LEAD INDUSTRIES ASSOCIATION

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To the Members of the Lead Industries Association:

"THERE IS NO EVIDENCE OF ANY ABNORMAL RISKS OF LEAD POISONING OF PERSONS DOING ORDINARY SOLDERING WORK."

Although the absence of more than a minimal hazard of lead poisoning in the usual types of soldering operations is well recognized by those who are conversant with the subject, troublesome misconceptions periodically arise and may lead to conclusions quite unfair to lead solders and allied products.

The article herewith, from the Medical Service of a leading producer of electric lamps, should be of value in overcoming such misunderstandings. In a further communication, solder manufacturers will be invited to participate in its wide distribution. Up to twenty-five copies are available without charge, larger quantities at cost.

Manfred Bruditch
Director of Health and Safety

Air Pollution

from Soldering Fumes

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60 East 42nd Street

New York 17, N.Y.

AIR POLLUTION

from Soldering Fumes

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There is no evidence of any abnormal risks of lead poisoning of persons doing ordinary soldering work.

In metal factories where assembly work is carried on, a great deal of soldering is often involved. The solder used is almost always a tin-lead alloy, and it may be assumed that larger or smaller quantities of lead escape into the atmosphere. For this reason, soldering is regarded in certain countries as dangerous work, and women and girls are not allowed to perform it. It seemed to us desirable that we should be better informed about the risk of poisoning. It was therefore decided to undertake investigations into various aspects of air pollution in a number of departments where soldering was done as part of the assembly routine.

The investigations described below were primarily intended to constitute nothing more than an approach to the problem; we are aware that only proven oral conclusions can be drawn from them, and that further investigations will be necessary. (See "Conclusions.")

General Lines of the Investigation

We have tried to gain an insight into the problem (a) by subjecting a number of employees from certain assembly departments to clinical examination, and (b) at the same time carrying out air analyses in order to determine the lead concentrations to which solderers are exposed. All these investigations were exclusively concerned with the danger from lead.

Other aspects of soldering, such as the possible harm or nuisance caused by resin components and the like, were not explored.

The investigations were carried out in two assembly departments; (1) a large department where 475 men and girls are engaged on assembling television sets, and (2) a department where 250 girls are engaged on assembling radio sets.

Some time previously, lead concentrations had been determined in two other departments, here called (3) and (4), where molten tin alloys were being used in a different way. The findings have been included in this report for the sake of completeness.

Department three employed about 30 girls in dip-soldering capacitors and resistors, and department four employed five men tinning small objects by dipping them in large baths containing molten lead alloy.

In one and two, only resin-cored solder consisting of 40% lead and 60% tin is used.

Medical Examination

In the television and radio assembly departments, 42 employees were picked whose duties included soldering. Our endeavor was to select those who had the greatest number of soldering operations to perform and who had been doing the work for some time. The personnel of these departments is mainly female, and accordingly women made up the majority of those examined.

A note was taken of the number of soldering operations performed per hour by each employee. From these data it was possible to calculate the amount of solder used by each individual, the consumption per 100 operations being known.

At each bench position where soldering is done there is normally a small fan which sucks away the fumes arising from soldering. The fumes thus removed are not piped off, however, but merely dispersed throughout the shop.

Choice of Criteria

The two criteria chosen for the medical examination of employees were (1) coproporphyrinuria and (2) basophilic granulation.

The first symptoms of incipient lead poisoning, familiar from descriptions in the literature, are increased excretion of coproporphyrin III with the urine and an increase in the number of stipple cells in the blood.[1] Fortunately, the two methods of examination happen to be convenient for employment on large groups.

On the day that the lead content of the air of the television and radio assembly departments was determined, blood smears were taken from the 42 selected employees, who also handed in specimens of their morning urine in bottles that had been provided. The urine tests were performed without delay. The coproporphyrin content of these employees' urine again was determined in a second test three weeks later.

Coproporphyrin Determination Method

The semiquantitative method of determination with Domath's apparatus[2] was the one decided upon. In this method a precipitate is obtained by treating the acidified urine with ether; the precipitate is then irradiated with ultraviolet light and its fluorescence color compared with the standard colors on a set of paper discs.

RESULTS

Concentrations gamma per liter	Number of persons 1st test	2nd test
0-100	34	40
100-200	6	—
200-400	2	2
400-800	2	—

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Determination of Basophilic Granulation Method

For the purpose of determining the basophilic granulation of the blood, a blood smear is fixed with methanol and then colored with an alcoholic methylene blue solution Lane[3]. The film is examined under a microscope with dark ground illumination and the number of stipple cells counted, the total number of cells being about 10,000. We disregarded the fine stippling that is sometimes visible in the cells.

RESULTS

Concentrations	Number of persons
0.-0.25%	39
0.25-0.50%	1
> 0.50%	2

It was remarked that no correlation existed between individuals with higher percentages of basophilic correlation and those exhibiting a prophyrine content greater than 400 γ/L.

Invitations to undergo a further check were extended to four employees who had been found to have either a rather high coproporphyrin III excretion rate or a rather high basophilic granulation. All four were girls, three living in Eindhoven and one in Belgium.

It was suspected that lead present in the domestic water supply might be the cause of the higher figures, and accordingly the girls were requested to bring a sample of drinking water from their homes in special bottles of lead-free glass that were given them.

All four were again subjected to the tests; hemoglobin content also being determined.

RESULTS

	Basophilic Granulation %	Porphyrins. gramma per liter	Hb. units
1 (Eindhoven)	0	< 50	87
2 (Eindhoven)	0.1	< 50	86
3 (Eindhoven)	0.1	< 50	90
4 (Belgium)	0.2	< 50	81

Analyses of Drinking Water

The employees resident in Eindhoven naturally drank water from the Maas; it was found that the Belgium girl was drinking well-water.

1 (Eindhoven)	9	gamma/Pb/L water
2 (Eindhoven)	41	gamma/Pb/L water
3 (Eindhoven)	46	gamma/Pb/L water
4 (Belgium)	256	gamma/Pb/L water

The fourth sample also contained a great deal of iron.

It is not known whether these samples of water from the Mains were taken after the water had been at rest or after it had been running for some time. The values of Samples two and three agree rather well.

Van Logbem[4] indicates a safety limit of 0.2 mg Pb/litre for water that has been at rest in underground mains for eight hours. An intake of 0.5 to 0.8 mg Pb per day can be regarded as safe; this corresponds to about 100 gamma/L. The concentration found in the well-water of case four was 268 gamma Pb/L, and somewhat excessive.

Measurement of Lead Concentrations in Air

Faced with the task of investigating a large department with hundreds of soldering positions, we were obliged in the first place to limit the number of sampling points. Four positions were selected at which the consumption of solder was known to be highest; it was therefore the worst conditions that were picked out for investigation. The air samples were taken from points as close as possible to the noses of employees while they were doing their normal work. Each time a sample was taken the fan that normally removes the soldering fumes was switched off. Sampling was twice repeated on later occasions at the same bench positions.

It was considered not unlikely that higher concentrations might exist away from the nose. Accordingly, a sample was taken directly above the point being soldered, in the fumes.

Initially, sampling was done with the paper filters (Schleicher and Schull 589) that we normally use for other measurements. Impingers were known to be less efficient for this purpose. Electrostatic filters were not particularly safe in the circumstances prevailing in this assembly shop. It was soon found that the efficiency of sampling was variable as well as low (sometimes as low as 28%). "Millipore" filters were therefore adopted; as stated in the literature,[5] these are particularly suitable for collecting the finer particles quantitatively, and they did in fact work with an acceptable degree of efficiency, from 83% to 91%. We were able to show, by photographing the filters under the electron microscope, that the particles of solder they strained off had dimensions between 0.04 and 0.1 micron. Resin residues and metallic compounds opaque to the electron beam (oxides) were also found to be present.

Samples were taken over periods of 30 minutes; in this way enough lead was collected for the lead content to be determined by the dithizone method[6] after it had been extracted from the filter with dilute nitric acid.

RESULTS

Department	Number of Samples	Concentration in gamma/M³			
		nose height		in the fumes	
		average	extremes	average	extremes
1	12	72	38- 94	104	67-123
2	8	28	18- 45	-	-
3	10	47	30- 60	67	40- 80
4	2	150	134-166	-	-

Some spread in lead concentrations was found; extreme as well as average values are included.

The MAC currently accepted for lead is 200 gamma/M³. The concentrations due to soldering are all below 100 gamma/M³ though they are somewhat higher in the fumes. The number of points sampled was on the low side.

Conclusions

Our examination of employees regularly engaged on soldering work has failed to reveal any fact which might point to their suffering from lead poisoning. In no individual was a high coproporphyrin content combined with an excessive percentage of stipple cells. It is true that some individuals exhibited values in excess of 200 gamma/L and 0.25% respectively for porphyrin and stippled cells which are regarded as the normal ones, but the number of such persons was no greater than might be expected in a group of this kind. Lead concentrations present in air and due to soldering were all found to be under 100 gamma/100M³.

The MAC's currently accepted for lead in America and England are 200 gamma/m³ and 150 gamma/m³ respectively; compared with these, our figures cannot be said to give evidence of any abnormal risks for persons doing ordinary soldering work.

One or two aspects remain to be investigated more thoroughly. In particular, since employees' hands are so frequently in contact with lead alloys, there is a chance that they are absorbing additional lead through the mouth. There have been fairly large differences in the porphyrine content of the urine from one person as determined at different times. More detailed investigations into these changes are now in progress.

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