

Memorandum on the Lead Exposure Associated With the
Prod of Leaded Steel at the Youngstown, Ohio,
Plan Republic Steel Corporation.

Certain General Considerations

The Significance of the Analysis of Air for Lead Content

The estimation of the significance of occupational lead exposure by determining the lead content of the air is based on the generally accepted principle that lead poisoning in industry occurs largely as the result of the inhalation of dangerous quantities of particulate lead which are present in the atmosphere of workrooms. It has been observed that if the concentration of lead particles in the atmosphere does not exceed certain levels, cases of poisoning either do not occur or are so mild as to be of little or no consequence. By reason of variations in the methods of collecting and analyzing air samples, and because of variation in such factors as the type of lead compound and its degree of dispersion in the air, and because of many associated occupational conditions such as prevailing temperatures, length of the working day, and steadiness of employment, the threshold values for dangerous lead exposure have been set at different levels by different hygienic workers. At present it can be said that the general consensus of opinion, as well as certain official and semi-official agencies, favors a permissible concentration somewhere between 1 milligram and 2 milligrams of finely particulate lead per 10 cubic meters of air. My experience has indicated that the higher figure, i.e., $2 \text{ mg}/10 \text{ M}^3$, is a safe one, regardless of the type and subdivision of the lead compound, provided general hygienic conditions are

maintained in a satisfactory state in industrial plants, and provided medical supervision serves to eliminate the definitely unfit worker from the plant population.

The Difficulties and Inadequacies of Air Analysis as a Mode of Estimating the Significance of Lead Exposure.

The provisional character of the statement above suggests that air analyses as the sole method of evaluating occupational lead exposure leave something to be desired. Such, unfortunately, is the case. The difficulties of sampling the air of workrooms are considerable, in that variability and periodicity in the operations, changes in plant equipment and ventilation, and shifting weather conditions introduce many factors which must be checked; the methods of analysis of samples must be of the utmost precision, and such precision is not easily obtained around industrial plants with contaminated atmosphere. Add to these technical difficulties the fact that the lead absorption of workmen under a given set of atmospheric conditions is determined by the length of their working hours in a specific area and by the character of their respiration during that period. The rate of pulmonary ventilation varies from 5 liters per minute to 25 liters per minute, i.e. from 2.4 cubic meters to 12 cubic meters per 8 hour working day, dependent upon the degree of exertion required by the occupation. Add the additional variable that relatively coarse particles never reach the lung tissue but are trapped in the upper respiratory tract and are subsequently swallowed (and partly absorbed in the alimentary tract), while finely divided particles may be so small as to behave like a gas and so be breathed out in large part after once having been inhaled. Thus the problem can be seen to become a complex one.

with not wholly predictable results. In addition to these considerations, which can be covered by introducing a large factor of safety into the level accepted as permissible (as some have done by urging the adoption of the concentration of 1 mg/10 M³ as the safe level), there is the problem of organic disease among the workmen as a factor in susceptibility to lead exposure. It is well known that general vascular disease, and especially liver disease are important factors in susceptibility to lead poisoning, while certain other types of illness are so difficult to differentiate clinically from the effects of lead absorption as to provide cases which must be handled as though they were lead poisoning, if once the possibility of lead intoxication be recognized or believed to be present. There is always the problem of deciding which condition is responsible for illness or disability, and when this decision has been made, the other is likely to be regarded as contributory.

Adjuncts to Air Analyses

It must be apparent, therefore, that some additional measures of hygienic control must be exercised, not only to avoid hazardous lead exposure, but to obtain more or less continual proof that such exposure is being currently avoided. This can be done in the opinion of the writer only by means of regular and adequate medical supervision of workmen. Such supervision must (1) exclude the physically unfit, i.e. those to whom the lead exposure of the occupation will probably be hazardous; (2) make such observations on the exposed as to determine whether or not they are actually absorbing significant quantities of lead; (3) maintain such records as will prove the adequacy of the supervision; (4) check carefully every case of

illness so as to exclude lead as a factor when it is not, by arriving at an acceptable diagnosis of the actual nature of the illness. Not to go into the details of procedures to accomplish the above purposes, suffice it to say here that preemployment and periodic physical examinations of a fairly comprehensive type are required, and that blood examinations of a standard type must be made and recorded. In addition, the urinary and fecal lead excretion of at least a few representative workmen should be determined at intervals, and, in cases simulating plumbism, study of the lead excretion should be made promptly.

The above recommendations are predicated, of course, upon the existence of hazardous lead exposure, or upon the existence of lead exposure which has not been proved to be harmless, and which, therefore, may be under suspicion. In a new industry, or in a new procedure involving lead in an old industry, lead exposure will usually be regarded as hazardous for purposes of compensation or litigation, until it has been proved otherwise.

Plant Conditions as Observed and Otherwise Demonstrated.

On the basis of the observations made, the lead hazards of the plant procedures seem to range themselves in order of decreasing importance as follows: (1) lead exposure during the pouring and cooling of lead heats; (2) lead exposure at the rolling mills, which apparently is at its worst at the blooming mill, and is less but probably significant at other mills; (3) welding and "scarfing" procedures are both associated with a dangerous production of fume. (It is apparent that the hazards of this type of steel do not end at the site of manufacture but extend into the general field of use, in so far as welding

and/ or other high-temperature processes are involved.)

The lead exposure associated with the pouring of ingots is being handled in part by local ventilation. There is evidence both from observation of the process and from the air analyses that the ventilation is not wholly adequate for the purpose. This fact had been recognized by plant and safety personnel and plans were under way to extend the ventilation to meet the requirements. Details of a discussion of the hazards arising at the pouring platform have been recorded elsewhere and need not be discussed here. Suffice it here to say that the degree of improvement associated with changes in the design and size of ventilating and other safety equipment must be determined by critical and rigid studies of the lead content of the air of all working spaces that are subject to contamination.

The exposure associated with the various rolling procedures, and especially that at the blooming mill, is not under control, in my opinion, and is likely to give considerable difficulty. The problem of control, here is admittedly a difficult one, technically, but some type of local ventilation would appear to be required.

The exposure which arises from "scarfing" is, I think, a serious one, if continued long enough, and that associated with welding belongs in the same category.

With the single exception of the exposure of pouring the ingots, which can readily be controlled by the improvement of present ventilating facilities, the other operations offer opportunities for exposure that will be difficult to control and that, in my opinion, may be expected to produce lead poisoning

among workmen, and, indeed might well have done so except for the irregularity of the operations.

Recommendations

So far as plant operations are concerned, the writer believes that the lead exposure can be controlled and kept within safe limits. (As to the significance of that beyond the confines of the plant, only time and investigation will serve to determine, but the outcome should probably not be left to chance.) Control, within the plant, is in engineering problem, involving the removal of lead from the plant atmosphere to the extent required for safety. For several reasons which need not be discussed here, it is advisable to remove lead from such atmosphere by collecting it, rather than by diluting it. It is gratifying to know, therefore, that electrostatic

precipitation of the lead particles from the exhausted air is definitely projected.

Whatever may be the means of reducing the lead exposure, a continual study of conditions should be carried out so as to establish the effectiveness of the measures of control. In view of the importance of air analyses in arriving at present conclusions, it is noted that the methods of analysis should be subjected to rigorous check, so as to eliminate any question as to their precision. This can be done in a variety of ways, and in order to make a start in that direction, it is suggested that a series of samples of known lead content be prepared in this laboratory and sent to the plant analyst for examination and report to us. On the basis of the results obtained further check may be made as needed.

In recognition of the fact that whatever exposure

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has existed over the past year will have left its record in the form of lead absorbed by exposed workmen, it is recommended that a group of workmen be examined as to their lead excretion. A number of men who are representative of the worst exposures believed to exist in the plant should be selected on the basis of their reliability in carrying out instructions and on the duration of their employment under conditions of exposure. These men should be given thorough physical examinations, if they have not recently been examined, together with the routine laboratory procedures. It would be helpful if the records (or copies) of these examinations were supplied to the laboratory for study in connection with the analytical results. In addition, one or two blood smears on each man made so as to be suitable for differential counts might also be obtained and sent to this laboratory for examination. These need not be fixed or stained but merely dried in air, marked for identification and then packed in a box and sent by mail. Each employee selected for the purpose should be provided with a container for the collection of his urine, and should be carefully instructed as to the means of collecting the sample. (Containers for these samples and instructions for their collection will be supplied and in each case the samples must be collected at the home of the employee.)

Pending the acquisition of information as to the significance of the present lead exposure, illnesses of any type among workmen might be believed to be lead poisoning either by the men or by local physicians. In such cases proof of the correctness or incorrectness of the diagnosis should be obtained at the earliest possible time. For this reason it is believed that cases of illness of any type among the exposed personnel

should be given complete and careful clinical study, and that analyses of blood and excreta should be carried out as an aid to differential diagnosis and as proof of the significance or insignificance of the lead exposure. Arrangement can be made to carry out the analyses involved in this recommendation if it seems desirable that they be done in this laboratory.

Additional Comments

This memorandum might give an unfair impression if it were not pointed out that the steps which have been taken to study and to control lead exposure in this plant have been, in my opinion, well conceived and well executed. The regime for the examination of the exposed workmen has provided useful information as a basis for further study. This should be continued in a careful and studious manner. The steps taken to provide ventilation have been in the right direction and require only augmentation. How much augmentation and in what additional areas, remains to be seen. Granting that the present lead exposure can be controlled adequately, two major problems remain for serious consideration. The one, which can be handled by mere extension of the means required for present purposes, has to do with increase in the production of leaded steel, with corresponding increase in hazard. Obviously the larger the proportion of the working day spent in making leaded steel, the greater the exposure of workmen. If the present levels of exposure were maintained daily and hourly, lead poisoning would surely occur. This factor, therefore, must be kept in mind and watched. The other, more difficult to grasp and to settle, is the extension of the hazards of lead exposure beyond the confines of a plant, where they are

subject to control, into the activities of a large group of more or less uninformed and unsupervised workmen, who will fabricate articles by welding procedures and by other heating processes, using leaded steel. The writer has no idea how far the dangers of lead absorption from this source will extend or how significant they will be. The lack of basis for judgment in this regard arouses some misgivings. Without taking an alarmist position, - and such a position would not be justified by the available facts - , one might well ask whether the steel industry as a whole wishes to assume the responsibility for introducing a new and undetermined risk into the trades and crafts which are concerned with its product, or whether it expects to prevent actual danger by maintaining a survey of the uses to which leaded steel is put and by carrying out an adequate study of the magnitude of the lead exposure associated with such usage.

Signed:

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