

Illustrative Concentrations of Lead in  
Plant Air During Production of Ledloy Steel

During the first months of production of Ledloy steel all air sampling was done with the intention of measuring only peaks of concentration of lead in working environments. Samples were accordingly collected as close as possible to the origin of lead fumes and in the thickest parts of visible fume drift. Sampling periods were intentionally restricted to avoid the effect of dilution by air not heavily contaminated. Wherever possible the sampling time and the volume of air sampled are shown in the tables which follow.

Table I  
Concentrations of Lead in Open Hearth Shop

| Date     | Dept.       | Sampling Position      | Minutes Sample Collected | Cu. Ft. Air Sampled | Mg. Pb 10M <sup>3</sup> |
|----------|-------------|------------------------|--------------------------|---------------------|-------------------------|
| 12/22/37 | Open Hearth | Pouring Platform       | not recorded             | not recorded        | 10.24                   |
| 1/ 6 /38 | " "         | " "                    | " "                      | " "                 | 17.66                   |
| 1/ 6 /38 | " "         | Fume drift, across pit | " "                      | " "                 | 21.19                   |
| 3/ 2 /38 | " "         | " " " "                | 24                       | 11.68               | 40.96                   |
| 4/ 1 /38 | " "         | " " " "                | 11                       | 6.8                 | 52.26                   |

Many other samples were collected in the Open Hearth shops during the foregoing months. The figures shown represent the maximum concentrations discovered. Heats were made at the rate of one per

turn of work, on scattered turns throughout a given month. The total exposure proved to be insufficient to produce clinically discoverable cases of lead absorption among workmen.

In April, 1938 a mechanical exhaust system was devised to remove fume from the tops of ingot moulds during the addition of lead to molten steel. The device was at once effective in removing most of the fume, and as time went on it was gradually perfected. The point of maximum concentration of fume shifted from the Open Hearth pit to the pouring platform where lead additions are made.

Table II  
Concentrations of Lead at Open Hearth Pouring Stand,  
Exhaust System in Use

| Date     | Dept.       | Sampling Position                                          | Minutes<br>Sample<br>Collected | Cu.Ft.Air<br>Sampled | Mg.Pb<br>10M <sup>3</sup> |
|----------|-------------|------------------------------------------------------------|--------------------------------|----------------------|---------------------------|
| 4 /26/38 | Open Hearth | Breathing zone of<br>men most exposed,<br>pouring platform | 20                             | 12.40                | 3.53                      |
| 5 /10/38 | " "         | " "                                                        | 23                             | 14.26                | 3.53                      |
| 5 /20/38 | " "         | " "                                                        | 15                             | 7.95                 | 16.95                     |
| 6/22 /38 | " "         | " "                                                        | 21                             | 11.13                | 1.41                      |
| 8/10 /38 | " "         | " "                                                        | 10                             | 5.30                 | 3.88                      |
| 10/27/38 | " "         | " "                                                        | not recorded                   | 10.07                | 3.53                      |

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Two attempts have been made to measure the exposure for a full turn of work on the pouring platform. Average lead concentrations in the air during each hour of a turn are shown on the next two tables. One heat of Ledloy steel was made during the eight hour turn represented by each set of tests. The sample taken during the pour is indicated in each table by an asterisk.

Table III

Open Hearth Pouring Stand 1/18/39\*\*

| Sample No. | Pb/10M <sup>3</sup> | Time of Sampling         |
|------------|---------------------|--------------------------|
| 1          | .233                | 10:23 A.M. to 11:23 A.M. |
| 2          | .328                | 11:25 A.M. to 12:25 P.M. |
| 3          | .547                | 12:27 P.M. to 1:26 P.M.  |
| 4          | .123                | 1:31 P.M. to 2:31 P.M.   |
| 5*         | 1.458               | 2:34 P.M. to 3:34 P.M.   |
| 6          | .360                | 3:38 P.M. to 4:38 P.M.   |
| 7          | .276                | 4:41 P.M. to 5:41 P.M.   |
| 8          | .219                | 5:45 P.M. to 6:45 P.M.   |
| <hr/>      |                     |                          |
| Average    | .443                |                          |

Table IV

Open Hearth Pouring Stand 1/27/39\*\*

| Sample No. | Pb/10M <sup>3</sup> | Time of Sampling         |
|------------|---------------------|--------------------------|
| 1          | .208                | 9:54 A.M. to 10:44 A.M.  |
| 2          | .543                | 10:46 A.M. to 11:19 A.M. |
| 3*         | .773                | 11:24 A.M. to 12:14 P.M. |
| 4          | .662                | 12:19 P.M. to 1:24 P.M.  |
| 5          | .632                | 1:27 P.M. to 2:19 P.M.   |
| 6          | .187                | 2:22 P.M. to 3:12 P.M.   |
| 7          | .434                | 3:14 P.M. to 4:04 P.M.   |
| 8          | .095                | 4:07 P.M. to 4:57 P.M.   |
| <hr/>      |                     |                          |
| Average    | .424                |                          |

\* Steel poured while sample was collected.

\*\* Eight consecutive samples, each collected for one hour.

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In each set of samples the apparatus was kept at one place on the pouring stand. It is realized that no method of air sampling can exactly measure the exposure of all the members of a work crew. It is believed, however, that studies such as are illustrated above present a more accurate estimate of the true hazard than do grab samples of any type.

Ingots are rolled (or bloomed) into slabs or billets in a Blooming mill. In the case of Ledloy steel most ingots rolled at this plant have been routed through the 36" Blooming Mill. Before being rolled ingots are reheated for varying periods of time, usually 6 hours or over, in soaking pits. In order to save heating costs the ingots are charged into soaking pits as soon as possible after being stripped of their moulds, while the ingots are still red hot. It so happens that Number One Open Hearth Shop, a battery of soaking pits, and the 36" Blooming Mill are all in one large building without any intervening walls. Determinations of lead in air at the soaking pits were made for eight consecutive hours, as shown on the following table. Sample no. 3 was taken during the hour a heat of Ledloy steel was being poured at the Open Hearth stand 150 feet away. The same heat was charged into the soaking pits some time later, during the time sample no. 6 was being collected.

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Table V

Concentration of Lead at 36" Mill Soaking Pits

Eight Consecutive Samples, Each Made For One Hour

| Sample No. - | Pb/10M <sup>3</sup> | Sampling Time            |
|--------------|---------------------|--------------------------|
| 1            | .159                | 9:44 A.M. to 10:34 A.M.  |
| 2            | .292                | 10:30 A.M. to 11:27 A.M. |
| 3*           | .294                | 11:31 A.M. to 12:25 P.M. |
| 4            | .677                | 12:27 P.M. to 1:30 P.M.  |
| 5            | .395                | 1:32 P.M. to 2:25 P.M.   |
| 6**          | .716                | 2:30 P.M. to 3:19 P.M.   |
| 7            | .116                | 3:21 P.M. to 4:11 P.M.   |
| 8            | .219                | 4:13 P.M. to 5:03 P.M.   |
| <hr/>        |                     |                          |
| Average      | .358                |                          |

\* Lead being added to steel at the Open Hearth pouring stand.

\*\* Same heat being charged into pits during samples No. 6 and No. 7.

A similar series of samples collected 10 days previously showed an average concentration for an eight hour turn, during which a heat was poured at the Open Hearth Stand and later charged into the Soaking Pits, of 0.397 mg. of lead per 10 cubic meters of air.

It is recognized that hot rolling of Ledloy steel is associated with the liberation of lead fume. As was stated above, most of the ingots have been rolled at the 36" Blooming Mill. The mill building is an old one, and is hemmed in by adjoining structures. Its natural ventillation is considerably less than is customarily found in Blooming mills. With the exception of the last two items in the following table (no. VI) the samples were all collected in the 36" Blooming Mill. All determinations shown were made from grab samples collected at expected peaks of concentration. There was usually a series of determinations

made for the 36" Blooming Mill on a given day. The results listed in the table represent the highest values found in each series.

Table VI

Concentrations of Lead at Locations in 36" Blooming Mill\*

| Date     | Dept.    | Sampling Position    | Minutes<br>Sample<br>Collected | Cu.Ft.Air<br>Sampled | Hg.Pb<br>10M <sup>3</sup> |
|----------|----------|----------------------|--------------------------------|----------------------|---------------------------|
| 3/29/38  | 36" Mill | Roller's Pulpit      | 35                             | 21.7                 | 20.63                     |
| 4 /1/38  | "        | " "                  | 23                             | 14.2                 | 2.83                      |
| "        | "        | Metallurgists' Stand | 28                             | 17.3                 | 6.71                      |
| 4 /3/38  | "        | Motor Room           | 23                             | 14.6                 | 4.94                      |
| 4 /6/38  | "        | Roller's Pulpit      | 28                             | 17.4                 | 5.30                      |
| 4/12/38  | "        | Metallurgists' Stand | 21                             | 13.0                 | 12.71                     |
| 4/20/38  | "        | Shears               | 30                             | 18.6                 | 1.41                      |
| 11/9/38  | "        | Metallurgists' Stand | Not recorded                   | 27.56                | 8.83                      |
| 1 /17/39 | 40" Mill | Roller's Pulpit      | " "                            | 37.9                 | 0.80                      |
| "        | "        | Metallurgists' Stand | " "                            | 38.2                 | 0.42                      |

\* The last two items represent samples collected in the 40" Blooming Mill.

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The last two items in the foregoing tables show concentrations during rolling of Ledloy steel at the 40" Blooming Mill. Natural ventilation at that place is of the quantity one would expect to find in a blooming mill of ordinary construction and free of too close approximation to other buildings.

The method of determining the average exposure for a work day by sampling continuously for eight hours was used at the roller's pulpit and at metallurgists' stand. There are two series of tests for each place in the 36" Blooming Mill. They are summarized below. The last column in the table shows the average lead content of all samples collected during eight consecutive hours, expressed in terms of milligrams of lead per 10 cubic meters.

Table VII

Concentrations of Lead at Locations in 36" Blooming Mill  
(Average Exposure for a Full Turn of Work as Determined by Eight Consecutive Samples, Each Made for One Hour\*)

| Date    | Location             | Hour in which steel was rolled | Hour in which sample was collected | MGH.s Pb/10M <sup>3</sup> |        | Average |
|---------|----------------------|--------------------------------|------------------------------------|---------------------------|--------|---------|
|         |                      |                                |                                    | Highest                   | Lowest |         |
| 1/31/39 | Roller's Pulpit      | Fifth and Seventh              | Seventh                            | 6.35                      | .      |         |
|         |                      |                                | First                              |                           | .12    | 1.39    |
| 2/2/39  | Roller's Pulpit      | Seventh                        | Seventh                            | 5.68                      |        |         |
|         |                      |                                | Third                              |                           | 0      | 1.06    |
| 1/31/39 | Metallurgists' Stand | Fifth and Seventh              | Fifth                              | 1.45                      |        |         |
|         |                      |                                | Eighth                             |                           | .03    | .455    |
| 2/2/39  | Metallurgists' Stand | Seventh                        | Seventh                            | 4.91                      |        |         |
|         |                      |                                | Second                             |                           | .02    | .778    |

It would appear that the practise of limiting the rolling of Ledloy steel in the 36" Blooming Mill to one heat per day simultaneously limits exposure of workers to a safe total intake of lead per turn. As

\* Only the highest, lowest, and average values are shown for each series.

KE 0013006

a matter of fact the average rate of production of the material has been considerably less than one heat per turn. Rather close clinical observation of the exposed men has to date revealed no case of lead absorption in any stage. It seems likely, however, that if production schedules are stepped up much beyond the rate of one heat per turn it will be necessary either to bloom Ledloy steel at the 40" Mill or devise an exhaust system for the 36" Mill.

The billets produced at the Blooming Mills are rolled to shipping sizes at either the 10" or 14" Merchant Mills. Only a few determinations are available for the exposure at the latter places. Both merchant mill buildings are very large and have excellent natural ventilation. For the most part men work at controls some distance away from hot steel. Maximum concentrations discovered to date are shown below.

Table VIII

Concentrations of Lead at Locations in Merchant Mills

| Date    | Dept.    | Sampling Position             | Minutes<br>Sample<br>Collected | Cu.Ft.Air<br>Sampled | Hg.Pb<br>10M <sup>3</sup> |
|---------|----------|-------------------------------|--------------------------------|----------------------|---------------------------|
| 8/9/38  | 14" Mill | Discharge Door Reheating Fce. | 58                             | 37.20                | 0.71                      |
|         |          | Platform #1 and #2 rolls      | 60                             | 37.20                | 1.78                      |
|         |          | Finishing rolls               | 37                             | 22.94                | 3.18                      |
| 8/26/38 | 10" Mill | 5 ft. away from roll          | 30                             | 11.13                | 5.3                       |
|         |          | Discharge end reheating fce.  | 29                             | 15.37                | 2.12                      |

The men considered to have most exposure in the two merchant mills have been seen regularly in the medical department. Their blood smears, histories, and physical appearances have failed to show any indication of lead absorption.

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