Inland Steel Company

MEMORANDUM ON THE LEAD EXPOSURE ASSOCIATED WITH THE PRODUCTION OF LEDLOY STEEL AT THE EAST CHICAGO PLANT OF INLAND STEEL COMPANY

An inspection of plant operations made in the company of Dr. Kammer and various members of the technical and production staff of the plant provided a fairly comprehensive grasp of the problems under consideration. Detailed study of the data obtained by the analysis of the air of workrooms and elsewhere over the period of the past year has served to fill out the picture further. For the purpose of making the present interpretation of the situation these analytical results have been accepted at their face value. It must be pointed out, however, that since these are the only quantitative data available, and since conclusions of far-reaching importance must be based upon them, it is neither wise nor safe to accept their accuracy without proof. For this reason I shall subsequently suggest the means of testing their validity.

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 nor 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 concensus 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 mg/10 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 M^3 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 to a very large extent by local ventilation and by the use of "hot tops" and "hot topping" materials. The analytical data indicate, however, that the control is not wholly adequate, in that dangerous concentrations of lead can be found at times, although perhaps not for long, in the immediate vicinity of the ingots. Unfortunately, there are no data on the extent of the volitalization of lead during the removal of the "hot tops" and molds and for some time afterward.

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 will produce lead poisoning among workmen, and would, in fact, have done so, except for the irregularity and infrequency of the operations. It would be surprising to me if workmen who have had the longest and most frequent exposure in the several types of occupation did not show a distinct elevation in their lead excretion.

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 an engineering problem, involving the removal of lead from the plant atmosphere to the extent required for safety. In general it would be advisable to remove the lead by collecting it, rather than by merely diluting it. This may or may not be feasible in terms of production costs, but it may well be found that the collection of the lead fume would reclaim enough metal to pay in considerable part or in whole, for the equipment required to collect it.

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 the air analyses in arriving at present conclusions, it is believed that the methods of analysis should be subjected to rigid 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 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. There are several ways by which this could be done, each involving a somewhat different amount of work and cost. (1) One means of approach would be to select two or more men whose lead exposure has been maximal, sending them to me in Cincinnati for complete examination and determination of the extent of their occupational lead absorption. It would require from 2 to 4 days, dependent upon the initial analytical results, to obtain the desired information. The cost involved in such a study would be the traveling expense, moderate hotel expense, a nominal examination fee of $10.00 per person to cover the cost of blood examinations etc., and the expense of analyses on the blood, the urine and the feces at $5.00 per analysis, (the actual proportional cost of operation of our analytical laboratory). (2) A second and better method involves the selection of a

group of men representative of the worst exposures believed to exist in the plant, and the examination of these men on the day immediately following the carrying out of the operations associated with exposure. These men might well be given thorough physical examination by the plant physicians, with reports forwarded to me, the examination to include making duplicate blood smears, one set of which is sent to me for examination, one set being studied at the plant laboratory by the present methods employed there. At least 10 employees (the most severely exposed) should collect samples of their feces on the day following their exposure, and samples of their urine over a period sufficient to obtain at least 2 liters of the latter. (Containers for these samples, and instructions for their collection will be provided by me, and in each case the samples must be collected at the homes of the employees rather than at the plant. A successful technique for this type of sampling has been developed in this laboratory.) This method of procedure would serve to determine the general order of magnitude of the actual exposure in the jobs carried out by the men so examined. The cost, here, would be the express charges on the shipped containers and the samples, the expense of examining the blood smears (determined by the actual cost of a technician's time), and the expense of the analyses at $5.00 per analysis. (3) A third method would be valuable as a measure of the comparative magnitude of the total lead exposure which has occurred up to the present in the plant operations. It, therefore, would be an attempt to determine how much lead absorption has taken place among the most severely exposed men. It would be less valuable than method #2 as a measure of the actual exposure associated with a typical day's work. It consists in carrying out exactly the same procedures listed above

in the case of men who have been engaged at this type of work for some months, but at a time some days or, if possible, 2 weeks after a day of actual exposure. (4) A fourth method would be the careful selection of men representing all of the types of work that present opportunities for exposure, studying them systematically and perhaps repeatedly by clinical and analytical methods both in relation to a day of exposure and between exposures, so as to obtain comprehensive information as to the extent of their exposure and their absorption. Such data once collected could be used in comparison with subsequent observations to determine the extent of the hazard arising from changes in plant operations or from increases in production, and to check the adequacy of improved measures of control. The cost of this type of study would depend upon the means of doing the clinical work, i.e. whether done by plant physicians or by our staff, - the number of blood smears to be examined, and the numberof analyses to be carried out at the rate indicated above.

Obviously the use of any of the methods mentioned above, some combination of them, or a choice among them, may well depend upon a number of factors, such as cost, convenience, or the urgency of obtaining information. Moreover, it would not be possible at this time to divert the efforts of the clinical or technical staff of this laboratory into the immediate accomplishment of such a program as is contemplated in method #4. In view of the apparent significance of this hygienic problem, however, and in view of our keen professional interest in the significance of various types and magnitudes of occupational lead exposures, we should feel constrained to carry out such early observations as might be mutually agreed upon as essential. In this connection it would seem to be the better part of wisdom, pending careful check of the adequacy of the air analyses,

to determine the extent of the actual occupational lead exposure of workmen up to the present time, in at least a few carefully selected instances, lest some actual or alleged case of poisoning should develop before any adequate information had become available.

In the present situation, almost any type of illness among the plant personnel might be called lead poisoning by physicians. In that case, granting that such a diagnosis might be incorrect, proof of its incorrectness would be required to absolve the industry from responsibility. 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.

Signed: _____

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