we submit, suggests cause for concern at such levels. Although there is further evidence relating to adverse effects in animals, it will not be dealt with due to the difficulty of evaluating its significance for humans.

There are several biological changes that occur in children in association with very low blood lead levels. One such effect is inhibition of ALA-D (delta aminolevulinic acid dehydratase), an enzyme that acts as a catalyst in the process of heme biosynthesis (heme is a constituent of hemoglobin). One study found that enzyme activity was inhibited by 50 percent at blood lead levels of 16 ug/dL. No threshold was observed below which

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[4]SEIA, p. 9

the effect did not exist.[5] The health significance of these changes at this level are controversial due to the apparent existence of a "reserve capacity" of ALA-D activity, but ALA-D impairment causes definite impairment of heme synthesis at higher lead levels, leading to anemia.

Heme synthesis is affected in another way. Lead interferes with the insertion of iron into porphyrin to form heme; the porphyrin combines with zinc instead resulting in an accummulation of zinc protoporphyrin in the erythrocytes (red corpuscles). Increased EP (erythrocyte protoporphyrin) levels can be detected at a blood lead level of 15-18 ug/dL.[6]

A recently discovered phenomenom is the effect of low blood lead on vitamin D. Interference with the activity of vitamin D has been noted at blood levels as low as 12 ug/dL.[7] Vitamin D

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[5]Hernberg, S.; Nikkanen, J. (1970) Enzyme inhibition by lead under normal urban conditions. Lancet 1(7637): 63-64.

[6]Roels, H; Buchet, J-P; Lauwerys, R.; Hubermont, G; Bruaux, P.; Claeys-Thoreau, F.; Lafontaine, A; Van Overschelde,J. (1976) Impact of air pollution by lead on the heme biosynthetic pathway in school-age children. Arch. Environ. Health 31: 310-316.

[7]Rosen,J.F.; Shesney, R.W.; Hamstra, A.; DeLuca, H. F.; Mahaffey, K.R. (1980) Reduction in 1, 25-dihydroxyvitamin D in children with increased lead absorption. N.Engl. J.Med. 302: 1128-1131; Mahaffey, K.R.; Rosen, J.F.; Chesney, R.W.; Peeler, J.T.; Smith, C.M.; DeLuca, H.F. (1982) Association between age, blood lead, and serum 1,25-dihydroxycholecalciferol levels in children Am. J.Clin. Nutr. 35:1327-1331.

aids in the intestinal absorption of minerals, and in maintaining cellular calcium homeostasis.

The effect of low blood lead on IQ in children has been a matter of some controversy. A 1981 study by Yule et al suggests that there is a small detrimental impact on the IQ of children even at blood lead levels less than 32 ug/dL.[8] A pioneering study by Needleman finding that relatively low blood levels correlated with an average lowering of IQ by 4 points was heavily criticized,[9] but reanalyses of the data by Needleman and the U.S. Environmental Protection Agency in 1984 to control confounding variables confirmed earlier conclusions.[10] Some other similar studies differ in their conclusions, so the evidence must be regarded with caution, but other research on

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[8]Yule, W; Lansdown, R; Millar, I. B.; Urbanowicz, M.A.;(1981) The relationship between blood lead concentrations, intelligence and attainment in a school population; a pilot study. Dev. Med. Child Neurol. 23; 567-576.

[9]For a summary of the criticisms, see Lead in Gasoline and Health in Canada, prepared by The Canadian Energy and Emissions Committee of the International Lead Zinc Research Organization (ILZRO), undated.

[10]Needleman, H. L. (1984) Comments on chapter 12 and appendix 12C, Air Quality Criteria for Lead (external review draft #1). Available for inspection at: U.S. Environmental Protection Agency, Central Docket Section, Washington, DC; docket no. ECAO-CD-81-2 IIA.E.C.1.20. Also U.S. Environmental Protection Agency, Office of Policy Analysis, (1984) Comments on issues raised in the analysis of the neuropsychological effects of low level lead exposure, presented by Hugh M. Pitcher at Clean Air Scientific Advisory Committeee (CASC) meeting, April 27. Available for inspection at: U.S. Environmental Protection Agency, Central Docket Section, Washington DC; docket no. ECAO-CD-81-2 IIA.F.19

mental effects is also disturbing. Recent work by Bellinger et al. with new born infants suggests that mean umbilical blood lead levels of 14.6 ug/dL were associated with lower scores on a mental development index.[11]

There is also good recent evidence to suggest that children with blood lead levels between 12 and 26 ug/dL may suffer from changes in reaction time.[12]

Electrophysiological studies of lead effects in children have also uncovered some worrisome indications. Benignus et al. and Otto et al. discovered a significant relationship between blood lead levels between 6 to 59 ug/dL and changes in slow wave voltage, and discovered EEG effects at 15 ug/dL.[13] Of

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[11]Bellinger, D.C.; Needleman, H.L.; Leviton, A.; Waternaux C.; Rabinowitz, M.B.; Nichols, M.L. (1984) Early sensory-motor development and prenatal exposure to lead. Neurobehav. Toxicol. Teratol.: in press. Available for inspection at: U.S. EPA, Environmental Criteria and Assessment Office, Research Triangle Park, NC.

[12]Yule, W; Lansdown, R; Hunter, J.; Urbanowicz, M.A.; Clayton, B.; Delvees, T. (1983) Blood Lead Concentrations in School Age Children, intelligence, attainment and behaviour. Background information to a paper presented at the annual conference of the British Psychological Society at the University of York; April 1983; York, United Kingdom.

[13]Otto, D. A.; Benignus, V.A.; Muller, K.; Barton, C. N. (1981) Effects of age and body lead burden on CNS function in young children. I: Slow cortical potentials. Electroencephalogr. Clin. Neurophysiol. 52: 229-239; Benignus, V.A.; Otto, D.A.; Muller, K.E.; Seiple, K.J. (1981) Effects of age and body lead burden on CNS function in young children: II. EEG spectra. Electroencephalogr. Clin. Neurophysiol. 52: 240-248.

particular interest is the fact that in a follow-up study two year later, slow wave effects were still noted, although blood lead levels had declined,[14] and another follow-up five years later found increased latencies in brainstem auditory evoked potentials.[15]

There are thus a significant number of physiological changes associated with lead in blood at extremely low concentrations: inhibition of ALA-D, inhibition of the addition of iron to porphyrin, interference with the activity of vitamin D, apparent interference with mental development, changes in reaction time, and changes in brain wave activity.[16]

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[14]Otto, D.; Benignus, V. Muller, K.; Barton, C.; Seiple, K.; Prah, J.; Schroeder, S. (1982) Effects of low to moderate lead exposure on slow cortical potentials in young children: two year follow-up study. Neurobehav. Toxicol. Teratol. 4: 733-737.

[15]Otto, D.; Robinson G.; Baumann, S.; Schroeder, S.; Kleinbaum, D.; Barton, C.; Mushak, P.; Boone, L. (1984) Five-year follow-up study of children with low-to-moderate lead absorption; electrophysiological evaluation. Available for inspection at: U.S. EPA, Environmental Criteria and Assessment Office, Research Triangle Park, NC

[16]It should be noted that some recent research raises, for the first time, the possibility that lead may be nutritionally important (See Kirchgessner, M.; Reichlmayr-Lais, A.M. (1982) Konzentrationen verschiedener Stoffwechselmetaboliten im experimentellen Bleimangel. [Concentrations of various metabolites with experimental lead deficiency.] Ann. Nutr. Metab. 26: 50-55). However, this research is somewhat anomalous in the field of lead research, and must be treated with caution since it involved rats rather humans. At any rate, we submit that that research is essentially completely irrelevant to the question of environmental lead pollution. The levels potentially of significance nutritionally are much lower than even the very low levels discussed in this paper at which apparent adverse health effects occur.

CELA recognizes that many of the more recent studies are pioneering efforts, and that there is not always consensus about the weight to be given to various experiments. Also, while some of the observed effects of low blood lead, such as the interference with vitamin D, seem directly linked to adverse effects, other physiological changes are less clearly injurious. In these circumstances, how is the data to be interpreted?

CELA believes that several principles are applicable. First, and most important, some of these studies do appear to indicate actual adverse health effects at these very low levels, such as the interference with vitamin D.

Secondly, the evidence must be seen in historical perspective. Present estimates of the point where health effects become significant are the result of a long process of downward revisions of perceived danger levels. Thus, the standard of 30 ug/dL recommended by the CDC in 1978 was a downward shift from the level of 40ug/dL proposed by the U.S. Surgeon General in 1970. If the future at all resembles the past, there is reason to expect that increasing knowledge will uncover further detrimental effects.

Thirdly, CELA believes that where the presence of lead clearly causes physiological changes, changes not associated with or expected to produce any benefit, the effects should be considered and treated as harmful effects, even when no specific functional disability can be linked to them. To do otherwise, we submit, amounts to deliberate and unethical experimentation with the health of individuals.

Fourthly, individual health is a preeminent value that should in any case be protected by requiring those who would disperse a potentially harmful substance into the environment to prove its harmlessness. The presumption, therefore, ought to be that lead should be phased out wherever possible, except where and only so long as the propounders of its use can satisfy doubts about its effects. This approach already exists in the Pest Control Products Act, which requires the seller of a product to prove its safety before it can be registered.

Reference might also be made to the work of the 1974 Ontario Ministry of Health Committee to Inquire into and Report upon the Effect on Human Health of Lead from the Environment. In assessing whether anything should be done about subclinical excessive lead levels, and deciding that it was not "worth taking the risk that would stem from a decision to leave things as they are", the Committee stated several principles: "Even if a moderate elevation of blood-lead is not harmful, a child at this level may, on relatively minor exposure to an additional source of lead, rapidly develop a dangerously high level." Furthermore, "the level of lead in the general environment is increasing steadily. If precautions are not taken to reduce to a minimum the distribution of lead that can be absorbed by people, dangerously high concentrations in the environment may be reached."[17]

CELA believes that all of these approaches are appropriate, and that any one of them would, in view of the medical evidence discussed above, result in a high priority being placed on reducing lead in the environment.

The Socio-Economic Impact Analysis of Lead Phase-Down Control Options lists some of the effects at levels of 10 and 15 ug/dL; it concluded that "the more recent data noted..., which indicate that adverse health effects can occur at lead levels of 20-30 ug/dL, provide added impetus for reducing lead exposure."[18] In our view, it is an inexplicable and serious lapse for the SEIA to limit concern to levels greater than 20 ug/dL in the face of its

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[17]At p. 38. The Committee was discussing levels in the vicinity of 40 ug/dL; in view of more recent evidence, it is submitted that the same principles apply to levels below 30 ug/dL.

[18]SEIA, p. 10

own findings. How much greater is the impetus when effects are noted at 10 ug/dL!

Dr. Sergio Piomelli, M.D., Department of Pediatrics and Hematology-Oncology, Columbia School of Medicine, head of one of the largest childhood lead poisoning clinics in the United States, summarized the situation well in testifying in 1982 before the Environment, Energy and Natural Resources Sub-Committee of the U.S. House of Representatives Committee on Government Operations. He stated that "lead has no physiological function and any amount in the human body reflects environmental pollution. Recent studies of ancient skeletons have shown negligible lead content, and even today, remote populations have been shown to have extremely low levels of blood lead."[19]

Dr. Piomelli called for a further reduction of environmental lead, and noted that "Lead is a contaminant of the human body and a powerful toxin. The present 'normal blood level' reflects massive environmental pollution."[20] "[C]lear evidence of danger to a number of essential biochemical systems at the present levels of exposure can be demonstrated in children, before

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[19]United States House of Representatives. Lead in Gasoline: Public Health Dangers. Hearing before a Subcommittee of the Committee on Government Operations, 97th Cong. 2nd Sess. (April 14, 1982), p. 12.

[20]*Id.* at 19.

obvious clinical damage. Low level lead exposure damages children's neuro-psychological function."[21]

Information as to the level of lead in the blood of Canadians indicates that the health effects reviewed above should translate into real concern. The most recent large scale study, from Toronto, indicates that 1% of children aged 0-4 years have blood lead concentrations greater than 30 ug/dL and 12% have concentrations greater than 20 ug/dL. "If these results are representative of urban centres, then an appreciable number of children would be potentially at risk from lead exposure."[22] The overall mean, including adults, was 12 ug/dL. This held true for both smelter and non-smelter communities. Between 3 and 6 percent of the total sample (including adults), for both smelter and non-smelter communities, had levels exceeding 20 ug/dL.

III THE OVERALL PICTURE

It is possible to get a general idea of the relative contributors to blood lead. in Canadians. The SEIA estimates that the average urban Canadian absorbs the following amounts of lead:

	Adult	Child

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[21]*Id.*

[22]SEIA, p. 16

From air	4.3ug	1.3
From food/water	114.4	62.6
From dust/dirt	1.7	25.5
	120.4	99.4

It is generally accepted that gasoline lead is the principal source of lead in the air. The SEIA estimates its contributions at 88% of air lead.[23]

It is very difficult to establish all the sources of lead in food. One preliminary estimate assigns 49% of food lead to atmospheric deposition (including gasoline lead).[24] The same estimate attributes 31% of food lead to solder in tin cans. Another study sets the solder contribution at 20% of food lead.[25] At any rate, can solder seems the largest single identifiable dietary source, other than gasoline lead.

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[23] SEIA, p. 23.

[24] United States Environmental Protection Agency, Air Quality Criteria for Lead, 1984, p. 7-50. This estimate is found in the preliminary, review draft of the document.

[25] U.S. Federal Register (1979, August 31) 44: 51233--51242. Lead in food: advance notice of proposed rulemaking: request for data.

It has been established that, in general, most lead in soil is attributable to gasoline lead.[26] Smelters also contribute to soil lead in their vicinity.

In view of the diverse sources of lead in the human environment, CELA maintains that an overall strategy to reduce lead should be formulated. This would include a long range goal for reduction of total environmental emissions to a stated figure, and a goal to reduce the average individual's daily intake of lead from all sources to the lowest possible level, such as 15 ug/day.

A short discussion of the individual major sources follows.

IV LEAD IN GASOLINE

CELA supported the long overdue initiative taken by the Department of the Environment to reduce lead in gasoline, the major contributor of lead to the environment. It was clear by a comparison of our lead regulations with other industrialized nations that Canada had one of the most lenient standards. Nevertheless, en the standard as presently set is unacceptable in light of the mounting evidence of the adverse health effects

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[26] Gulson, B.L.; Tiller, K.G.; Mizon, K.J.; Merry, R.M. (1981) Use of lead isotopes in soils to identify the source of lead contamination near Adelaide, South Australia. Environ. Sci. Technol. 15: 691-696.

of lead, especially on children, at smaller concentrations than formerly believed.

In England, the Royal Commission on Environmental Protection in April, 1983, after a year-long study, recommended that all lead should be banned in gasoline.[27] Further, it has recommended that the British government press for a ban through the Common Market.[28] Following quickly on the Commission's recommendations, the British government announced that all leaded gasoline will be banned by 1990.[29]

It is our submission that Canada should also move quickly to ban leaded gasoline and that a lead-free standard should be put into effect as soon as possible.

A. Gasoline Lead and Blood Lead

It is no longer doubted that lead in gasoline contributes to blood lead.

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[27]Geoffrey Lean, "Ban lead in petrol, key report says", The Observer (London), April 3, 1983 at 11.

[28]Id.

[29]Stephen Handelman, "U.K. cracks down on leaded gas", Toronto Star, April 24, 1983. Prior to 1981, the British Standard was 0.40 g/L. In that year the government enacted a Standard of 0.15 g/L to take effect in 1986.

One important study on the subject is the analysis of the association of mean U.S. blood levels found from February 1976 to February 1980 with the amount of lead used in gasoline production during those years, performed during the second National Health and Nutrition Examination Survey (NHANES II). Vernon Houk, Acting Director of the Center for Environmental Health Centers for Disease Control, appeared before the U.S. House of Representatives Subcommittee of the Committee on Government Operations in 1982 to discuss the analysis. He again noted that lead has no known useful function in the body and exerts adverse effects on both adults and children.[30] He indicated that one significant finding of the NHANES II study was a decrease over the years of the mean blood lead level from 15.8 ug/dL to 10.0 ug/dL (a 37 per cent reduction). During the same period of time, there was a 50 per cent reduction of the amount of lead in gasoline.[31] The study showed a "remarkable association between lead used in gasoline production and the average NHANES II blood lead levels. This clearly demonstrates that as we have removed lead from gasoline, we have also removed lead from ourselves and our children."[32]

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[30] U.S. House of Representatives, <u>Lead in Gasoline</u>, p. 43.

[31] <u>Id</u>. at 39-40.

[32] <u>Id</u>. at 48.

The Isotopic Lead Experiment conducted in Turin, Italy from 1977 to 1979 traced a special isotope of lead added to local gasoline and showed that in that particular case (where blood lead levels were higher than Canadian averages), approximately 24% of blood lead in urban adults derived from gasoline.

The SEIA includes an estimate of the total contribution of gasoline lead to uptake of lead in Canadian adults and children. It estimates that the average urban child absorbs 1.1 ug of gasoline lead daily through the lungs, 3.1 ug of gasoline lead from food, and 23.3 ug of gasoline lead from dust, for a total of 23 ug of gasoline lead daily, representing 40% of daily uptake.[33]

B. Socio-Economic Impact Analysis

The SEIA declined to adopt a cost-benefit analysis of the question of a phase-down in gasoline lead, opting instead for a cost-effectiveness measure. CELA agrees with the SEIA that the cost-benefit approach "is not feasible because the benefit in question -- the benefit to the health of Canadians resulting from a reduction of lead emissions -- cannot be assigned a monetary

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[33]SEIA, p.23

value".[34] In addition, CELA believes that a cost-benefit approach is not statutorily authorized.

CELA also notes that it has been well documented that industry generally tends to overestimate the costs of complying with environmental regulation.[35]

The SEIA cost-effectiveness comparison begins by quantifying the costs and benefits, other than those related to health, for each option. These costs and benefits are outlined in net form in tables 13-18 of the SEIA. These net benefits or costs are then transferred to table A (p.xvi and Table 21, p. 62), where the benefit/cost of each option is related to the reduction in emissions that the option would produce.

Option 4, consisting of a changea to only lead free gasoline, is of particular interest to CELA. It should be observed at the outset that this course would reduce by 44,000 tonnes the amount of lead that would be emitted into Canadian air over the next 20 years, in comparison with the amount projected to be released under the presently planned option of a reduction of gasoline

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[34] Environment Canada, SEIA, p. 7

[35] Richard Kazis, Richard L. Grossman, Fear at Work: Job Blackmail, Labour and the Environment (New York: The Pilgrim Press, 1982).

lead to 0.29g/L.[36] Also, according to the Environment Canada cost estimates, a total lead-free option has a far smaller total cost than the present option.[37] There is, in fact, the additional possibility that the elimination of lead in gas will be not only less costly than the present program, but will actually produce a net benefit over no regulatory action at all (due to savings in automotive fuel and maintenance costs).[38] Thus, somewhat surprisingly, the no-lead option may be more desirable than the present course.

Other effects of the lead-free option are not included in these figures, but are considered separately. For example, the lead-free option would reduce sales of spark plugs and exhaust system mufflers. However, these together represent only 11.5 per

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[36]SEIA, p. 62

[37]Environment Canada's calculation incorporates information provided by Petroleum Association for the Conservation of the Environment (PACE; see SEIA, p. 113).

PACE's own estimate of costs of total lead phase-out are higher, but they apparently include as costs refinery investments that would be needed even without regulatory action, due to present market trends to unleaded gas, they double count by including as a future cost investment already made in presently existing capacity for lead free production, and they are based on capital cost estimates over $200 million greater than ones the organization originally accepted (SEIA, p. 116-117). They also assume that sufficient new refinery capacity will have to be built to produce gasoline with a Research Octane Number (RON) of 94, arguing that that is the level required by automobiles if no lead is used. However, the U.S. industry has reduced to a 92.5 level over the last decade (SEIA, p. 112, 115).

[38]SEIA, p. 62

cent of the total market for repair parts, and would face declines only in the order of 10-15%. Furthermore, the sale of replacement parts is expected to decline over the next decade even without regulatory intervention, as a result of market shifts which are currently under way.[39] In addition, due to the diversity of activity and product lines in the parts industry, most companies are relatively insensitive to regulatory changes.[40]

A factor of particular interest that is not included in the cost-effectiveness calculations is the issue of the effect on jobs. According to an Environment Canada consultant, a no-lead option would result in the loss of 337 jobs due to the closure of both Canadian lead-additive plants.[41] The figure provided by the International Lead and Zinc Research Organization (ILZRO) is 82 higher (419), as well as including 1260 jobs lost through a "ripple" effect, for a total of 1679.[42] There are offsetting gains however. The SEIA estimates that a minimum of 250 jobs would be created due to increased refining for higher octane levels. Up to 4000 person-years of construction labour would

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[39]SEIA, p. 48

[40]SEIA, p. 48

[41]SEIA, p. 55

[42]SEIA, p. 55

also be required (roughly equivalent to 100 jobs: 4,000/40).[43] The result would be a very small job loss, if any (and therefore no spin-off job losses). Indeed, if extra refining to a 94 RON level is required to replace the lead, as industry claims,[44] another 500 jobs would be produced, (plus possibly an additional 1500 spin-off jobs, using ILZRO's ratio).

It should also be remembered that the SEIA predicts that some loss of lead additive jobs will occur even without any regulatory intervention at all, due to the predicted decline in the market share of leaded gas.[45] Note also that option 2, the course presently selected, involves a net job loss, so the move to a lead-free option could, in fact, be an improvement from the point of view of jobs as well as costs.[46]

The cost of health care required by the effects of lead might also be mentioned. Dr. Houk, in the testimony described earlier, noted that lead toxicity places a substantial economic burden on society. He cites a study by Provenzano that estimated that the cost for medical care and special education for pre-school age

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[43]SEIA, p. 54

[44]SEIA, p. 115-116

[45]SEIA, p. 55

[46]SEIA, p. 55

and school-age children affected by lead at $971 million in 1978. These social costs "snowball" as these children grow older.[47]

C. The existing regulatory Scheme

The Clean Air Act[48]

Currently, section 22 of the Clean Air Act prohibits anyone from producing or importing any fuel that contains additives in excess of those prescribed by the regulations. Section 23 provides that the Governor-in-Council may make regulations prescribing the maximum concentration of any fuel additive if "in his opinion, if present in a greater concentration than that prescribed would result in a significant contribution to air pollution on the combustion of the fuel under ordinary circumstances."

Air pollution is also described in the Act as

> "a condition of the ambient air, arising wholly or partly from the presence therein of one or more air contaminants

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[47] U.S. House of Representatives, Lead in Gasoline, p. 47. He refers to: G. Provenzano, "The social costs of excessive lead exposure during childhood", in: Needleman HL, ed. Low level lead exposure: The clinical implications of current research. New York: Raven Press, 1980) at 299-315.

[48] S.C. 1970-71-72, c.47,s.3.

that endangers the health, safety or welfare of persons, that interferes with normal enjoyment of life or property, that endangers the health of animal life or that causes damage to plant life or to property."[49]

The 1970 U.S. Clean Air Act[50] also provided for control of fuel additives if the emission products "will endanger public health or welfare".[51] In 1973, the Environmental Protection Agency established a 0.5 gram per gallon (gpg) standard as the ultimate level of control to be reached. The standard was challenged by members of the refining and lead industries, but was upheld by the federal courts.[52]

It is interesting to note that, in the court challenge, industry basically argued:

1. that in order for EPA to regulate lead, it had to, in effect, show dead bodies; and

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[49] Id. s.2 (1)(b).

[50] 42 U.S.C.A. S 1857 et seq.

[51] S.211 (c)(1)(A).

[52] See Ethyl Corp. v. EPA, 541 F. 2d 1 (D.C. Cir.) (en banc), cert. denied, 426 U.S. 941 (1976).

2. that EPA had to demonstrate that public danger came from lead-in-gas emissions "in and of itself" and not the cumulative impacts of lead additives from all other sources of human exposure to lead.[53]

The Court rejected both these arguments. First, it emphasized the precautionary nature of the relevant section of the Clean Air Act and stated that proof of actual harm was not needed. The court held:

> "We believe that the precautionary language of the Act indicates quite plainly Congress' intent that regulation should precede any threatened albeit unprecedented disaster. Ethyl [the industry petitioner] is correct that we have not had the opportunity to learn from the consequences of an environmental overdose of lead emissions; Congress, however, sought to spare us that communal experience by enacting section 211(c)(1)(A)".[54]

The court also affirmed that taking into consideration the cumulative impact of lead was a central part of the EPA mission. "Lead enters the human body in multiple sources," said the court,

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[53] *Id.* at 12, 29-30.

[54] *Id.* at 13, note 18.

"so that the effect of any one source is meaningful only in cumulative terms".[55]

The Court reached its conclusion that EPA could regulate on the basis of less than certain adverse health effects by a general analysis of the nature of environmental regulation:

> "Questions involving the environment are particularly prone to uncertainty. Technological man has altered his world in ways never before experienced or anticipated...[Hence] speculation, conflicts in evidence, and theoretical extrapolation typify [a regulator's] every action. How else can they act, given a mandate to protect the public health but only a slight or non-existent data base upon which to draw?"[56]

Amendments to the U.S. Clean Air Act in 1977 strengthened the conclusions reached by the court in the Ethyl Corp. case. "Will endanger" in section 211(c)(1)(A) was replaced with "causes, or

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[55] *Id.* at 30.

[56] *Id.* at 24.

contributes, to air pollution which may reasonably be anticipated to endanger".[57]

It is our submission that the Canadian test is very similar to that in the U.S. Clean Air Act which successfully withstood the Ethyl court challenge and that similar industry arguments should be defeated by the same rationale. It seems clear that the test in section 23 is precautionary in nature and does not require proof of actual harm before preventative regulations are issued.

D. Summary and Recommendations

In view of the recent information about adverse health effects from low levels of blood lead, the significant contribution of gasoline lead to the risk of these effects, the lack of any substantial costs of any certainty, and the apparent authority of the government to regulate to prevent a health risk, CELA recommends that a regulation under the Clean Air Act be adopted phasing out all lead in gasoline.

V LEAD FROM SECONDARY SMELTERS

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[57]SS 7401-7642. See discussion in United States Senate. The Clean Air Act in the Courts. A Report prepared by the American Law Division, Congressional Research Service, Library of Congress for the Committee of Environment and Public Works, April 1981, at 120-130.

A. Secondary Smelter Emissions and Blood Lead

Secondary lead smelters emit a small proportion of overall lead emissions, but their significance derives from their often urban locations.

Emissions of lead from smelters are most readily absorbed by humans through the media of ambient air or through dust. Most emphasis has been placed on absorption through dust.

Extensive studies of Toronto secondary smelters found that lead in dustfall decreased with distance from the plants (and ranged up to 4 or 5 tons per square mile per month). The lead in dust near the Toronto Refiners and Smelters plant averaged 5,828 ppm, compared with a mean of 1,002 ppm in a control urban area. Concentrations in soil near the plant reached 11,950 ppm.[58]

Several studies show blood lead increasing with proximity to secondary lead smelters. A 1975 Ontario Ministry of the Environment study showed that children within 300m of two secondary smelters averaged blood levels of about 27 ug/dL, compared with 17 ug/dL for the control group.[59] A 1979 study

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[58]Ontario Environmental Hearing Board, Lead Contamination in the Metropolitan Toronto Area, 1976, p. 87

[59]Ontario Ministry of the Environment, Report of the Lead Data Analysis Task Force, (1975).

of an Arnhem smelter found that blood lead levels for children within 1 km of the plant averaged 19.7ug/dL compared to 11.8 ug/dL for the control group.[60]

While the issue is complex, a 1982 study by Stark et al estimates an increase of about 2.0 ug/dL in the blood of children for each 1000 increase in soil lead.[61]

CELA recognizes that actual blood lead levels near smelters may vary in specific circumstances, but maintains that a process of ad hoc blood testing based on reaction to public pressure (in situations where members of the public generally suffer from lack of information) is an inadequate response to this overall trend. It is thus important that the regulation incorporate a safety margin, and be enforced.

B. The Existing Regulatory Scheme

1. The Clean Air Act

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[60]Zielhuis, R. L.; del Castilho, P.; Herber, R.F.M.; Wibowo, A.A.E.; Salle, H.J.A. (1979) Concentrations of lead and other metals in blood of two and three year-old children living near a secondary smelter. Int. Arch. Occup. Environ. Health 42: 231-239.

[61]Stark, A.D.; Quah, R.F.; Meigs, J.W.; DeLouise, E.R. (1982) The relationship of environmental lead to blood-lead levels in children. Environ. Res. 27: 372-383

The Secondary Lead Smelter National Emission Standards Regulations SOR/76-464, as amended by SOR/77-1029 and SOR/80-126, under the CAA, limit the quantity of particulate matter emitted into the ambient air to 0.046 or 0.023 grams per normal cubic metre of total emissions, depending on the type of process, and the concentration of lead in the particulate matter to sixty three per cent.

CELA applauds an approach including an evaluation of emissions, rather than relying only on point of impingement measurements. Use of impingement measurement is grounded on the belief that it is the end impact that should be measured, thus taking into account variations in the environment's capability to absorb emissions. The result, however, is that there is no overall limit, and any amount can be emitted so long as it can be sufficiently dispersed and diffused. This provides an incentive for dispersion, for example by means of tall stacks, rather than for reduction. Long range transport results, and problems of measurement and regulation (when the problem begins to affect several jurisdictions) are multiplied. The regulation should therefore include a level of maximum total emissions, based on the overall strategy for reduction of lead, as discussed earlier.

CELA also disagrees with the provisions of s. 8 of the regulation, which allows emission standards to be exceeded during a limited amount of time (eg. 2 hours) per month in the event of a breakdown of pollution control equipment. In our view, it is not uncommon or unreasonable to require back-up equipment--which is probably necessary at any rate to actually meet the limits on down time. It might also be asked, as the Ontario Environmental Hearing Board did, whether this gap in the limit might not also give the company an incentive to clean out its equipment and emit large amounts of pollutant during this period.[62]

Since secondary smelters are in fact a relatively minor contributor to overall lead emissions, it is perhaps most important of all that consideration should also be given to placing similar restrictions in the regulations on other sources. Mining, milling, smelting, and refining all emit a great deal more lead than secondary smelters.[63] Regulations for these sources should be promulgated as necessary, based on an overall reduction plan.

2. The Ontario Environmental Protection Act

Regulation 308 under the EPA sets out in Schedule 1 under s. 5(3) an ambient air limit for lead of 10 ug/m^3 for a 30 minute

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[62]Ontario Environmental Hearing Board, Public Hearing on Lead Contamination in the Metropolitan Toronto Area, 1976, p. 192

[63]National Research Council Canada Associate Committee on Scientific Criteria for Environmental Quality, Effects of Lead in the Environment-1978: Quantitative Aspects, p. 622

average, measured at the point of impingement. This is the only numerical enforceable standard for lead in ambient air in Ontario. It was established in 1972 by the Ontario Ministry of the Environment on the basis of limiting total daily intake to 60 ug/dL.

CELA believes that ambient air limits are important for protection of areas near smelter, but as noted above, it is important that they be supplemented with emission standards. Furthermore, in view of more recent medical knowledge of low level health effects, this standard should be reviewed with the possiblity of lowering it, based on the principles elaborated earlier for situations where the health effects can not be easily measured.

In practice, point of impingement levels are generally calculated rather than measured, and are calculated by applying mathematical models to stack emissions as measured. At this point, it does not appear that models reliable for complex urban landscapes have been developed, nor have existing models actually been tested with lead. CELA thus maintains that reliance on models is unwarranted at this point.

Since 1979, the Ontario Ministry of the Environment has been using a tentative ambient air quality criterion of 3.0 µg/dL (arithmetic mean, 30 day average). CELA considers the use of non-enforceable "tentative criteria" as unacceptable on the grounds that they lack the force necessary to make them meaningful, both for enforcement officials and the public.

VI LEAD IN FOOD

A. Food Lead and Blood Lead

The SEIA estimates total daily dietary intake as averaging 62 and 114 ug for urban children and adults, respectively.[64] The SEIA notes that lead in canned food contributes an estimated 13-22% of the total dietary intake of lead for children and adults.[65] Estimates by the U.S. FDA suggest that lead in solder contributes more than 66% of the lead in canned foods where a lead solder seam is used.[66]

B. The Existing Regulatory Scheme

At present, Health and Welfare Canada has a cooperative programme with industry to reduce lead intake from canned foods.[67] CELA

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[64]SEIA, p. 21

[65]SEIA, p. 13

[66]U.S. Federal Register (1979 August 31) 44: 51233-51242. Lead in food: advance notice of proposed rulemaking request for data.

[67]SEIA, p. 15

considers such an approach inadequate in that it inadequately informs the public, it fails to state clear and authoritative goals for and expectations of industry, and it may conflict with existing legislation, as described below.

Two legislative schemes most directly affect food in lead, the Hazardous Products Act R.S.C. 1970, c. H-3 (the HTA), and the Food and Drug Act R.S.C. 1970, c. F-27 (the FDA). The FDA states in s. 4 that "no person shall sell an article of food that (a) has in or upon it any poisonous or harmful substance" or "(d) is adulterated..." It is possible that some articles of food, particularly canned goods, are in violation of section 4(a) at present lead levels, since although the lead in any given article might not cause the item to be harmful, lead is a harmful substance and it is contained in it (and may be a contributing factor to an overall injurious level in the individual).

It is also possible that existing canned food is in violation of the second provision, s. 4(d), since lead adulterates the food. This section was challenged as being beyond the power of the federal government in the case of Berryland Canning Co. Ltd. v. The Queen, (1974) 44 D.L.R. 568. The court upheld the prohibition as a valid exercise of the federal government's criminal power. It quoted an earlier case: "Nor is it any less a crime because it may be shown scientifically that some of the ingredients prescribed may not, if used in proper quantities, be deleterious at all" (at p. 572).

One of the arguments in that case was that "adulteration" referred only to "those substances which have, in fact, been proven to be base or harmful and that ... there is no proof here of any harmful effect on humans". The court ruled that "In my view, the word 'adulterated' cannot be restricted to only those substances which have been proven to be harmful. I consider the ordinary meaning of the word to be wide enough to encompass all foreign substances, harmful or otherwise" (at p. 578). In view of the origin of lead in canned food (predominantly the can and gasoline), many articles of canned food would appear to be in breach of this section.

However, the Act goes further. S. 25 authorizes the Governor General to make regulations "for carrying the purposes and provisions of this Act into effect", including the power of "declaring that any food... is adulterated if any prescribed substance...is present therein or has been added thereto...to prevent injury to the health of the consumer" (s. 25(1)(a)), the power of "prescribing standards of ... purity ... of any article of food" (s. 25(1)(c), and the power of making regulations "respecting the method of preparation, manufacture, preserving, packing...of any food...in the interest of, or for the prevention of injury to, the health of the consumer" (s. 25(1)(e).

In the Berryland case, the court considered the extent of this regulation making power. It states that

> I cannot conceive that Parliament intended to so restrict the Executive Branch of Government as to limit them in the administration of the Act to banning only those substances which had been proven to be harmful to humans. There are many cases where definitive conclusions have not been reached, where the results are inconclusive. I am satisfied that s. 25(1)(a) is wide enough to cover this category and to permit the Governor in Council to ban substances in this category in the public interest (at p. 579, emphasis in original).

Regulations have been made under the FDA. Section B.15.001 of the Food and Drug Regulations, C.R.C., c. 870, as amended by SOR 79-249, sets out in Table 1 the limits for lead in parts per million for some seven food items, including infant formula. However, section B.23.001 of that regulation states that "No person shall sell any food in a package that may yield to its contents any substance that may be injurious to the health of a consumer of the food". The words "may be injurious" indicate the preventative tenor of the regulation, and it it is possible that present cans for food are in violation of this provision.

In summary, it appears that the present practice of selling foods in cans that contribute significant amounts of lead to the contents may violate the FDA and its regulations. At any rate, it is clear that the government has the power to ban solder seam cans as a prudent preventative measure.

The Hazardous Products Act also allows regulation of certain goods. It establishes two schedules, one for products whose sale is prohibited in Canada, and one whose products can be sold only subject to the conditions in the regulations (s. 3). The Governor in Council can add to the schedules "any product or substance that is or contains a poisonous...substance...or substance of a similar nature that he is satisfied is or or is likely to be a danger to the health or safety of the public" (s. 8(1)(a)). The Act does not apply to a food covered by the FDA, but the Act is an optional vehicle for prohibiting or regulating lead in cans. Several products containing lead have already been banned: children's articles painted with lead paint (SOR 78-433), and pencils coated with lead paint (SOR 78-394). Others have been restricted: paint containing lead (SOR 75-651), kettles containing lead (SOR 74-355, CRC 927), and ceramic products containing lead glaze (SOR 71-347, CRC 925).

VI SUMMARY AND RECOMMENDATIONS

1. There is a substantial amount of evidence pointing to physiological changes in children associated with blood lead levels below 20 ug/dL, a level once considered safe. These

changes include: inhibition of ALA-D and inhibition of the addition of iron to porphyrin (both examples of interference with the production of heme for hemoglobin), interference with the activity of vitamin D, apparent interference with mental development, changes in reaction time, and changes in brain wave activity.

2. In view of these effects, priority should be given to reducing lead in the environment for a number of reasons. The most important reason is that some of these effects appear harmful. However, even where the evidence is not conclusive

1) it should be remembered that to this point, studies of lead have continually discovered new effects at lower levels
2) physiological changes known to be caused by lead should be presumed to be undesirable; to do otherwise uses humans as experimental subjects
3) the burden of proving the safety of low level lead should be on those proposing to discharge it into the environment
4) there should be a real margin of safety in what is considered an acceptable level of lead
5) it should be remembered that lead is increasing and accummulating in the environment.

3. Average Canadian blood lead levels appear at or near levels where physiological changes occur.

4. In view of the diverse sources of lead in the environment, an overall strategy is needed to reduce total emissions.

5. Gasoline is an important and probably the preeminent contributor to lead in humans. It is not clear that there will be any net costs to Canadian society from the total removal of lead from gasoline. There may in fact be net financial benefits. The federal government has the legislative authority under the Clean Air Act to remove lead from gasoline as a preventative measure. In view of the health effects discussed above this should be a priority.

6. Emission standards for secondary lead smelters under the Clean Air Act should be strengthened and set according to an overall strategy, and extended to the most important lead emitters such as mining, milling, smelting, and refining.

7. Ontario ambient air standards for lead should be reviewed with an eye to revising them; unenforcable criteria should not be relied on as regulatory instruments.

8. Lead from soldered seam cans is a major contributor to dietary, and in turn total, lead intake by individuals. Present lead levels in canned food may be in violation of the Food and Drug Act and regulations. At any rate, authority exists under the FDA and the Hazardous Products Act to pass regulations limiting lead in canned food or to phase out solder seam cans, and the health concerns described earlier justify such an initiative.