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February 21, 1967

To: All Members of the Lead Health and Safety Committee

Re: Survey on Public Knowledge and Attitudes on Lead

Attached you will find an analysis of some of the findings of a survey on public knowledge and attitudes on lead conducted for us in November, 1966 by the Opinion Research Corporation of Princeton, New Jersey. This survey was designed to determine whether people consider lead as a "harmful" substance and why, and to get an indication of what people know about the uses of lead.

Carefully planned sampling techniques were used in this survey to preclude the possibility of stirring up undue interest in lead. The sampling population was selected as representing an accurate cross section of the entire U.S. population.

Four questions concerning lead were asked among a number of other unrelated questions. These four questions, together with a tabulation of the percent response to each, are also attached for your review.

Very truly yours,

JC Roumas

James C. Roumas

JCR/jv
Attachments (2)

Look Ahead with Lead

Discussion of ORC Caravan Survey on Lead

The ORC Caravan Survey on Public Knowledge and Attitudes on Lead provided data valuable in evaluating present and planning future programs and activities for Lead Industries Association, Inc. The survey respondents were selected on a probability sampling basis and therefore the population questioned can be projected to the entire U.S. population of men and women over 18 (within certain sampling variations).

Here are some of the major findings provided by the data:

1. A large proportion of the public -- 42 percent -- identifies lead among 10 substances as being harmful to health. If those who picked "all substances" are included, this figure would rise to 44 percent. Lead was the second most frequent substance named, following carbon monoxide which was picked by 75 percent. Lead ranked well ahead of the third (carbon dioxide 29 percent) and fourth (sulfur dioxide 28 percent) substances named.

Lead was picked more frequently by those with some college education, 53 percent, and by professional and managerial people, 49 percent. Included in these groups would be those who are most likely to be communicators and community leaders.

2. Considerable lack of sophistication concerning knowledge of uses of lead was shown among the general population and specific segments of the population. Nearly one-fourth of the respondents said "don't know" when asked to name a use for lead.

"Pencils" as a use for lead ranked second, 17 percent, among responses (largely because 25 percent of the women vs. 9 percent of the men gave this), trailing paint, 27 percent, which was named about equally by men and women.

Gross uses of lead metal received high mention, largely because of responses by men. These included fishing weights 13 percent, ammunition 15 percent, and pipe 16 percent, the latter being named about equally by men and women.

Lead for batteries was volunteered by only 6 percent -- 12 percent of the men and only 1 percent of the women. Other important uses of lead were little mentioned -- soldering 7 percent, cable 2 percent, type metal 1 percent, ceramics, unmentioned; and anti-knock compounds 8 percent.

3. Health dangers from lead are not associated with leaded gasoline or automobile exhausts to any appreciable extent. Only 1 percent specified gasoline fumes as a reason for believing lead harmful to health. Only 3 percent named lead as coming from automobile exhaust. (This figure contrasts with 8 percent naming gasoline as one use of lead, but the lead use question was asked after the auto exhaust question, and this could have stimulated a thought-association with gasoline.)

4. In the public mind, the question of lead being harmful seems to be associated primarily with paints. Although the leading response, 17 percent, is that of "lead poisoning (general)", other responses related to paint mount up to 11 percent.

Based upon these data, the following observations are made:

1. A far larger segment of the population associates lead as being "harmful to health" than with any of lead's major and beneficial uses.

2. Nearly half of the population (over half of the college-educated) believe lead is "harmful to health." This means that they could be expected to be receptive to -- or are, in effect, pre-conditioned for -- suggestions that lead emissions into the atmosphere may constitute a health hazard. That they are not now aware of use of lead in gasoline or emission of lead from auto exhausts should be kept well in mind in future planning. However, this should not lead to complacency that they will not be made increasingly aware of leaded gasoline, as the official and mass media publicity campaigns on air pollution intensify.

3. The general lack of knowledge among the public of important and useful applications of lead and lead compounds in modern society is obvious and offers a challenge for bringing a better understanding of lead's contributions to many industrial and consumer activities.

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PRELIMINARY TABULATION OF RESPONSES
TO LEAD QUESTIONS IN CARAVAN SURVEY
(By Percentage of Responses)

1. Here is a list of subjects which are known to be in our environment. Which, if any, do you feel are harmful to health?

cadmium	2%
carbon dioxide	30%
carbon monoxide	73%
hydrocarbons	9%
lead	42%
iron	6%
nitrogen oxide	13%
sulfur dioxide	28%
nickel	8%
ozone	25%
all of these	2%
none of these	2%
no opinion	10%

2. In what ways do you think lead is harmful (asked of those who mentioned lead as being harmful in question No. 1)?

poison (general)	19%
lead poisoning from paint	3%
paint taken internally	3%
paint fumes	2%
harmful to lungs(non-specific)	3%
lead fumes	3%
harmful if taken internally (paint non-specified)	4%
harmful if gets in blood stream	4%
lead pencils	1%
gasoline-gasoline fumes	1%
as ammunition in bullets	2%

3. Looking over this list again, which of these substances do you think come from motor vehicle exhaust?

cadmium	1%
carbon dioxide	17%
carbon monoxide	80%
hydrocarbons	71%
lead	54%
iron	5%
nitrogen oxide	42%
sulfur dioxide	32%
nickel	5%
ozone	15%
all of these	4%
none of these	1%
no opinion	3%

its gasoline consumption will be less by virtue of a high compression ratio" in its engine. And a high compression engine calls for a high octane gasoline, made possible by lead additives.

For years -- from 1926 to 1959 -- the maximum amount of TEL for automobile gasolines was held at a level of three cubic centimeters a gallon -- or about 1/10 of an ounce to a 128-ounce gallon. However, the average annual amount used was far below this, and never got much above two cubic centimeters per gallon.

Because of increasing difficulties by gasoline makers in upgrading gasolines to the octane ratings called for by newer and better engines, the maximum was increased in 1959 to four cubic centimeters per gallon -- although again, the average remains below this, running at 2.36 cubic centimeters per gallon in late 1966.

Two Surgeon General Committees Reported On Lead Use

Between the time of the first commercial use of TEL (in 1923) and the present, much knowledge from experience and scientific research has developed concerning not only the use of lead in gasoline but also about all of the lead in man's environment and about how man handles the lead to which he is exposed.

A first major step in the accumulation and application of knowledge about lead came in 1926 with the report of a special committee of the U.S. Surgeon General which concluded "that there are at present no good grounds for prohibiting the use of ethyl (leaded) gasoline...provided that its distribution and uses are controlled by proper regulations."

The 1925-26 committee was appointed after the industry suspended sale of leaded gasoline in May 1925, following some lead poisoning cases in a plant involved in the manufacture and handling of tetraethyl lead. The Surgeon General's committee, in May 1926, recommended certain procedures and regulations covering the manufacture, blending, mixing, and distribution of leaded gasoline, which were accepted by existing and subsequent manufacturers of lead additives and by the oil industry.

The result has been that in 1959 the Public Health Service said it "has no knowledge of any occurrence of clinical lead poisoning in the manufacture, blending, mixing or use of TEL or in the use of leaded gasoline since the adoption of the recommended regulations of the 1926 Committee."

This observation was included in the report of another Surgeon General's Advisory Committee convened in early 1959 to consider raising the maximum level of lead alkyl additives in gasolines from three cubic centimeters to four cubic centimeters per gallon.

This committee, which Dr. Harold J. Magnuson of the U.S. Public Health Service served as chairman, reviewed past findings and the present state of knowledge concerning lead additives and lead in the environment. Although the committee observed that a "conclusive answer" is impossible because of lack of medical data, it concluded that the proposed increase "would not increase the hazards involved in the manufacture and distribution of leaded gasoline" and that available data do not indicate that the change "would significantly increase the hazard to public health from air pollution."

In making its recommendations, the 1959 Surgeon General's committee took into account, among many other things, the considerations that the increase in the permissible level of TEL would--

-- effect a saving on the drain on crude oil resources

-- relieve capital requirements of oil refiners for making better gasoline

-- permit many (especially small) refiners better to meet competition

-- provide economic advantages to the motoring public

And would NOT be a factor in formation of atmospheric smog and irritants

Thus it was that in 1966 about 99 percent of all gasoline marketed in this country contains some lead additives, with the average amount per gallon calculated at 2.36 cubic centimeters for the first 10 months of 1966.

However, in its report the committee recommended that the Public Health Service, in cooperation with industry groups, "conduct studies to provide more definitive data on levels and trends of atmospheric lead contamination in selected urban areas and of the body burden of lead of selected population groups. If these studies should bring to light any data of significance, you (the Surgeon General) may wish to reconsider the recommendation of this Committee." The results of some studies conducted because of this recommendation are discussed later.

Many questions about lead in gasoline can be answered on the basis of scientific evidence, but not without considering other sources of lead in the environment to which man is exposed.

II. DEVELOPMENT OF KNOWLEDGE ABOUT LEAD AND MAN

The adding of lead to gasoline would probably be of little or no import of and by itself. But several compelling other aspects enter into the situation.

First, there are tiny amounts of lead in our food and drink.

Second, leaded gasoline is only one source of lead in the air.

Third, attention to all the substances in our air has increased in recent years.

And fourth, the basis of any concern is the fact that lead, as a metal, can be toxic when too much of it is taken in by man.

This acknowledged toxicity of lead has resulted in the accumulation of a large body of scientific knowledge about lead in the environment and its effects on man, how to measure tiny amounts and evaluate their significance, and how to control and treat over-exposure.

This knowledge did not come about because of any direct concern over the general public's exposure to lead. However, in certain lead-working occupations and through accidents, over-doses of lead could, did, and still do occur, but with decreasing frequency. Experimental and observational studies on lead over the past several decades have brought about a marked decrease in occupational exposures and illnesses. Also, importantly, there has been developed a scientific understanding of what happens to the lead that man takes in and how much of it he can absorb before he approaches a toxic zone, and what that toxic zone may be.

At a symposium on lead sponsored by the Public Health Service in late 1965, Dr. Herbert E. Stokinger, chief, Toxicology Section, Division of Occupational Health, PHS, Cincinnati, reported: "Exposure to air-borne lead, dust and fume, is less by a factor of several magnitudes in all industrial categories since 1934." This decrease in exposure has continued to the present he said, even though as early as 1945, the average industrial exposure in most work categories was below the acceptable limits because of the acceptance of safe work standards for lead.

Benchmarks Developed for Lead Measurements

Occupational and accidental lead exposures are relevant here because medical and scientific experience with such cases

provided basic benchmarks essential in considering the general public's exposure to lead in the environment -- from air and all other sources. Important among these are:

1. Lead levels in the blood and urine of man can now be measured and any unusual rise in these levels can indicate an unusual intake of lead. The lead content in urine, since it is being excreted, is considered as an indicator of a change in lead intake. When it approaches 150 micrograms per liter of urine, this is considered a signal for further checking. Usually, the next thing checked is the lead level of the blood. If this is approaching 80 micrograms per 100 grams of blood, this is considered a warning signal, for lead intoxication may occur somewhere above this level, but is not known to occur below it.

In studies of people with diagnosed lead poisoning, it was found that relatively large quantities of lead were absorbed and that the concentration of lead in the blood ranged from 150 to 800 micrograms per 100 grams of blood.

2. The average man takes in about 300 micrograms of lead daily in his food and drink and about 30 micrograms in the air he breathes. And he eliminates this same amount daily, mainly through his feces and urine. Thus the average individual is considered in "lead balance" and is not accumulating excess lead in his body.

3. Experiments have shown that a normal man can almost double his normal intake of lead through his diet for a prolonged period without showing an increase in lead concentration in his blood. (This was tested by adding 300 micrograms to the daily diets of human subjects under study.)

4. In lead-working industries, a level of 200 micrograms per cubic meter of air has been generally accepted as safe for workers on an eight-hour work day. Besides limiting exposures, other protective measures have been taken. Removal from exposure is the simple and effective step to take if any tendency toward an increased lead level in the blood shows up. Removal from exposure brings down the level. The application of preventive measures relating to lead exposure has been widely accepted in industry.

Reduction in Over-Exposure to Lead

Good industrial hygiene practices have prevented any cases of lead intoxication in the manufacturing of lead alkyls in the last 30 years. Similar good records are reported for other segments of the lead industry. Even inadvertent poisoning by lead has been reduced and development of medical treatment has decreased the possible damaging effects of over-exposure to lead.

The above facts are only a small part of the accumulated knowledge about lead in the body -- in the bones, liver, kidneys, brain, and other organs and tissues. Medical experiments have involved feeding two or three times the normal daily diet intake of lead to human subjects to determine what happens to the lead and to the subject. Other experiments, still going on, test human subjects in rooms with artificially high lead content in the air.

On the basis of accumulated information about lead intake and its effects on people, Prof. Ralph G. Smith of Wayne State University's School of Medicine, commented at the 1965 lead symposium that the current knowledge of safe body levels of lead is "entirely adequate in the prevention of diagnosable lead poisoning in industry, and it is widely believed to be applicable to the population-at-large."

This scientific knowledge has also made it possible to study the relative contribution of lead emissions from gasoline engines to environmental lead to determine whether there appears to be any effect on the general population.

III. THE "THREE CITY SURVEY" AND OTHER LEAD STUDIES

To single out one of the many substances in the air and then to consider a single source for this one substance entail the risk of distorting a complex problem.

"Lead is but one of many metals present in the atmosphere and diet of man. Further, it is only a minor component of the tremendous mixture of chemical and biological matter which permeates the environment. There are many substances present in this mixture which man never encountered at all until relatively recent times..." said Professor Smith of Wayne State University Medical School, Detroit.

Tiny specks of dust -- unseen and relatively sparse -- in the air of our cities (and countryside) are made up of many things. This dust (called particulate matter) can be measured in terms of micrograms (one one-millionth of a gram) contained in a cubic meter of air, about the amount of air contained in a box 40 inches on a side. Studies indicate that lead particles may range from 1.5 percent to 2.5 percent of all city particulate matter, on the average.

Of course, the amount of particulate matter, including lead, is never constant. It is affected by humidity, temperature, geography, wind currents, and a number of social and industrial factors. As just one example, in one city the amount of particulate matter measured during a year ranged from a high of 192 micrograms per cubic meter of air in one location in February, to a low of 51 micrograms per cubic meter of air in another location in March.

Nine Sources Listed for Lead in Air

Further complicating the study of lead in the air is that there are at least nine sources of lead in the air, said Dr. Joseph F. Tomashefski and Ralph I. Mitchell of the Battelle Memorial Institute, Columbus, Ohio at the 1965 lead symposium. They listed along with motor vehicle exhausts, pesticides, coal burning, refuse incineration, industrial, natural, dusts and sprays, tobacco smoke, and paint attrition.

"Lead occurring naturally in soils and rocks contributes only a small part to air pollution," they commented. "In industrial areas and where distillation and burning of coal occurs, higher atmospheric levels can be attained. Lead can be emitted into the atmosphere from smelting processes, from the incineration of scrap and other industrial uses, and from dusts and sprays

(insecticides containing lead). The most important source of lead contamination in the atmosphere is exhaust from vehicles using leaded gasoline... Studies on cigarette smokers indicate higher blood levels of lead than in nonsmokers..."

Studies continue to be made to answer such questions as: How much lead is in city air? In areas of heavy traffic? Of little traffic? Is the amount increasing? Or decreasing? What about the people who live or work in these areas? What is their lead level as measured by amounts in their blood and urine?

Although there had been considerable previous work, a massive effort to get more definitive answers to these questions was reported in 1965 with publication by the Department of Health, Education, and Welfare of the results of "Survey of Lead in the Atmosphere of Three Urban Communities" -- Los Angeles, Philadelphia and Cincinnati. This report is usually referred to as the Three City survey.

The survey was undertaken specifically as result of the suggestion, referred to previously, by the 1959 Surgeon General's committee that such studies be conducted. For a period of one year (June 1961 through May 1962), some 3,400 samples of air were taken from 20 representative rural, residential, commercial and industrial locations in the three cities.

Results of the Three City Survey

Some of the findings (which were reported in a 94-page booklet) are given here.

For Cincinnati, the average in all samples was 1.4 micrograms of lead per cubic meter of air, with the highest monthly concentration at any one site being 3.1 micrograms in October.

For Philadelphia, the average of all samples was 1.6 micrograms per cubic meter of air, with the highest monthly concentration at any site being 4.4 micrograms in October.

For Los Angeles, the average of all locations was 2.5 micrograms per cubic meter of air, with the highest monthly concentration at any site being 6.4 micrograms in December.

By comparing these results with previous samplings (done by the National Air Sampling Network of the Public Health Service and the Kettering Laboratory in Cincinnati), it was found that there was no consistent trend, up or down, in lead

content of the air of the three cities during the previous five years. "Data obtained by the Kettering Laboratory indicate that in Cincinnati the trend has been downward since 1946."

The reasons for the general decline in Cincinnati since 1946 include the diminishing use of solid fuels, better collection and removal of particulates from industrial operations, an increasingly effective enforcement of the ordinance relating to abatement of smoke, and changes in traffic flow and land use in the metropolitan areas," the report explains.

In commenting on these measurements, Dr. Robert A. Kehoe, a pioneer in lead research at the Kettering Laboratory and University of Cincinnati, said that none of these concentrations is in the range considered as making a significant contribution to the lead burden of individuals. He said even "the observed high results have been far below the range that is capable of causing lead intoxication in any individual even after many months of exposure."

Lead Levels Also Checked in People

However, to determine what might be happening to the lead in people in these cities, the Three City study also checked the lead levels in the blood of about 2,300 people, and in the urine of 1,700 of these. The people to be checked were selected to get different types of exposure to traffic and other fumes. They included policemen in areas of heavy traffic, firemen, post office workers, aircraft workers, suburbanites, commuters, and the like. In addition, 126 patients with chronic illnesses were examined to see if the lead content of their blood was of significance. "No relationship was found between levels of lead in the blood and age. Levels in females were slightly lower than those in males from comparable groups. In nearly all instances, the mean concentration of lead in the blood of smokers was slightly higher than that of non-smokers. There were no unusual findings concerning persons who were investigated because of chronic diseases," the PHS report stated.

Out of the total studied, only 11 persons were "found to have concentrations of lead in the blood equal to or in excess of 0.06 milligrams (60 micrograms) per 100 grams of blood... These 11 persons were from groups which had an opportunity for occupational exposure to lead."

(Subsequently, seven of these 11 were re-examined and their blood lead levels were in the range of 20 micrograms -- indicating either an analytical error in the first place, or a fluctuation in the lead levels, which is often observed.)

The findings did show that lead levels in the blood of people tended to be higher in those areas where lead concentrations in the atmosphere were higher -- that is, in rural or suburban areas both blood lead levels and the concentration of lead in the air tended to be lower than in congested downtown districts.

Similarly, people who were exposed more to traffic conditions -- such as policemen, parking lot attendants, commuters, and garage mechanics -- tended to have slightly higher lead levels than those not so exposed. However, even these were well within the accepted safe ranges.

In addition to the regular sampling stations for lead in the atmosphere, the study also included some special sampling in dense traffic areas These showed lead concentrations in the air rising during heavy traffic periods and declining after the traffic "rushes" eased off.

Various Factors Influence Lead Significance

The Three City survey findings seemed to confirm what had been shown in previous studies -- that some of the lead exhausted from gasoline engines becomes air-borne, but that after the source is removed or abates, there is a settling down of lead particles and the degree of concentration in the air declines.

Estimates vary as to how much of the lead which is in the gasoline gets into the air, depending on many conditions, including the condition of the engine. Less lead will be discharged, for example, under city driving conditions than under conditions of higher speeds in the country. Some of the lead remains in the oil, engine and exhaust system of cars.

One rounded estimate is that about 42 percent of the lead in gasoline becomes air borne for varying periods of time. About 70 percent is exhausted from the car but the heavier particles fall to the ground.

Other Factors Affect Significance to Man

As far as significance to man is concerned, there are other important factors - such as the particle size (whether small enough to be inhaled and retained in the body), chemical composition of the lead compounds (whether absorbable or not), and others. In combustion of gasoline, practically all of the lead additives are converted into inorganic compounds of lead and part of these go out the exhaust.

In discussing some of these factors, Dr. Tomashefski and Mitchell stated that the cleansing mechanisms of the respiratory system will remove the majority of inorganic lead particles that are inhaled. Since inorganic lead is relatively insoluble, any remaining "should be poorly absorbed," they said.

A California Institute of Technology toxicologist, Dr. Thomas J. Haley, wrote in 1966 that "the fact that a particle is present in ambient air does not mean that it will be inhaled and if inhaled, retained." Because of variations in particle size and the lung's mechanisms for cleaning out particles, Dr. Haley observed that "the lead compounds in automotive exhaust may not be available; or if available, not absorbed; or if absorbed, not retained, so no contribution is made to lead body burden."

It has been observed that the body burden of lead tends to remain in balance, with body excretions adjusting to slight changes in lead intake.

Such considerations help explain why, in the study of the 2,300 people involved in the Three City survey, the measurements of body content of lead, while showing variations according to place of residence and occupation, did not show any levels that were not "well within the presently accepted range of lead levels for humans."

This was so even among some 25 male population groups that were especially selected for expected varying exposure to lead. Some of these, such as garage mechanics, service station attendants and refinery workers, are exposed to lead in their occupations as well as to lead in the atmosphere and in their food and drink.

The Three City survey, with all the new information developed and reported by it, was considered not an answer, but a start for a continuing surveillance. "These results have established a base-line for future investigations of these types," concludes the report.

The report on the Three City survey expressed the hope that similar studies would be continued and extended so that there can be comparisons in findings over periods of time and in different community exposures.

International Study of Lead Levels in Man

Subsequent to the publication of the Three City survey report, a special study group of the World Health Organization

reported results of a study that similarly measured the lead levels in the blood and urine of people in 16 different nations, including the United States.

The findings showed, the WHO reported, that "there has been no increase in lead contamination in the last two decades... If there has been any change, it would appear that at present man is exposed on the whole to less lead in his environment than he was 20 years ago."

The WHO committee cautioned that there was "no cause for complacency because there are new sources of exposure, chiefly tetraethyl lead which is used as an 'anti-knock' additive to motor fuels. Wider use of lead in industry has also introduced new hazards, mainly by inhalation."

The report noted that "great progress has been achieved in eliminating the most obvious and dangerous sources of lead poisoning: lead paints, lead pipes for water, lead insecticides on fruit and vegetables, etc. In most countries this type of exposure has become insignificant."

Lead in New Guinea Aborigines

Dr. Leonard Goldwater, professor of occupational medicine at Columbia University, who was chairman of the WHO study group, reported in November 1966 results of a study of blood lead levels in New Guinea aborigines, compared with those of persons in other countries.

"The lead levels reported in the blood of the New Guinea aborigines are of particular interest," the scientist reported, "in that they demonstrate that these natives, living in the hills of New Guinea, away from industrialization and motorization, showed blood lead levels higher in range than urban and rural Californians. The mean figure of 22 micrograms per 100 milliliters of blood was higher than that of samples from 13 other localities, including California, Ohio and New York City. Mean levels from England, Yugoslavia and Finland are slightly higher than the New Guinea mean."

IV. RESEARCH NEED AND PROBLEMS PUBLICLY DISCUSSED

Despite currently extensive knowledge about lead in man's environment everyone seems to agree that considerably more research should be carried out to be certain that lead does not become a hazard to the public at some future date.

Some areas of future research were indicated in a three-day symposium on lead in the environment held in December 1965 with representatives from government, universities and research institutions, and industry participating.

The published proceedings (PHS Publication 1440, March 1966) report the formal and informal discussions of leading scientists on various aspects of lead in the environment, including lead in the air from automotive and other sources. For someone seeking more details about current knowledge on lead, these proceedings offer informed summaries of much basic work.

In one summation, Dr. Robert J. M. Horton, chief of the Field Studies Branch, PHS Division of Air Pollution, Cincinnati, said "some sources of lead air pollution have increased with the passage of time (for example, leaded gasoline) and others have decreased (for example, coal). It is very difficult, if not impossible, to determine with certainty whether general urban air levels have changed over thirty or forty years due to the lack of strictly comparable measurements. Changes occurring in recent and future years need further study."

Economics, Health and Smog

The question of continued use of lead in gasoline, or its reduction or elimination, was one subject for attention at the symposium. Dr. John A. Zapp, director of the Haskell Laboratory for Toxicology and Industrial Medicine, E. I. du Pont de Nemours and Co. Wilmington, Delaware, made special note of this question and said: "Before recommending to eliminate lead from gasoline, we should be sure that it is necessary to do so, and this will require information not presently available...it is imperative that more information be obtained on the economics, the health implications, and the potential for smog formation..."

On the last of these three points, existing studies show that lead emissions from automobile exhausts have no effect on the formation of photochemical smog -- the kind that plagues Los Angeles.

The "health implications" have been discussed in previous sections of this presentation and future research areas will be set forth in the next section.

The "economics" were discussed to some extent at the symposium. A representative of the American Petroleum Institute told the symposium that API would undertake to develop more precise and broader information than is presently available concerning possible effects of eliminating lead from gasoline.

Considerations Suggested for Non-Leaded Gasoline

Some analyses of what might result if production of only non-leaded gasolines were to be required have indicated these considerations:

1. Costs of comparable gasoline would rise to the point of costing the motoring public many hundreds of millions of dollars annually.

2. Drain on crude petroleum reserves would be increased by tens of millions of barrels a year.

3. Oil refineries would have to expend an estimated total of several billion dollars to re-equip their plants.

4. Dozens of oil refineries, mostly smaller ones, would be forced to close down if they could not afford capital requirements to convert.

5. Effectiveness of much military and defense equipment, here and abroad, would be greatly affected, insofar as this is geared to use the leaded gasoline.

6. Many existing automobiles would not be able to run efficiently, and possibly redesigned engines for automobile users would be necessary.

Many other possible results, such as an effect on other emissions of auto exhausts, would require study. Some such studies are going on now.

In Five Years, "Better Judgments"

On the basis of this lead symposium, Dr. Richard Prindle of the U.S. Public Health Service told Congress that "we simply do

not have the data we need to determine to what extent control action may be necessary to curb human exposure to lead in the urban environment." He added that he thought "at the end of a period of 5 years we might well have sufficient information on which at least to make much better judgments than we can do today."

These observations from the government official who late in 1966 became head of the PHS's new Bureau of Disease Prevention and Environmental Control, which includes the National Center for Air Pollution Control, were made during hearings on lead in the environment conducted by a Subcommittee on Air and Water Pollution of the Senate Committee on Public Works. Dr. Prindle was responding to questions from Senator Edmund Muskie of Maine, subcommittee chairman.

Senator Muskie devoted one part of a series of hearings on air pollution to the lead question and heard medical and scientific witnesses as well as representatives from the American Petroleum Institute and the Lead Industries Association.

Dr. Robert A. Kehoe of the University of Cincinnati summarized for the Muskie subcommittee some results and conclusions from research on lead and its effects on man conducted by him and his colleagues across more than 40 years.

Dr. Kehoe told the subcommittee that "the impression has existed in certain circles that little information is available on this subject, especially as to certain matters that relate to the safety of the public. The fact is, however, that no other hygienic problem in the field of air pollution has been investigated over such a prolonged period of time, and with such definite results."

Geophysicist Expresses His Concern

Senator Muskie's group also heard testimony from Clair C. Patterson, a geophysicist who has expressed alarm at what he calls the "chronic lead insult" which he considers the population is subject to.

Patterson based his concern about lead on calculations which he said show that modern environment contains many times more lead than "natural" environment of prehistoric times and that modern man has many times more lead in his body than did prehistoric man, due primarily, Patterson said, to the widespread industrial and automotive uses of lead.

Patterson had previously published his views in the September 1965 Archives of Environmental Health, which subsequently has published a number of dissenting communications, including a lengthy letter of explanation by the editor of the journal. (See references for full list of citations of these communications.)

Some objections were that the geophysicist erred when he got into assumptions involving toxicology, an area which is not his field. The Archives' editor acknowledged that consulting editors had divided opinions about the Patterson paper, and that the decision to publish it was based on the desirability of getting the Patterson views into discussion.

Patterson's position, as described to the Muskie Subcommittee, was that he disagreed with interpretation of existing data and believed that lead in the environment has increased to a point of concern and is increasing.

Patterson told the Muskie Subcommittee that he also disagreed with interpretation of findings in the Three City survey, with a statement made by the American Medical Association's Committee on Occupational Toxicology, and with the statement of the World Health Organization's study group on lead which he termed "false and fallacious."

Medical Group Disagrees

Commenting directly on the Patterson paper in the Archives of Environmental Health, the Committee on Occupational Toxicology of the American Medical Association stated in February 1966:

"The Committee feels obliged to point out that as a result of years of careful clinical study in workers in the lead industry, significant, subtle and unrecognized or 'unrecognizable' changes are not occurring in the general population as a result of its exposure to environmental lead. In fact, this vast clinical evidence, evaluated by a great number of clinically trained scientists, suggests that the general public is not now, nor in the immediate future, facing a lead hazard."

Subsequently, the Archives carried a review article by Thomas J. Haley, a toxicologist at the University of California School of Medicine, Los Angeles, which examined the Patterson thesis from a toxicological viewpoint. Haley concluded that "The supposed chronic lead intoxication from environmental contamination is a myth not a fact."

V. CONTINUING INTEREST IN RESEARCH EFFORTS

From recent discussions on the question of environmental lead, including the lead symposium and the Muskie hearings, have come several suggested areas for further scientific investigation.

Among these, for example, is a concern expressed by public health officials about people who may, by reason of peripheral occupations, be more exposed to lead than the average adult or others who may, or may not, be particularly susceptible.

Vernon MacKenzie, then head of PHS Division of Air Pollution and subsequently deputy to Dr. Prindle, told the Senate subcommittee that "we are not concerned with the average human being, and whether or not he is being affected, because I don't think he is in any essential, important way, but, rather, with smaller groups in the population, and they may be of significant numbers, that may be having a greater than average exposure."

PHS officials have subsequently said investigations were going forward on such special occupationally exposed groups, similar to those studied in the Three City Survey.

General Areas for More Research

Other general areas suggested for research include:

1. Determining whether there are any "subclinical" effects of lead in human beings, that is, effects which may occur in body lead levels below those ordinarily considered safe but which may not show up as lead intoxication. While this question has been raised, the evidence against such effects comes primarily from observation of workers in lead industries. "Many thousands of men in industry have been followed by competent clinicians for from thirty to forty years with no evidence of any effect on their health when these levels have not been exceeded."

2. Continued monitoring of ambient air in certain cities to determine whether leaded gasolines, or other sources, are contributing to an increase in lead in the atmosphere, and if so, whether this is important. There is wide support for continuing to gather information on lead concentrations in air, as one important step in surveillance of the total lead question.

3. Conducting studies on levels of lead in the air that may have a measurable effect on absorption of lead by people in breathing normal ambient air 24 hours daily. Although the

industrial level of 200 micrograms per cubic meter of air is generally accepted, this is based on a 40-hour work week and also on continued check-ups of men working in such atmospheres. Such a level would not be expected to apply on a continuous exposure basis.

4. What happens to the lead exhausted from gasoline that does not go into the air and is eventually diluted or dispersed? Some studies have shown higher than expected amounts of lead deposited in the soils and vegetation around highways, which could have an influence on lead in food and water. Suggestions have been made for research in this area.

5. Is lead a necessary trace metal in human body function, as are several other minerals and metals? There have been suggested, and are being carried out, studies relating to "natural levels" of lead in man -- that is, without man-made exposures -- and the effect of "no lead" on living tissues.

Projects Undertaken with API Support

Some indications of the range of research activities under way, or in the planning stage, on questions about lead were described in 1966 in Washington before the House Subcommittee on Science, Research and Development which held hearings on Pollution Abatement Technology. A joint statement by P. N. Garmelgard, director, and Dr. Robert E. Eckardt, medical advisor, of the American Petroleum Institute's Committee for Air and Water Conservation, outlined some major research projects on lead in which the API is participating as a sponsor.

They said API is "ready to carry forward the mandate of continued surveillance" and that API would welcome sponsorship by the Public Health Service of a study that would provide "early detection if any tendency toward lead accumulation should occur in the population. We would be indeed pleased to cooperate with the Public Health Service in such a study."

Other projects on lead discussed by the API officials were:

1. Medical research is being conducted that may detect the subclinical effects of lead in man, or the effects of lead, if any, on well-established clinical conditions, such as respiratory diseases.

2. For a severe test of lead effects, laboratory animals will be fed for a long time amounts of lead far above levels normally encountered.

3. An attempt is under way to determine the lowest level of lead in the atmosphere that will produce a measurable change of lead in the blood. This is being carried on in cooperation with the Public Health Service, du Pont, Ethyl Corporation and Lead Industries Association, at the Kettering Laboratory of the University of Cincinnati.

4. API and Lead Industries Association are supporting a project, being conducted by Wayne State University scientists, to study the lead burdens of laboratory animals exposed to heavy concentrations of automotive emissions in contrast to the lead burdens of other animals that have not been exposed to such concentrations. This work is a continuation of a major study begun by the Public Health Service.

5. It is planned to monitor lead levels in the ambient air and in the blood and urine of man to permit early detection, if any tendency toward lead accumulation occurs. This is a possible continuation of the so-called "Three City" study.

6. Another project is being directed toward understanding of the relationship between bone lead and blood lead.

7. A similar study will seek to determine the relationship of bone lead to the total of lead in the body and how this relationship has changed with time.

8. A study is being made of lead concentrations in soil and vegetation at known distances from highways in order to assess the significance of lead fall-out adjacent to highways.

9. A project will analyze what effect, if any, there would be on evaporative and exhaust emissions from automobiles by varying fuel composition and volatility, and by blending gasoline with and without lead. An effort will be made to determine the effect on the output of nitrogen oxides and carbon monoxide resulting from variations in gasoline formulas. This work is being done by the U.S. Bureau of Mines.

10. Case studies are being made of representative refineries throughout the country to determine the capital investment and incremental costs of making gasoline without lead antiknock additives.

11. Another study has two purposes: a) to compare the present total environment -- land, air and water -- with the ancient environment by using the isotopic character of lead as an environmental tracer, and b) to discover the relative importance of various possible sources of lead and to better understand the mechanisms of lead transfer.

This list includes only those API-sponsored projects related to lead research. Many other projects are under way dealing with other aspects of air and water conservation.

VI. SUMMARY OF API VIEWS

In discussing the API's views on the lead situation and its plan to pursue research, P. N. Gammelgard told the Muskie subcommittee that data available "convince us that the question of lead in the atmosphere is not now a concern from the public health point of view. No one accuses lead, either, of being an air pollution nuisance or a contributor to smog formation. And so, in our view, lead from gasoline exhausts is not at this time an air pollution problem.

"We do, however, as demonstrated by our intent to pursue research in this area, want to keep a close and continuing watch in this area...

"We feel that continued collaboration on this type of study is essential if we are to move forward following the recommendation made by the Advisory Committee on Tetraethyl Lead to the Surgeon General in 1959 calling for cooperative studies to provide more definitive data on the levels and trends of atmospheric lead contamination in selected urban areas and of the body burden of lead of selected population groups. The Environmental Pollution Panel of the President's Science Advisory Committee last year recommended continuing surveillance of body levels of lead, more intensive research to gain understanding on the uptake and excretion of lead, the mechanisms of action of lead, and the relationships between tissue lead levels and disease or the aging process. The sense of the PHS Lead Symposium last December was surely to continue work toward such objectives."

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References

(Note: The scientific literature on lead is extensive, but many research findings have been summarized in various papers, discussions and symposia. The following citations were the source for most, but not all, of the material presented in this paper.)

1. U.S. Public Health Service: Public Health Aspects of Increasing Tetraethyl Lead Content in Motor Fuel. PHS Publication No. 712, 1959.

2. U.S. Public Health Service: The Use of Tetraethyl Lead Gasoline in its Relation to Public Health. Public Health Bulletin No. 163, 1926.

3. U.S. Public Health Service: Symposium on Environmental Lead Contamination (Dec. 13-15, 1965). PHS Publication No. 1440, March 1966.

4. Kehoe, Robert A., M.D.: Statement Concerning the Hygienic Aspects of Lead in the Human Environment. Hearings before Subcommittee on Air and Water Pollution of Committee on Public Works, U.S. Senate. Washington, D.C., June 9, 1966.

5. Haley, Thomas J., Ph.D.: Chronic Lead Intoxication from Environmental Contamination: Myth or Fact? Archives of Environmental Health, Vol. 12, pp. 781-785, June 1966.

6. U.S. Public Health Service: Survey of Lead in the Atmosphere of Three Urban Communities. PHS Publication No. 999-AP-12, January 1965.

7. U.S. Senate: Air Pollution -- 1966. Hearings Before a Subcommittee on Air and Water Pollution of the Committee on Public Works. Washington, D.C., June 7, 8, 9, 14, and 15, 1966.

8. U.S. Senate: Automotive Air Pollution. Third Report of the Secretary of Health, Education, and Welfare to the United States Congress. March 25, 1966 (ordered to be printed).

9. Symposium on Lead (held at Kettering Laboratory, University of Cincinnati, February 25-27, 1963). Archives of Environmental Health, Volume 8, pp. 202-354, February 1964.

10. Lead Industries Association, Inc., New York City: Facts About Lead and Industrial Hygiene. 1965.

11. World Health Organization: No Increase in Lead Contamination Found by WHO Investigation. Press Release WHO/36, December 15, 1965.

12. Gammelgard, P. N., director, and Robert Eckardt, M.D., medical advisor, of Committee on Air and Water Conservation, American Petroleum Institute: Testimony at Hearings of Subcommittee on Science, Research and Development of the Committee on Science and Astronautics, U.S. House of Representatives. Washington, D.C., August 9, 1966.

13. Haagen-Smit, A. J., Dr., California Institute of Technology: Statement Submitted to Subcommittee on Science, Research and Development of Committee on Science and Astronautics, U.S. House of Representatives. Washington, D.C., August 3, 1966.

14. Committee on Occupational Toxicology of Council on Occupational Health, American Medical Association: Comment. Archives of Environmental Health, Vol. 12, page 273, February 1966.

15. Threshhold Limit Value for 1966, adopted 28th Annual Meeting, American Conference of Governmental Industrial Hygienists, May 1966.

16. Goldwater, Leonard J., M.D., and Hoover, A. Walter, M.D.: An International Study of "Normal" Lead in Blood and Urine. Presented November 1, 1966, at annual meeting, American Public Health Association, San Francisco.

17. Patterson, Clair C., Ph.D.: Contaminated and Natural Lead Environments of Man. Archives of Environmental Health, Vol. II, pp. 344-360, September 1965.

18. Note: The following citations relate to the discussion of the Patterson paper on page 20. All citations are from Archives of Environmental Health:

Dr. Haley's article (June 1966 issue), and communications from Dr. Robert A. Kehoe (November 1965); Dr. Harriet L. Hardy, assistant medical director, Occupational Medical Service, Massachusetts Institute of Technology (December 1965); also, the late Robert L. Ziegfeld, executive vice president, Lead Industries Association, Inc.; Dr. Clair C. Patterson; Dr. Rutherford T. Johnstone, Los Angeles; Dr. Katharine R. Boucot, editor of the Archives (all in January 1966).

Also, Committee on Occupational Toxicology of the Council on Occupational Health, American Medical Association; Dr. Henry A. Schroeder, Dartmouth Medical School; Dr. Willard Machle, University of Miami School of Medicine (all in February 1966); also, Dr. M. K. Williams, London (England) School of Hygiene and Tropical Medicine; Dr. Lester W. Sanders, Sr., The Kettering Laboratory, University of Cincinnati College of Medicine (all in March 1966); also Dr. John J. Hanlon, Health Commissioner, and Dr. William G. Frederick, director, Bureau of Industrial Hygiene, Detroit Department of Industrial Hygiene (May 1966); and E. I. Hamilton, Radiological Protection Service, Surrey, England, (August 1966).