REPORT OF AN INVESTIGATION OF OCCUPATIONAL LEAD EXPOSURE

From the Kettering Laboratory of Applied Physiology,
University of Cincinnati, Cincinnati, Ohio.

1. Particulate Lead Content of Dust Deposits and Air in Garage of Consolidated Telegraph and Electric Company, New York City

Purpose of the study

The purpose of this study is to determine the extent of the lead exposure hazard during a typical day in the garage of the Consolidated Telegraph and Electric Subway Company, as represented by the lead contained in the air as dust or fumes which would be breathed by workmen in the garage. A special effort is made to determine the exposure in and near the stock room where some cases of lead poisoning have been reported.

Description of the building

The garage is a single story building occupying a space approximately 200 ft. deep by 150 ft. wide. Light is admitted through windows at front and back and through fifteen skylights conveniently placed in the roof of the building. Winter ventilation is practically limited to infiltration through cracks and walls and natural venting of warm air from the top of the room through small vent cracks which are always open in the skylights. At times when the paint shop is in operation a large amount of air is exhausted through it by means of the exhaust fans in the paint spray hoods.

The paint shop is against the north wall of the building and is joined on the south side by the stock room and on the west by the machine shop. These three rooms with the repair shop occupy a space 50 ft. wide by 110 ft. long

across the back of the building. The remaining floor space is occupied by the garage in which trucks and other machinery are stored over night and by a locker room 15 ft. by 60 ft. Two garage doors are at the front of the building, one for entrance and one for exit. Inside the entrance door a gasoline pump is located at which all trucks are fueled as they enter the garage in the evening.

Sampling procedure

Two types of dust samples were taken. Scrapings of settled dust were collected from various places about the building which may be expected to show some indication of the average lead content of atmospheric dusts over a considerable period of time previous to the sampling. These samples were returned to the laboratory and analyzed for percent lead and are given accordingly in the tabulated results (Appendix B).

Samples of the dust in the air were obtained by means of electrostatic precipitation using the Mine Safety Appliance's electrostatic dust sampler. The dust was collected in aluminum tubes and after return to the laboratory were washed out in triple distilled water for analysis. From the analysis the lead content of the air was calculated in milligrams per 10 cubic meters and is given accordingly in the tabulated results (Appendix A).

Locations of sampling points were determined by a careful study of the building with a view toward locating the possible sources of lead. Also spot samples were taken all over the building to determine the point of maximum lead

concentration and thus to isolate the hazardous places. At two places a series of samples were taken over a period of several hours to determine the time variation of lead concentration in the air.

Simultaneously with operation of the electrostatic dust sampler observations of concentration of carbon monoxide in the air were made and recorded for all samples. This was expected to give an indication of the extent of pollution of the garage air by exhaust gases from engines running in the garage.

Results

Tabulated results from analysis of samples taken by the above procedure may be found appended to this report. By examination of these data certain significant facts are discovered and are listed as follows:

1. At only one time during the day did the carbon monoxide concentration reach a significant figure. During the time of the morning when truck engines were being operated in the garage a concentration of 0.02% CO in air was noted.

2. The highest concentration of lead in the garage air was found at 7:30 a.m. That concentration was 1.10 milligrams of lead per 10 cubic meters of air.

3. Immediately after all operating trucks had been removed from the building, the lead in the air dropped sharply in concentration.

4. Samples taken on different days at the same hour of the day show the concentration of lead in the air to

be 0.31 milligrams per 10 cubic meters of air in the garage just outside the stock-room door and 0.06 milligrams per 10 cubic meters of air in the garage near the gasoline pump.

5. Analysis of dust deposits for lead show 1.59 percent lead by weight in dust settled on stock-room cabinets next to the paint-shop wall as compared with 0.80 percent on the cabinet one aisle away from the wall and 0.46 percent two aisles away from the wall.

6. The highest concentration of lead found in dust deposits was 7.47 percent by weight in the dust scraped from outside the glass in the paint-shop skylight. This is comparable with 2.02 percent found in similar scrapings from the stock-room skylight. Other dust deposits such as garage floor sweepings, dust collected from machines in the machine shop and from the cabinets near the battery stand ranged between 0.11 and 0.55 percent lead content.

Discussion of results

From the above statement of results it is possible to draw reasonably definite conclusions regarding relative exposures to inhalation of lead particles and fumes in the garage of the Consolidated Telegraph and Electric Subway Company.

1. The time of maximum lead exposure occurs at the time when there is the maximum of activity in the garage and is simultaneous with the maximum exposure to carbon monoxide gas. At the time of this study the time of maximum activity was between 7:30 and 8:30 a.m. while trucks were

warming up in the garage preparatory to leaving. At this time the sources of dust in the air were the engine exhausts and dust stirred from the garage floor by motion of the machines and men within the building. Dust from both of these sources are known to contain small amounts of lead.

2. The place of maximum lead exposure by reference to analysis of both suspended and settled dusts is centered near the paint shop. Particularly, analysis of dust deposits give very definite indication of the paint shop as the center of maximum lead concentration. This conclusion is apparently contradicted by the conclusion that the time of maximum concentration occurs at a time of maximum activity in another part of the garage. This apparent discrepancy may be accounted for by the fact that all particulate lead emitted by the exhaust of engines is of so small a size as to remain almost indefinitely suspended in the air and be carried out of the garage by exhausted air in the same manner as a gas would be. Thus the portion of atmospheric lead dust attributable to engine exhausts would not form an appreciable part of the lead contained in dust deposited in the garage.

2.

The Lead Content of the Blood and Urine of Two Employees in Garage of Consolidated Telegraph and Electric Company - New York City

Purpose of the observations.

Study of the lead content of air samples as described in another section of this report relates to conditions in the garage during the short period of the observations, while analytical data on dust samples from floors and other surfaces where deposition occurred, although concerned with longer periods of time, are always questionable in their hygienic significance, by virtue of the fact that some or all of the lead in such dusts can be derived from sources which are in no wise hazardous to workmen. For example, large particles of lead-containing material fall out of the air rapidly, cannot be inhaled and therefore are of relatively little importance.

For the reasons above, and for others as well, the degree of lead absorption of workmen who have been exposed regularly to the conditions which are under examination, constitute the best possible measure of the magnitude and significance of that exposure over any prolonged period of time. In this case there was a special point in favor of examination of workmen, in that two cases of alleged lead poisoning had developed out of exposures that had occurred some months previously. The test of those exposures could be made only in terms of other

workmen who had been employed during that period and who presumably had been subject to the same occupational conditions. (The experimental and factual background for these statements has been given elsewhere and need not be discussed here.)

Selection of workmen for study

Careful consideration was given to the employment records of workmen, and although more extensive observations might have been made with profit, it was decided for various reasons to select two men on whom ddterminations of the lead content of blood and urine were to be made.

E.W., a night foreman, had been employed in the garage for 11 years, and had been exposed to any lead hazards which may have existed during that shift and that period of time.

A.W., had been employed as stock-keeper for a period longer than any other person. If there had been any special conditions of lead exposure he should have experienced them.

Any serious occupational exposure, sufficient to produce lead levels in the blood and urine such as had been reported in the men suspected as having lead intoxication, would confidently be expected to leave some trace of their existence in the two workmen E.W. and A.W. who were presumably exposed to the same occupational conditions.

Procedure and Results

Blood and urine samples were taken for analysis by physicians of Consolidated Telegraph and Electric Company, in containers supplied by this laboratory, and in accordance with the following instructions.

INSTRUCTIONS FOR THE COLLECTION OF BLOOD FOR LEAD ANALYSIS

Blood samples must be taken in a space which is free of dust. Despite this precaution it is necessary to use the most meticulous care against the contam nation of samples with surface or atmospheric dusts.

The subject or patient must remove any dust laden clothing before entering the room in which the sample is to be taken, and must wash hands and face or any other parts of the body that may be dusty.

The cork should be removed from the tube in which the blood is to be drawn only during the withdrawal of the blood, and should not be permitted to come in contact with the table top or any other potentially unclean surface but should be held by its topmost part or laid down within its filter paper wrapping, and replaced as soon as the blood has been obtained. The filter paper cover should be replaced and secured around the neck of the tube by means of a rubber band.

The sterile needle provided in a second tube should be used to withdraw approximately 10 cc of blood directly into the blood tube. Under no circumstances may any anticoagulant or other substance be added or any intermediate container be used, nor may the needle be sterilized by boiling in water. If the latter should be rendered non-sterile accidentally, it should be flamed gently before use. After use it may be rinsed out with cold water and returned to the tube. Cotton should be placed at either end and around the hub to prevent breakage in transit.

The blood sample should be labeled with the name of the patient and the date and hour at which the sample was taken, and packed with care to see that the cork is secure, and that breakage may not occur in transit.

The sample should be mailed to Dr. Robert A. Kehoe, Kettering Laboratory of Applied Physiology, College of Medicine, Cincinnati, Ohio.

INSTRUCTIONS FOR THE COLLECTION OF SPOT SAMPLES OF URINE FOR LEAD ANALYSIS

Urine samples must be taken in a space which is free of dust.

The subject or patient must remove any dust laden clothing before entering the room in which the sample is to be taken and must wash his hands and face or any other portion of the body that may be dusty.

Approximately 100 cc of urine should be voided directly into the sample bottle in the presence of the physician or attendant. The stopper (and the protective cover of filter paper) should be removed and held by its tip in the hand of the attendant so that it may not be contaminated through contact with desk, table or other object. It should be restored to the bottle as soon as the sample has been obtained, after which it should be covered with the filter paper shield. No preservative or other material may be added to the sample.

The bottle should be labeled with the name of the patient and the date and hour at which the sample was taken, and packed with care against the possibility of breakage in transit.

The sample should be mailed to Dr. Robert A. Kehoe, Kettering Laboratory of Applied Physiology, College of Medicine, Eden Avenue, Cincinnati, Ohio

The results of the analyses are tabulated below:

Concentration of Lead in Blood and Urine

Identification	Lead in Blood	Lead in Urine
	Mgm/100 grams	Mgm/ liter
E.W.	0.045	0.045
A.W.	0.045	0.085

Discussion

The lead concentration in the blood samples is quite within the range of values found in normal persons with no occupational lead exposure. (Normal range 0.01 mgm to 0.06 mgm. Mean 0.03 mgm.)

The lead concentration in the urine samples is likewise within normal limits in both instances. The one is higher than the other but this variation in the two is well within the limits of variation for normal persons, and within the limits of variation for the same individual at different times, if due allowance is made for the smallness of the samples. The range of normal values for spot samples on normal individuals is from 0.02 mgm to 0.11 mgm per liter with a mean value of about 0.04, but with some slight seasonal variation in the mean, i.e. slightly higher in summer when the urinary volume is reduced. Theactual level of urinary lead excretion of these two men could best be determined by repeated observations on larger samples. However, experience has shown that the correlation of a blood sample with a single spot urine sample is generally adequate for the purpose of determining the facts with respect to lead exposure, since the blood value varies little from hour to hour, and thereby serves to fix the significance of the urinary result.

It is apparent from these results that neither of the men under examination has had any recent lead exposure worthy of consideration. In view of this fact it seems highly

improbable that any conditions of lead exposure sufficient to cause significant lead absorption, and capable of inducing lead poisoning, have existed in the garage in question within a period of the year preceding these observations. (Experimental evidence is available to indicate that the lapse of a year or somewhat more is required for the resumption of normal levels of lead excretion after some months of hazardous lead exposure.)

General Conclusions

As compared to garages in general, this garage was in excellent condition with respect to cleanliness and ventilation.

The paint-shop was equipped with special ventilating devices of a type which on inspection seemed adequate and the general manner of handling the painting was such as to give no occasion for anxiety as to lead exposure. Nothing in our results would indicate the existence of significant lead exposure from this source.

Observation indicated that exhaust gases from operating automobiles were disposed of satisfactorily except for a short period during which a considerable number of cars were warming up and going out at once. The analyses of the air, with reference to carbon monoxide and lead, verify these impressions and demonstrate that the conditions in this garage are very similar to those prevailing in a very large number of establishments in all parts of this country and others.

The prevailing lead concentrations in the air of the garage are of a magnitude which has not been associated with the occurrence of even the milder symptoms of lead intoxication, and can be said to have no significance as occupational hazards. Literally thousands of garage mechanics are exposed daily to such conditions without evidence of clinical illness and without signs of materially increased lead absorption. Our fifteen years of study of this problem and of search for cases of significant human lead absorption under conditions of occupational lead exposure comparable to these, have failed to reveal the occurrence of a single case of lead intoxication among garage mechanics and other employees of garages. Moreover, our study of the lead excretion of such workmen has given negative results, in that no evidence of increased lead absorption or excretion, comparable to that readily found in workmen in the hazardous lead trades, has been discovered.

The conclusion is justified, therefore, that the conditions of lead exposure existing in this garage at the time of these observations, and apparently for a considerable period of time previously, were not such as to result in the occurrence of lead poisoning among the men employed therein.

Signed:_____
Director
Kettering Laboratory of
Applied Physiology

July 13, 1940