PERSPECTIVES ON AIRBORNE LEAD

A Statement Prepared by the Office of Criteria Development
In the Office of the Director
National Environmental Research Center
Research Triangle Park, North Carolina

(A line by line or paragraph by paragraph critique of this Document by Robert A. Kehoe, M.D.)

Page 1.

Paragraph No. 1:

Sentence No. 1: "Excreted" - the last word in the sentence - is not the word to be used here. Rather, "lost from the body," by whatever means (as in desquamating skin, falling hair, etc.), better expresses the issue of balance or imbalance.

Sentence No. 2: The parenthetic clause, "(though not indefinite)," is unnecessary here, and is untrue in relation to the ingestion of lead, which, because of the long residence of swallowed lead within the alimentary tract, followed by the addition of new amounts before the residue of the last previous amount has been evacuated, yields continuous absorption into the tissues. If such ingestion persists at a given rate in excess of that associated with current environmental conditions, accumulation continues indefinitely at the same rate, so far as present evidence indicates.

Sentence No. 3: The fact, without "presumption" is that, if one's exposure to airborne lead, at a certain level, is discontinuous as in the case of the workmen in the lead trades, accumulation also is discontinuous, reaching a steady state day by day, and month by month, after a period of time (months) required to reach equilibrium.

Sentence No. 4: The lumping together of automobile mechanics with parking garage personnel and traffic policemen fails to recognize the quite different types of exposure to lead incurred by these men. This is an error which persists in the

discussion of this subject by people who have not examined the literature on this subject. American automobile mechanics, usually referred to as garage mechanics, hav numerous opportunities for occupational exposure to lead by ingestion. This factor, apparently, differentiates these men, sufficiently, from the other groups referred to in this sentence, in that they absorb enough lead in their work to give rise to a significantly high (statistically) mean lead content in their blood than those of the others. There is no evidence to show that parking garage attendants (who do not repa automobiles) or traffic policemen are in this same category of statistically elevated blood values. The statement has often been made to the contrary, but the statistical evidence is lacking. The difference between them and ordinary men (not women) in the general population is within the variability of the methods of statistical analysis. It is this erroneous statement, emphasized by a tabulation of various groups in the Three Cities Survey of 1961, that has been responsible for an inference that the relationship between the lead content of the blood of persons in the general population and the lead content of the ambient air has been demonstrated. The fact is that no such relationship, under the ordinary circumstances of urban life, has ever been documented. Furthermore, the low level of the concentration of lead in the blood of women, generally, in ordinary life, is almost certainly a matter of dietary rather than airborne lead. Persons have been found in the general population of this country who have been subjected to unusual types of respiratory exposure to lead, but references to the findings in such cases, in the general discussions of this matter, are irrelevant.

Sentence No. 6: The evidence said to exist for the accumulation of lead in the skeleton of persons who have <u>never</u> been subjected to unusual conditions of exposu to lead, beyond those incurred in the common environment, is not at all definitive. Undocumented statements on this subject do not represent evidence. There is no hint in them of evidence concerning the actual experience of deceased persons during their

lifetime, except in the few instances in which it could readily be established by casual inquiry that the living person had been involved in a specific occupational exposure to lead. The likelihood of the occurrence of episodes of intermittent exposure to lead, as in painting, soldering, ingesting contaminated food or beverages, and in a variety of other ways, simply cannot be ignored in considering the widely varying content of the skeletons of deceased persons taken at random for examination. Statistically, the alleged evidence on this matter in the literature is worthless, in relation to the absorption of lead from the ambient air, although it is highly valuable as a record of human experience in relation to the absorption and retention of lead.

Entire Paragraph No. 2:

In this paragraph, the relationship of the concentration of lead in the whole blood to the onset of illness - that is, the triggering of intoxication - is not mentioned, despite the fact that it is the crucial issue to be dealt with. It will be recognized by any person of experience, that the concentration of lead in the blood declines very shortly after the specific exposure responsible for an elevated concentration has been terminated, although the illness may persist for some time. The concentration of lead found in the course of illness, without regard to what it was at the onset of illness, when (as a rule) the exposure to lead was being incurred, is relatively unimportant.

This paragraph continues with a discussion of the inhibition of certain enzymes which have to do with the synthesis of the heme moiety of hemoglobin. Speculation concerning the meaning of the latter phenomena in relation to intoxication by lead is, of course, unavoidable, in view of the importance of hemoglobin in the animal organism, and also in consideration of the frequent but not inevitable occurrence of anemia in lead poisoning. Thus far, however, the principal usefulness of the available biochemical information of this type lies in its stimulation of further

research into the mechanisms involved not only in the production of hemoglobin, but also in other cellular responses to lead and other trace metals. It would be foolhardy, in the present state of our knowledge, to do much more than to speculate, as a basis for further investigation, on the meaning of phenomena of this type. The most important practical matter which has come to light in this biochemical field, so far as lead is concerned, is found in the strong correlation which exists between the concentration of delta aminolevulinic acid in the urine, under well-controlled conditions, and the concentration of lead in the blood, whereby the determination of delta aminolevulinic acid in the urine (under appropriate conditions) can be substituted, up to a point, for the more troublesome and time-consuming determination of lead in the blood. Certainly, a simple test which, indirectly but reliably, will portray the extent of the absorption of lead by workmen in the lead-using industries, would be of considerable value in occupational medical practice. Beyond this practical consideration, an earnest and apprehensive discussion is being engaged in, concerning phenomena about which, in relation to the hazard of lead absorption, there is little understanding. This aspect of this matter is emphasized for the simple reason that it is the basis for a great deal of apprehension concerning the effects of present day exposure to lead which, in all likelihood, is not very much greater, in either absolute or toxicological terms, than that which has been the common lot of men for many generations. It is, indeed, the price paid, among men whose judgment is but meagerly balanced by experience, for the further investigation of the behavior of living organisms, especially man. In some men it inspires wonder; in others, fear.

Page 2.

Second (Incomplete) Paragraph:

It would be advisable to include "probably" after "groups" in line 1 of

this paragraph, since the general statistics on lead poisoning in the United States are unreliable. It is certain that the incidence of this disease in this country, especially in the general population, is unknown. This is suggested only because it is not good practice to assume a knowledge which one does not have. Only recently, for example, have a series of publications brought to the fore the occurrence of lead poisoning among the habitual users of "moonshine" whiskey, although local physicians have been seeing cases of lead poisoning from this source for many years.

In line 6 from the bottom of this same page, the statement is made that workers in the lead trades are exposed to lead primarily in the form of contaminated air. This is not true, generally, and it is even less so, if one means to convey the idea by this statement that the absorption of lead under these circumstances occurs only in the respiratory tract. Not only do workmen swallow lead, sometimes in considerable amounts, through the contamination of articles put in their mouths, but a large proportion of particles of lead in excess of 1 micron in diameter find their way into the nasopharynx and are swallowed. For this reason, mainly, it is impossible to relate the concentration of lead in the air to the quantities of inhaled lead retained and (presumably) absorbed in the respiratory tract, unless the particles inhaled are known to be so small as to be deposited exclusively, for all practical purposes, in the depths of the respiratory tract, including the alveoli. For this reason, the simple statement that "500 mcg. of lead per cubic meter of air" may be expected to yield cases of lead poisoning among men who work in such an atmosphere, is meaningless as an expression of an unsafe work environment. Unless the character of the lead dispersed in the air is known, both as to its degree of dispersion and as to the compound concerned, no standard of safety or danger is more meaningful than a common "rule of thumb."

Page 3.

Top Sentence: "It is believed." Rather, it should be said that, as the result of years of investigation, it is well known (and documented) that the incidence of lead poisoning among urban children of the slums, up to, but infrequently exceeding, four years of age, results almost entirely from the ingestion of paint, scaling from or chewed from internal surfaces of houses painted and repainted with paints high in lead pigment, which were applied before modern (cheaper) paints were developed for interior painting. The quantities of lead ingested in this manner by small children are generally so large as to have induced a type of acute poisoning, the like of which is rarely seen otherwise. Indeed, the quantities are so large as to render somewhat absurd the apparently deep concern about the potentialities for harm (contribution) of the much smaller quantities made available through the deposition of lead in city streets, in park areas, and on other urban surfaces. This is not to say that this matter is not worthy of further investigation, but to regard it in the ultra-serious light of this discussion is to be more concerned about a theoretically potential issue than about the preventable, tragic problem which is known (and has been for many years of public health temporization) to exist. The entire discussion of this subject comes very close to being a super erudite exercise in futility.

Page 3 continued - line 5 from the bottom lists "chronic nephropathy" as an established lesion of lead poisoning. Actually, this is a controversial matter, which certainly does not justify so flat a statement of fact as that made here. Only one who is unfamiliar with the subject would classify this lesion in the same category as abdominal colic, which, of all primary clinical responses to lead absorption, is, by far, the most frequent in occupational lead poisoning.

Page 4.

Entire Paragraph:

This discussion does not follow from the rich material presented in the Report of the National Academy of Sciences. It has resulted from the author's use of fragmentary, often controversial, statements of authors and investigators in that Report. The flat statement that cases of mild lead poisoning have been associated with whole blood concentration of 50 to 80 mcg. (of lead) per 100 grams, is more than likely untrue. In the extensive experience of this reviewer, no case of lead poisoning at the onset of illness, in child or adult, has ever been seen below 80 mcg. per 100 grams of whole blood. Such cases have been reported in the literature, to be sure, but not under conditions of observation which have permitted the determination of the concentration of lead in the blood at the time of onset of the intoxication. Moreover, it seems not to be appreciated that diagnoses of lead poisoning have been reported as such on the exceedingly flimsy evidence, as the best that could be made by the observer under the circumstances. The difficulties of arriving at a certainly correct diagnosis are admittedly great at times.

Page 6. Part II. Exposure Cycle. A. Intake.

No comment. Material taken from literature.

Page 7. B. Excretion.

It is true that the available information as to the relative contributions made to the true excretion of lead by human beings, generally, by the alimentary tract and the urinary apparatus, is meager. There is, however, quantitative evidence to demonstrate that an individual can, under ordinary circumstances, especially when the daily intake of lead is low, eliminate most of the excreted lead in the urine. Other individuals, whose intake is somewhat larger, excrete as much in the feces as in the urine. At high levels of intake (several times the normal level), the fecal

excretion may be twice or three times that of the urine. Balance experiments have shown that the latter is not an uncommon situation under experimental conditions in which the rate of the absorption of lead is comparable to that observed during occupational exposure to lead. This information is available in the literature.

Page 7. C. Relationship Between Daily Assimilation /Should be Absorption/ of Lead and Blood Level.

This paragraph is regarded as redundant in a report or abstract prepared as a basis for official action, the reason being that too many assumptions (which may well have little validity) are made in order to draw a figure (figure 11-1, page 8). That this statement may be considered to be a criticism of the original Report of the Academy of Sciences, is true, but the latter is less subject to criticism because of its larger mission and scope.

Pages 10 and 11. III. Welfare Effects. A. Animals. B. Vegetation.

This discussion requires no critical appraisal, except for the comment that the use of domestic animals as food for man would seem to deserve some consideration in relation to the possibility of dietary contamination. The facts, however, do not justify much serious concern on this score, since the food chain of man has been found not to be affected to any important extent by the lead in the ambient air, and its deposition on vegetation. It might be desirable to so indicate in a paper of this type, since the contrary concept has been expressed repeatedly in current lay writings on this subject, which reach the public.

Page 15. IV. Environmental Appraisal (continued). A. Media Levels.

Second Whole Paragraph:

In this paragraph, there is a failure to state the important fact that the lead emitted from the tail pipe of an automobile is composed predominately of the combustion products of tetraethyllead or tetramethyllead or both. Only small

quantities of the uncombusted alkyl lead compounds escape from the internal combustion engine when the latter is operating satisfactorily. Under unsatisfactory conditions of operation such as the initial (brief) performance of a cold engine in starting up, or when the contents of one or more cyclinders of the engine fail to be ignited, the uncombusted contents of the inoperative cyclinders are discharged into the exhaust system, and at such times the alkyl lead compounds can readily be detected at, or near, the tail pipe. They are dissipated rapidly, and can be detected by fairly sensitive methods only near to the car. It is fair to say that the alkyl lead compounds in the air generally are present in such low concentrations as to be insignificant. The truth of this matter, despite the uncertainty as to the precise low concentration of these compounds which can be detected in strategic places, in relation to the operations of automobiles, should be made clear to those who may be apprehensive about the toxicity of these compounds.

Page 16. B. Media Interchanges.

No comment.

Page 17. C. Nonoccupational Exposure /to Lead/.

First Paragraph:

The statement that the air overlying the largest American cities contains 20 times as much lead as that overlying sparsely populated ares is hardly an informative expression of the significance of the fact. Twenty times a number so small as to be beyond ordinary comprehension is still a very small number, which, in this instance, appears to be physiologically insignificant.

Second Paragraph:

The statement here, again, is unfortunate. The impression conveyed by the reference to the combination of "lead in street dust" and that in paint applied in the interior of neglected houses, is that the two potential sources of the exposure

of "preschool age children" to lead in the same areas, are of comparably hazardous character. To the contrary, the one - the interior surfaces of old deteriorating houses coated with paint of high lead content - is a documented, highly hazardous situation which has taken a serious toll of sickness and deaths among small children. The other - lead in the dust in streets and other areas - is an hypothetical source of the exposure of children to lead, which will require careful, meticulous investigation in order to prove or disprove its significance. The combination of the two sources, at worst, is tantamount to adding a few micrograms of absorbed lead per day from the one source to the absorption of lead, from the other, in quantities of several milligrams of lead per day. Obviously, the two may combine. One does not consider any artificial exposure of a child to lead to be insignificant until it has been proved so to be, but one does not give much credence to the significance of the summation of a milligram of lead with its thousandth part, to yield a hazardous dose. The inferred additional effect of the inhalation of lead from the ambient air by children must, again, be regarded as an hypothesis, since there is no evidence indicative of such an effect. This type of speculation must be put in the same category as that of lay persons who, for the lack of tutelage, argue that since lead is highly dangerous in relatively large amounts, it must be a little dangerous in small amounts. Quantitative information is an absolutely essential feature of toxicological concepts.

Pages 18, 19, 20, 22, 23 and 24.

These pages contain tabulated data or references taken from the original Report issued by the National Academy of Sciences, and, therefore, speak for themselves so far as this statement is concerned. Page 21, on the "Sources" (of lead in the atmosphere), page 25, on the "Measurement" (of lead in the atmosphere), and page 27, on the "Principles of Control," contain factual information, which

generally elicit no comments from this reviewer. The contents of the final pages which deal with "Summary" (pages 29 and 30) and "Conclusions" (page 31) arouse certain comments which appear below:

Pages 29 and 30, - VIII. Summary. Page 31, - IX. Conclusions.

The initial statement, while not untrue, leaves much to be desired from the aspect of information on the subject at issue. Lead poisoning, in various forms, is well known to have occurred among men. Lead is, indeed, poisonous when absorbed into the body of man (and animals) in sufficient quantity, either in one dose or in multiple dosage over variable periods of time. The levels of dosage, as modified by the time involved in the process of repetitious consumption, inhalation, or administration, have been investigated to such an extent as to have provided more elaborate information about this element than that which is available concerning the overwhelming proportion of the substances with which mankind may come into contact in his general environment.

Up to the present time, after an experience of hundreds of years during which there have been appreciable increases in the quantities of lead with which men (including women and children) have come in contact in their general environment, and after 48 years during which a further addition to general human exposure to lead has resulted from the discovery, development, and use of alkyl lead compounds in motor fuels, no demonstrable ill effects have been found among people who have been subjected only to lead which is confined to the general ordinary environment of urban and rural human society, despite repeated efforts over the years to seek out and identify untoward effects in the more exposed segments of the general urban population, and more recently, elaborate surveys of ordinary men and women in urban areas in which the opportunities for human exposure to lead are at their peak, because of the density of motor traffic.

Considering these simple matters of fact, this reviewer submits that this "Summary" of the very large body of facts made available in the Report of the American Academy of Sciences, together with the "Conclusions" which follow, are both specious and irrelevant, in that they do not give a rational interpretation of the findings of investigators as represented in the Report, nor of the mandate for action or inaction as presented by the facts therein disclosed. The situation described in the Report in its essential characteristics, calls for a watching brief (accompanied by intensive efforts in carrying out further investigations, including those recommended in the Report of the National Academy of Sciences) in order to determine whether or not there is any indication of a future development of any hazardous situation, through the maturing of any of the potentialities for injury which have been given thorough ventilation in numerous and varied types of investigation, the results of which have been brought together in the Report of the Academy of Sciences.

In view of the factual status of this matter, there seems little virtue in reviewing in minute detail the individual items of the "Summary," or the brief statement of "Conclusions." Both of these have missed the main issue of the Report of the Academy of Sciences.