U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HAZARD EVALUATION AND TECHNICAL ASSISTANCE
REPORT NO. TA 77-18

KW BATTERY DIVISION
SKOKIE, ILLINOIS

NOVEMBER, 1978

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50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. 77-000-018	2. NA	3. Recipient's Accession No. PB82 19595

4. Title and Subtitle
HETA, KW Battery Division, Skokie, IL., November 1978

5. Report Date
November 1978

6. NA

7. Author(s)

8. Performing Organization Rept.

9. Performing Organization Name and Address
NIOSH
4676 Columbia Parkway
Cincinnati, Ohio 45226

10. Project/Task/Work Unit No.
NA

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address
NIOSH
4676 Columbia Parkway
Cincinnati, Ohio 45226

13. Type of Report & Period Cove
HETA

14. NA

15. Supplementary Notes

16. Abstract (Limit: 200 words) The National Institute for Occupational Safety and Health (NIOSH) co an environmental/medical survey to determine employees' exposures to inorganic lead a Battery Division, Skokie, IL. The survey was accomplished on May 17-19, June 2-3, an August 11-12, 1977.

Based on medical results it appears that the bag house rupture occurring sometime in fall of 1976 led to excessive lead exposure with a number of workers being seen and t at Cook County Hospital. Review of company lead monitoring data suggests that the ma of workers treated possibly had blood lead values over 60 ug/100 ml at the time they seen. Almost none of the workers seen at Cook County were available at the time of t NIOSH study.

17. Document Analysis a. Descriptors

lead-batteries, lead,

b. Identifiers/Open-Ended Terms

I. SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) conducted an environmental/medical survey to determine employees' exposures to inorganic lead at KW Battery Division, Skokie, Illinois. The survey was accomplished on May 17-19, June 2-3, and August 11-12, 1977.

Environmental data, i.e., personal and area samples, were collected during eight-hour day shifts in order to characterize the employees' exposure. The environmental results indicate that a health hazard, under the conditions surveyed, did exist in several work areas. Approximately 53 time-weighted average (TWA) samples were collected during the initial survey. Of these 53 samples, 38 samples exceeded the new NIOSH recommended lead standard (1978) and the Occupational Safety and Health Administration (OSHA) proposed standard (1975) of 0.10 milligrams per cubic meter of air (mg/M^3). The lead concentrations ranged from 0.02 mg/M^3 to 5.81 mg/M^3; however, the majority of the samples (27) ranged from 0.10 mg/M^3 to 0.40 mg/M^3. Additionally, 50 percent of the 16 TWA samples collected during the follow-up survey exceeded the proposed standard of 0.10 mg/M^3. The lead concentrations for these 16 samples ranged from 0.01 mg/M^3 to 0.96 mg/M^3.

It should be noted that the company implemented or intended to implement the following steps in order to ameliorate the safety and health problem: (1) Elimination of an uncontrolled source of contamination (slyver operation); (2) issuance of coveralls to any employee working in the battery processing operation; (3) improved ventilation controls; (4) change in material flow patterns. On the follow-up survey, it was observed that items #1 and 2 above had been implemented, and that minor repairs had been made on the ventilation system.

The medical evaluation included a review of the company's blood lead monitoring data and an evaluation of the current work force with questionnaires, blood lead determinations and zinc protoporphyrin determinations. To better evaluate laboratory results all bloods were split between the laboratory used by the company and NIOSH. Some additional splits were made to include the Cook County Hospital Laboratory and the Chicago Division of Health Laboratory. An attempt was made to check medical records of workers who had been treated for lead poisoning but this was largely unsuccessful.

Based on medical results it appears that the bag house rupture occuring sometime in the fall of 1976 led to excessive lead exposure with a number of workers being seen and treated at Cook County Hospital. Review of company lead monitoring data suggests that the majority of workers treated possibly had blood lead values over 60 ug/100 ml at the

The NIOSH study showed 13 of 101 workers with blood leads in the 61-80 ug/100 ml range and 2 in the 81-100 ug/100 ml range. The zinc protoporphyrins (ZPPs) suggested that exposures in the previous few months were probably higher than those found at the time of the NIOSH study. This included office workers who would not normally be expected to have any appreciable exposure.

The split samples for blood lead determinations confirmed that Cook County Hospital Laboratory was giving readings appreciably higher than the other three laboratories. This could lead to more vigorous treatment than warranted if this laboratory difference was not considered when applying generally accepted lead level standards.

II. INTRODUCTION

A request for technical assistance was submitted to NIOSH by the Personnel Relations Manager, KW Division Plant, Division of Westinghouse. The request was submitted because employees' blood lead levels measured at Cook County Hospital were consistently higher than the blood lead levels measured at KW contract laboratory. The company requested NIOSH to investigate this problem because workers may have been incorrectly diagnosed as having lead poisoning, and thus received unnecessary chelation therapy.

It was learned, during the initial visit, that the bag house dust collector for the pasting department was found ruptured in November 1976. However, this rupture was repaired by the time NIOSH conducted its investigation.

III. EVALUATION

A. Process Description

KW Battery Division is a manufacturer of lead storage batteries such as those used in fork lift trucks and locomotives. The facility occupies 83,000 square feet, and the ventilation system is reported to operate under a 10 percent negative pressure.

The company has a work force of 180 employees who either work the 7:30 to 4:00 p.m. shift or the 4:00 to 12:00 a.m. shift. Approximately 120-130 employees are factory workers; 15 of these are women.

There are approximately seven areas associated with the production of the lead storage batteries. Each departmental operation is briefly described as follows.

1. Metal-Alloy Department - This department uses one furnace; it is connected to a high efficiency particulate air filter (HEPA) which is mounted on the roof. The operator charges the furnace with scrap sheeting lead from cable. Additionally, antimony, tin and arsenic oxide are added to the molten lead to produce the desired lead alloy. When the lead-alloy concentration is obtained, the molten metal is poured into small ingots. The ingots are transferred to the storage area or the grid casting department where they are readily used.

2. Grid Casting Department - There are four grid mold machines. Each machine is continuously monitored by one operator. The operator also adds defective grids and ingots, as needed, to the grid machine melting pot (furnace). The molten lead is automatically supplied to the grid mold jacket where the grids are formed, cooled and solidified. On occasion, defective grids are formed; therefore, the operator is required to clean the mold jacket with hot water and a brush, and subsequently spray the jacket with a mold releasing agent, which is a silicon type material.

It should be mentioned that the grid mold machine furnace contains an exhaust fan which vents the lead fumes through the roof. Respirators are not required in this area.

3. Paste Department - This area contains two operations: the paste mixing operation and the grid pasting machines. Employees are required to wear respirators in this department.

a. Paste Mixers - There is one positive and one negative oxide mixer. As oxide is needed, an air pump is manually activated, which blows oxide from the silo to the weighing hopper, after which the load is dropped into the mixer beneath. (The air is vented to a cyclone, baghouse, and secondary filter prior to being vented to the environment.)

Water, sulfuric acid and other necessary constituents are added to the mixer to form the paste. Once the paste is ready, it is dumped into a mobile bin and transported to the pasting machine. A hoist adjacent to the pasting machine is used to lift the mobile bin and empty the paste into a hopper which is mounted above the pasting machine.

b. Pasting Machine - There are several paste machines in this department; however, only one machine was being utilized during the survey. The paste machine operator loads grids onto the paste machine. As grids are automatically supplied to a conveyor belt system, the paste hopper gravity feeds the paste onto the grid plates, and the rollers press the paste onto the grids. Most of the excess paste on the grid plates and the conveyor belt falls into a trough which is strategically positioned. As the trough becomes filled with the paste, an employee

The pasted grid plates are manually removed from the conveyor line, dipped in a trough of very dilute acid and loaded onto a rack. Depending on the type of plate and paste, the racks are placed in one of five drying ovens to be cured for a specified time, at a specified temperature and humidity. Subsequent to the curing operation, the plates are either wrapped or temporarily stored until they are needed.

There was no local exhaust ventilation for any of the pasting machines.

4. The Slyver/Wrapping Operation - This operation has been modified since the initial survey.

Prior to the process change, the slyver operator would take a positive plate and place it on a turning device wrapping the plate with fibrous glass. The plate wrapper would next wrap the plate with a fibrous glass mat and a plastic plate wrapper. The plates would then be stacked on skids and transported to the burning rack where the batteries are assembled. Since the process changes, the turning device has been eliminated. The wrapper places two fibrous glass mats and a Koroseal®* cover around the plates.

5. Cell Assembly - There are three burning racks with three stations at each rack. At the first station, the positive and negative plates are assembled in a jig. Next, the plates are fused together by the burner operator, and finally the plates are inspected and placed into a jaring machine. This machine compresses the plates so that they can be loaded into a plastic jar which is in turn loaded into an epoxy-coated steel battery tray.

6. Finishing Department - This department contains several operations. Once the battery has been assembled, it is sent to the traying and sealing area. Repairs of new battery terminals and/or posts are periodically accomplished here. Sealing compound is used to coat the inside of the battery tray; after which the battery cover is applied. Sealing compound is poured over the plastic covers to form a better battery seal. Next, the inter-cell connectors are fused together, and the battery is transported to the forming room. At the forming room, the battery is filled with a sulfuric acid solution and slowly charged. After charging, the battery is returned to the finishing department for final inspection, battery touch-up and cable installation. The batteries are then ready for shipment.

7. Small Parts Department - Burning lead and tacking lead are used in this department. The lead is melted and used to make inter-cell connectors and terminal posts. In addition, rubber charging cables are made here.

B. Evaluation Design

Environmental

Environmental sampling was performed only during the day shift because this shift was described as being typical of the second shift. Depending upon the condition of the filters, samples were either collected for as much an eight hour shift as possible, or two-four hour samples were collected and time-weighted. Approximately 89 lead samples were collected during the initial survey and time-weighted for a resultant number of 53 samples. On the follow-up survey, 22 lead samples were collected and time-weighted for a resultant number of 16 samples.

During the follow-up survey, several ventilation measurements were made at stations where exhaust ducts were located.

Medical

Evaluation consisted of 1) a review of available historical data on the company's lead monitoring program and other medical records; and 2) an evaluation of current status. For the current status NIOSH conducted a blood lead survey of the entire work force. This included split samples between NIOSH contract laboratories (Medical Diagnostic Services - Ohio Valley, Cincinnati [MDS]) and a laboratory of the company's choosing (Environmental Sciences Associate Inc., Bedford, Massachusetts [ESA]). The company payed for their own laboratory tests. All bloods (with few exceptions) were split between the two laboratories. In addition, 17 samples were split with the Division of Biochemistry, Cook County Hospital (CCH), and 13 of these were also split with the Division of Laboratories of the Chicago Department of Health (CDH). This last laboratory was chosen on recommendation by the Center for Disease Control (CDC) Childhood Lead Screening Program.

To help interpret the blood lead results, a brief questionnaire (Appendix A) was given to each participating worker. These were given to the worker at the time the blood specimen was obtained and collected the following day. This was to allow family members or friends who were fluent in English to assist the workers in completing the forms.

A tube of blood was drawn for a zinc protoporphyrin to be done on site.

C. Evaluation Methods

Environmental

Environmental sampling for inorganic lead consisted of collecting personal samples with Mine Safety Appliance (MSA) pumps operating at flow rates

The filter samples were wet-ashed in distilled nitric acid and brought to a volume of 25.0 milliliters with deionized water. An alliquot of the sample was directly aspirated into an atomic absorption spectrophotometer. A more detailed description of this analytical technique is described in reference #2.

Medical

1. Sample Selection

All workers from both day and evening shifts were to be included. Of about 130 workers, 101 participated. Almost all workers had three tubes of blood drawn using a multidraw needle and Vacutainer® tubes as specified or supplied by the laboratories to be used. The first and second tubes were sent for blood lead analyses by MDS and ESA (the order was alternated between laboratories). The third tube was saved for a ZPP determination utilizing an Environmental Sciences Associates Number 4000 Hematoflurometer calibrated in microgram (ug) ZPP/100 ml whole blood with an assumed hematocrit of 42 percent.

Every fifth worker had additional tubes drawn. A fourth of these had duplicate tubes drawn for MDS and ESA with the two tubes being submitted with different control numbers. Five splits were submitted in this manner. The other three quarters of these workers had tubes drawn for CCH and CDH. At CCH's request, blood analyzed by them was drawn into green-stoppered vacutainer tubes (supplied by NIOSH) and they were sent the first tube drawn, the last tube drawn (with the exception the ZPP tube), and the last alcohol swab used for cleansing the arm prior to venipuncture. The three tubes for the other three laboratories were drawn into tubes supplied by the respective laboratories. Order was alternated. Three workers not in the routine split specifically requested that we send samples to CCH, so this was done.

2. Supplementary Sample

Because very few of the workers who took part in the study had been treated for what might have been lead poisoning, it was felt that workers absent on the two days of the study should be contacted. Letters were written to the 48 workers identified by the company as being absent. Six were returned as undeliverable, and 4 were returned with a history of treatment for lead poisoning. Evidently, the cover letter was interpreted by the recipients to mean that only those who had been treated for lead poisoning should return the questionnaire, as all the questionnaires returned indicated there had been treatment for lead poisoning. The same questionnaire was used as in the main part of the study.

3. Laboratory Methods

MDS uses a Delves cup with atomic absorption and participates in the CDC Clinical Chemistry Proficiency Testing Program. ESA uses anodic stripping and also participates in the CDC program. CDH uses an acid chelation extraction method and atomic absorption and also participates in monthly testing through CDC's Childhood Lead Screening Program. CCH uses a neutral chelation extraction method and atomic absorption. They participate in the CDC Proficiency Testing Program and, in addition, receive blood standards from the National Bureau of Standards (NBS) which contain blood from a herd of pigs fed lead. The pooled blood is then assayed by NBS via isotope dilution mass spectrometry.

D. Evaluation Criteria

Environmental

Airborne exposure limits for inorganic lead have been recommended or promulgated by several sources. For this study the criteria used to assess the degree of health hazards were collected from three sources:

1. NIOSH: Criteria for a Recommended Standard ... Occupational Exposure to Inorganic Lead, 1972 and Revised Recommendations 1978.

2. Threshold Limit Values (TLV): Guidelines for Chemical Substances and Physical Agents recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) for 1977.

3. OSHA Standard: The air contaminant standard for inorganic lead enforced by the Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor (DOL) found in the Federal Register - CFR 1910.1000(b) (Table Z-2), and 1975 proposal.

Source	8-Hour Time Weighted Average Concentration (TWA)[1]	Acceptable Ceiling Concentration[2]
NIOSH Criteria Document - 1978[4]	100 ug/M^3 [3]	-
OSHA Standard	200 ug/M^3	-
OSHA Standard Proposed - 1975	100 ug/M^3	-
1977 TLV	150 ug/M^3	450 ug/M^3

[1]USDOL employee exposure standards are based on a computed time-weighted average occupational exposure for up to a 10-hour workday, 40-hour work week. This standard represents conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse effects. In some instances, however, a few employees may experience discomfort at or below the time-weighted average.

[2]This value should never be exceeded during a commonly used 15-minute sampling period.

[3]ug/M^3 = micrograms of lead per cubic meter of air (1 ug = .001 milligrams)

[4]NIOSH recommends that workers shall not be exposed to inorganic lead at a concentration greater than 0.10 mg/M^3 determined as a time-weighted average exposure for a 10-hour work day, 40-hour work week.

Medical

1. Toxic Substances Medical Data

Although capable of causing acute toxicity when absorbed in large amounts, lead is usually associated with chronic toxicity due to much smaller exposures repeated over a period of time. Lead and its inorganic compounds can be absorbed by inhalation of vapors, fumes or dust. Oral intake can also lead to poisoning, but absorption is not as complete. The three systems affected by lead of most concern are: the nervous system; the red blood cell forming tissue (the bone marrow); and the kidney. Classic symptoms of lead intoxication are wrist drop (a weakness of the muscles which cock the wrist caused by effects upon the nerves supplying these muscles), anemia (with small, hemoglobin-poor red cells), colicky abdominal pain, and constipation. The muscles which raise the ankles may also be affected. In children, but rarely in adults, there can be acute encephalitis. None of the symptoms due to lead poisoning are absolutely specific, and most of the individual complaints can also be caused by a number of other conditions. Other symptoms referable to the nervous system might include peripheral neuritis with muscle weakness. Central nervous system symptoms might include convulsions, irritability, personality change, headaches, forgetfulness, or tiredness. Signs of impaired kidney function (including the ability of the kidney to excrete lead) include protein in the urine, increased nitrogenous wastes in the blood, and increased blood uric acid with consequent gout.

2. Interpretation of Laboratory Results

Blood Lead values are important in helping to make the diagnosis of lead

not anemic), 60 ug/100 ml to 100 ug/100 ml represents an unacceptable elevation which may be causing problems (4), and over 100 ug/100 ml is considered dangerous (4). (Until recently lead levels up to 80 ug/100 ml were considered acceptable by most authorities.) One problem with determination of blood lead levels is that values are subject to a laboratory error of up to 10 ug/100 ml even in well-run laboratories.

Zinc protoporphyrin accumulates in the red cell when lead interfers with the introduction of iron into the hemoglobin as the red cell is formed in the bone marrow. The same thing is also seen in anemias. Once formed, the red cell will carry however much hemoglobin and zinc protoporphyrin it obtained in formation until its destruction (normally in about 120 days). ZPP can be reported in ug zinc protoporphyrin (ZPP)/100 ml whole blood or ug free erythrocyte protoporphyrin (EP)/100 ml whole blood. According to a letter dated September 28, 1977 from Environmental Sciences Associates, Inc., the manufacturer of the machine we used, the proper conversion between ZPP units and EP units is: 1 ug EP/100 ml equals 1.3 ug ZPP/100 ml. Based on this and several other studies it appears that a ZPP of 40 ug ZPP/100 ml whole blood corresponds to a blood lead of 40 ug/100 ml whole blood. The ZPP rises exponentially as the blood lead rises linearly. In other words, the ZPP rises much faster than does the blood lead. The relationship of ZPP with blood lead will be discussed in the Results and Discussion section of this report.

E. Evaluation Results and Discussion

Environmental

Environmental samples collected during the initial survey (see Table X) and the follow-up survey (see Table XI) have two airborne lead concentrations calculated for each worker. The "actual exposure" is based upon the number of hours the employee was monitored, and the "extrapolated exposure" assumes the workers had no lead exposure for the remainder of their shift. The extrapolated values are only provided as a reference to determine a state of compliance with the federal regulations. However, it would be incorrect to assume the workers were not being exposed to lead for the rest of their 8-hour day if, in fact, the workers were to continue to perform the same tasks.

The 53 TWA samples collected during the initial survey indicate that 38 of the samples (72 percent) exceeded the proposed standard of 0.10 mg/M^3. The extrapolated data indicates that 34 of the samples (64 percent) exceeded the proposed standard.

The same calculations were used to analyze the 16 TWA samples collected during the follow-up survey. Approximately 8 of the 16 actual exposures

After the initial visit, coveralls were issued to workers in the pasting department. It was reported that the remaining production workers were also going to be issued coveralls. The company engaged two workers to launder the contaminated coveralls on a daily basis. Since both employees worked in the laundry room most of the day, a four-hour area sample was collected. The airborne lead concentration (0.04 mg/M^3) was below the proposed standard.

Furthermore, a four-hour area sample was collected in the lunch room to ascertain if excessive lead contamination was occurring there. The lead level (0.04 mg/M^3) was below the proposed standard.

The company maintains a comprehensive respirator program in which trained personnel clean and inspect the respirators on a daily basis, and the respirator cartridges are changed once per week. The employees are counseled as to the purpose and correct use of their safety devices when the respirators are first issued.

Ventilation measurements were made during the follow-up survey. Several discrepancies were noted throughout the various departments. There was insufficient ventilation at each of the burning stations in the cell assembly department. A small moveable hood was positioned over each burning station and used as an exhaust. Unfortunately, this hood is open on all sides, and it only has an indraft velocity of approximately 50 feet per minute (fpm). This type of burning operation could be considered an active lead generation station and thus requires 200-500 fpm of indraft velocity. (6)

Velocity measurements were taken at each wrapping station. The indraft velocity at the face of each intake was about 150 fpm. Measurements in the workers' breathing zone were too low to be measured accurately. In many instances, the indrafts were located down and away from the point of generation; consequently, the exhaust duct served no purpose in removing the lead dust released from the plates.

Medical

1. Laboratory Results - Laboratory Comparisons

    a. Evaluation of Split Samples in Single Laboratories

Five workers had split samples sent to each of the Environmental Sciences Associate (ESA) and Medical Diagnostic Services (MDS) laboratories. Seventeen different workers had split samples sent to the Cook County Hospital laboratory. Cook County Hospital (CCH) knew which tubes of blood were pairs and also knew which tube had been drawn first. The

b. Comparison Between Environmental Sciences Associate Laboratory (ESA) and Medical Diagnostic Services Laboratory (MDS)

Out of 101 workers who had blood leads done, 100 had results from ESA and 99 from MDS. Ninety-eight (98) had bloods done at both laboratories. Excluding the 5 workers who had split samples sent to these two laboratories and including two NIOSH controls there were 95 samples split between the two laboratories. Results are shown in Table II for the comparison of first tube drawn minus second tube drawn. Those who had multiple tubes drawn for other laboratories were excluded. None of the differences are statistically significant.

c. Comparison Between All Laboratories Used

Thirteen workers had blood split between ESA, MDS, CCH and the Chicago Division of Health laboratories (CDH). An additional 4 were split only between ESA, MDS and CCH. Results of the 13 with a 4 way split are presented in Table III. Because the results on each individual can be considered "paired data", an analysis of variance for a single variable of classification was carried out using the difference between the particular laboratory's result and the mean (average) of all five results for that individual. The means showed statistically significant differences at the $p=0.0005$ level ($F\ [4,60] = 56.2$). The differences between the mean values for ESA, MDS and CDH were not statistically significant. Also the difference between the two means for CCH was not significant. However, the differences between the means for ESA, MDS, and/or CDH and the means for CCH were statistically significant. The q value for the two CCH means compared to the means of the other three laboratories was 10.63. The probably of a q this large being due to chance is less than o.001.

d. Analysis of Alcohol Swabs

Analysis of the amount of lead which could be leached from 17 final swabs used in cleaning the venipuncture site yielded from 9 to 334 ug lead. Cook County Hospital usually shows between 0.3 and 3 ug lead.

2. Blood Lead Results and ZPP Results

a. Relationship between Blood Leads and ZPPs (Table IV)

As will be explained in more detail in Section 5 c, it appears that the zinc protoporphyrin determination will have its greatest value in estimating the average blood lead over the three or four months preceeding the ZPP determination. Based on ZPP and blood lead determinations on 669 male workers taken from this and several other studies, the relationship

Blood Lead = 17.02 x logZPP + 14.14 (r = 0.86)*

This assumes a hematocrit of 42 percent.

Women showed a similar relationship, but ran a lower blood lead for a given ZPP. Based on 37 women the formula is:

Blood Lead = 19.08 x log ZPP + 1.81 (r = 0.74)†

The differences in slope and intercept for the two lines causes the predicted lead level for women to run about 10 ug lead/100 ml lower than the predicted level for men with the same ZPP.

In this study it was possible to calculate a regression line between an individual's ZPP and his average blood lead over the last six months for 33 men and for 11 women. The average blood lead was based on at least two determinations in the company's records and the NIOSH determination done by MDS. (The ESA determination which was made at the time of the study showed up in the company records.) Further, only workers who had worked at least six months were included. Formulas based on just the leads from this study were also calculated using the average of the two lead determinations.

b. Findings by Work Area

Table V gives average length of service, ZPP, estimated blood lead level, difference between observed and estimated blood lead, and 6-month average blood lead from the company data broken down by work area (cost center for hourly workers). The company data is for those workers included in the NIOSH study. It is of note that about half the workers with less than six months in the plant worked in Pasting, and about a third of those with blood leads 60 ug/100 ml or over were also to be found there. Other areas of note for blood leads 60 ug/100 ml or over were Casting, Maintenance and the inspectors in Assembly.

Overall, the average expected blood lead was close to the average actually observed and the average as found in the company records. Except for Maintenance and the inspectors in Assembly, the average blood lead was close to the averages found in the company records. (Note, however, that the company records involved only hourly workers.)

The office workers and laboratory workers were found to have lower blood leads than would be predicted from their ZPPs. The workers in Pasting and Maintenance and the inspectors in Assembly had higher blood leads than would be expected from thier ZPPs.

c. Blood Lead Data from Company Records

Table VI presents the results of the company's blood lead monitoring program for 1975, 1976, and January and February of 1977. The findings of the NIOSH study are included for comparison. Figures 1-5 present graphs of average blood lead and high and low values by Department from December, 1975 through April, 1977. These graphs show a general peaking of blood leads in late 1976, the earliest indication being the Maintenance Department in August, 1976. The generally higher blood lead values shown in January and February, 1977 in Table VI are a reflection of the same phenomenon.

3. Signs and Symptoms of Lead Toxicity

Table VII summarizes employees' complaints regarding work related health problems, and/or any other health problems. The symptomatologies were categorized into those which might be lead-related, either by the association given by the worker or because chronic exposure to lead is known as a possible cause of the problem; other job-related complaints not related to lead exposure; and non job-related complaints not likely to be related to lead exposure. No clear-cut group of symptoms was found to suggest current lead toxicity clinically. Table VIII compares ZPPs, predicted blood leads, observed blood leads, and the company records of blood lead of workers grouped by thier history of symptoms. Also shown are workers with less than 6 month's work in the plant. Those who gave a history of transfer because of an elevated blood lead had statistically significantly higher blood leads and ZPPs than the workers in general and higher blood leads than would be predicted from their ZPPs. Workers with less than 6 months in the plant showed statistically significantly lower ZPPs and higher blood leads than predicted. Their observed blood leads were higher than the blood leads for the study as a whole, possibly statistically significantly.

4. Inquiry into Treatment for Lead Poisoning

a. Review of Company Records

On the sheets showing blood lead monitoring results (without personal identifiers) 30 had notations indicating treatment for elevated blood leads, predominantly at Cook County Hospital. This cannot be considered a complete listing as the NIOSH study identified a few individuals who could not be represented by the notations but who gave a history of treatment of elevated blood leads. Table IV presents this data by month of initiation of treatment and by likelihood of the worker's blood lead being in excess of 60 ug/100 ml by the laboratory in use by the company in its monitoring program. It is of note that only 1 out of 30 could be expected to have had an acceptable blood lead level at the time of

treatment whereas 20 out of 30 could reasonably be expected to have had blood lead levels of 60 ug/100 ml or above. For the other 9 there was either no company data sufficiently close to the time of treatment to make a judgment as to probable level or although blood levels close to the time of treatment suggested acceptable levels, the individual had showed excessively elevated levels in the past and so might have been in excess of 60 ug/100 ml at the time of treatment.

b. Individual Case Review

The response in trying to review individual cases treated for lead poisoning was too poor to allow meaningful conclusions.

5. Medical Discussion

a. Interlaboratory Comparison

The data shows that Cook County Hospital's determination of blood lead levels differs significantly from that of the other three laboratories. This does not necessarily mean, however, that the other three laboratories are "right" and Cook County is "wrong", nor that Cook Court is "right" and the other three are "wrong". What it does mean is that different methods of running blood lead determinations and different methods of standardizing the readings lead to different results. The problem arises when the laboratory results are put to clinical use to aid in diagnosis of disease. It is common practice in medicine to ask the laboratory doing blood tests what its normal values are and what values are clinically important. For a fairly standard test the individual laboratories' "normals" are usually close to those which can be found in a published text on laboratory methods, but may not be exactly the same. Further, a major change in method may lead to an appreciable change in what is commonly considered as "normal".

This may well be the case here. Apparently the sum total of Cook County's method of analysis and standardization leads to higher lead readings than the methods of analysis and standardization used by the other three laboratories. This may mean that the upper limit of acceptable blood levels of 60 ug/100 ml as proposed by NIOSH is inappropriate when looking at blood leads analyzed at Cook County Hospital. One can also note that there has been a shift of method of analysis between the time that Dr. Kehoe (7) established 80 ug/100 g whole blood as the upper limit of safety and the time NIOSH recommended 60 ug/100 ml whole blood as the upper limit of acceptability.* In any case, the level is established by clinical experience relating signs and symptoms of illness or physiologic changes with the reported laboratory values. The difference between laboratories does need to be further investigated, but the resolution of

Two minor possibilities for explaining the difference were also considered. The fact that NIOSH investigators did not get the skin as free of lead before venipuncture as is usually done at Cook County Hospital does not seem a likely cause for the laboratory differences because one could reasonably expect the first tube drawn to be more contaminated than succeeding tubes. In fact, the first and last tube drawn were both done by Cook County Hospital and did not show a significant difference. In case the difference was caused by some contamination in the green stoppered tubes, some blank tubes were run. No lead was found.

b. Appropriateness of Treatment

Based on the very sketchy data available it is not possible to determine if treatment has been appropriate in workers said to have "lead poisoning". However, the review of the company lead monitoring results strongly suggest that the majority of workers with a notation indicating treatment for an elevated blood lead had unacceptably high blood leads at the time.

c. Use of ZPP in Helping to Assess Lead Exposure

Although ZPP levels appear to be related to blood lead levels and have proved valuable in the Childhood Lead Program run by CDC, their use in occupationally exposed adults as a screening tool has been fraught with difficulties. In the childhood program the question asked of the screening test is, "Has this child been exposed to lead in excess of the normal background amounts in soil and food?" As in most cases the answer is an unqualified "no", the screening level can be set low enough to virtually exclude false negatives (ZPP all right, lead too high). Further, as it is unlikely that the child will have a rapidly changing exposure, the ZPP, which changes more slowly, will adequately reflect the blood lead, which can change more rapidly.

In the occupational setting where we know the workers have been exposed to lead in excess of the normal background amounts, the question to be answered is, "Does this worker have an excessive blood lead level?" This difference in perspective is compounded with the possibility of fluctuating air-borne lead exposures with fluctuating blood lead levels. From what experience NIOSH has had with ZPPs, if the screening level is set low enough to eliminate false negatives, there will be so many false positives (ZPP higher than the screening level but blood lead within the acceptable range) requiring a blood lead that it would have proved easier to simply do blood leads on everyone in the first place.

The data on the relationship between ZPP and blood lead supports an interpretation that relates ZPP to the average blood lead level over the previous 3 or 4 months. The data on men is much better in this respect

than that on women, because we have considerably more data. The probable mechanism is that the lead in the bone marrow where the red cells are made interferes with the production of hemoglobin (the iron containing pigment in the red cells which enables them to carry oxygen). As a substitute, zinc protoporphyrin is built into the structure of the red cell and remains there until the red cell is worn out and removed from the blood in about 4 months. Assuming the lead moves into and out of the soft tissues (and bone marrow) fairly easily, the blood lead would be a good indication of lead levels in the soft tissues (although not necessarily at the same numerical value). Then ZPP, which reflects lead levels in the bone marrow during red cell production, will reflect average blood lead levels.

IV. SUMMARY AND CONCLUSIONS

Environmental

The environmental data (approximately 89 samples) collected during both surveys from the various departments indicates that a health hazard existed in five of the seven departments: Metal-alloy department, grid casting department, pasting department, cell assembly department, and the slyver/wrapping department (slyver operation has been discontinued).

There were many discrepancies in the design and installation of the ventilation system. Either there was no exhaust ventilation, or the exhaust ventilation had inadequate capture velocities. In several cases, exhaust ducts had become inadvertently disconnected.

Housekeeping appeared to be good in most areas except the pasting department. Excess paste from the pasting operation would fall on the floor and be carried to the other departments by the workers' boots or shoes.

Medical

Based on history, an evaluation of the company's blood lead monitoring data, and a survey of blood lead levels of the workers (including split samples), the following sequence of events appears to best explain the situation which caused concern at K & W Battery Division.

Although the company had a lead monitoring program, it was not as rigorous as could be desired, probably due to lack of clear direction. This allowed the effects of the bag house rupture to show up first with an increased number of workers being seen at Cook County Hospital with ill effects which could reasonably be attributed to lead. Judging from the spikes in the blood lead monitoring data, it is possible that the

until November, 1976. By the time NIOSH conducted its study, the bag house had been repaired, consultation had been obtained for the lead monitoring program, blood lead levels had begun to fall, and an apparent discrepancy between blood lead levels as obtained by the company and blood lead levels obtained at Cook County Hospital had come to light.

At the time of the NIOSH study about 13 percent of the 101 workers seen had blood leads in the 61-80 ug/100 ml range and 2 percent in the 81-100 ug/100 ml range. This is higher than would be expected in a well-run lead control program. However, no clearcut cases of lead toxicity were found in the workers on the job at the time of the study. ZPP readings suggested that the Pasting Department and some of the inspectors had higher lead levels than they had averaged in the past and that the office workers had run higher blood levels in the past than currently. Although office workers are not usually considered to have any appreciable exposure, they probably were affected by the bag house break through in the ventilation system.

NIOSH confirmed that lead determinations at Cook County Hospital were running significantly (statistically and clinically) higher than duplicate determinations done at three other laboratories. Due to differences in method and standardization techniques, it would appear appropriate for Cook County to develop its own clinical correlation between laboratory findings and disease diagnosis and treatment rather than utilize values published by others utilizing laboratory results based on methods more akin to those used by the other three laboratories utilized in this study.

V. RECOMMENDATIONS

Environmental

1. The grid casting furnace hoods should be closer to the furnace in order to more effectively capture the fumes.

2. The grid casting furnace should be enclosed on three sides to avoid splashing of molten metal when defective plates or ingots are added to the furnace.

3. The data collected in the grid casting department during both surveys indicates variability. Ergo, it is recommended that periodic monitoring be performed to determine the typical airborne lead concentration for this area. Subsequently, the proper engineering controls and respirator protection can be implemented.

4. The ventilation system should be periodically serviced and/or maintained in order to assure proper connections and operation

5. The ventilation system in the pasting department should be modified to include ventilation of the pasting process.

6. The pasting operation should be modified to eliminate the use of a hoe to fill the pasting machine hopper.

7. The pasting process should be modified to eliminate the manual removal of oxide paste from the collecting point between the pasting machine conveyers.

8. It is recommended that each of the burning stations be equipped with a permanent hood arrangement enclosed on three sides. The work bench could be mounted on a revolving pedestal. This would allow the operators to rotate the work rather than move themselves from front to back.

9. The existing wrapping stations' exhaust system should be replaced with down draft hoods equipped with side plenum chambers (see Diagram 1).

10. The curing ovens should be equipped with an additional exhaust fan. The exhaust fan could be turned on approximately one-half to one hour prior to anyone entering or unloading the ovens. This system should be under a 10 percent negative pressure.

11. Employees who assemble the plates in the cell assembly area should leave the plates stacked on the skid until they are needed rather than stack the plates on the down draft table.

12. Workers should be advised not to bend or break oxide plates anywhere except over the trash receptacles in order to minimize contamination.

13. Since respirator cartridges are replaced weekly, the workers should be advised that cartridges can become clogged with dust particulates before the filters are periodically changed; hence, a resistance to breathing may occur.

Medical

Because lead is eliminated from the body only very slowly, it requires only small amounts of excess absorption over a period of time to allow a worker to develop unacceptable blood lead levels. Therefore, the health of workers in lead plants can only be assured by a well-run lead monitoring program which samples both air levels and biologic levels, preferably blood lead. As pointed out by this study, attention to the laboratory doing the analysis is important.

1. Continued attention should be given to the lead monitoring program. If not already done, supervisory personnel should be included in the program.

2. ZPPs are not recommended for routine screening, although ZPPs or FEP (free erythrocyte protoporphyrin) levels may be of help in evaluating an individual's status in relation to the blood lead level.

3. Although current knowledge suggests that 60 ug/100 ml whole blood is an acceptable level for adults working with lead, it is probably not a safe level for the developing fetus. Women who are pregnant or intend to become pregnant in the future should be advised that the current state-of-the-art will not necessarily protect their fetus. They would be advised to limit their activities to areas of the plant where average blood leads are below 30 ug/100 ml, and then be especially careful of work practices to help assure as little exposure as possible.

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TABLE I

Comparison of Split Blood Lead Samples
within Individual Laboratories

K-W Battery Division
Skokie, Illinois
June 2-3, 1977

TA 77-18

Laboratory	Number	Mean Differences ug Pb/100 ml whole blood	Standard Deviation	Range
MDS	5	4.4	4.3	1 to 10
ESA	5	2.2	1.3	1 to 4
CCH	17	2.8	2.0	0 to 6
CCH First Tube minus Last Tube	17	+0.5	3.5	-6 to +5

TABLE II

Comparison of Blood Leads
ESA and MDS Laboratories

	Number	Mean ug Pb/100 ml whole blood	Standard Deviation	Range
Difference Between Laboratories	95	7.1	7.2	0 to 38
ESA minus MDS	95	+0.4	10.1	-29 to +38
First Tube minus Second Tube	78	+0.9	10.6	-26 to +38

TABLE III

Comparison of Split Blood Lead Samples
between Four Laboratories

K-W Battery Division
Skokie, Illinois
June 2-3, 1978

TA 77-18

Laboratory	Number of Workers	Mean Blood Lead ug Lead/100 ml whole blood	Mean Differences from Individual Mean	Sum of Squares of Mean Differences
ESA	13	41.5	-7.25	89.77
MDS	13	41.9	-6.78	455.56
CDH	13	41.7	-7.02	144.76
CCH - 1st Tube	13	59.9	+11.22	286.36
CCH - 2nd Tube	13	58.5	+9.83	310.39
Totals	65	48.7	0.00	

	Sum of Squares	Degrees of Freedom	Mean Square	F ratio
Category Means Mean Differences	4812.4	4	1203.1	
Within	1286.8	60	21.4	
Total	6099.2	64		= 56.2

TABLE IV

Comparison of ZPP-Blood Lead Regression Lines

K-W Battery Division
Skokie, Illinois
June 2-3, 1977

TA 77-18

Formula x logZPP + c slope onstant	Number	Mean LogZPP	Corresponding ZPP	Range	Mean Blood Lead	Range	Correlation Coefficient	Mean Square for Error	95% Confidence Limits of Slope
'.02 x logZPP + 14.14									
individual values averaged to 49 points)									
	49	1.8674	73.3	5.3-404.3	45.9	30.3-70.6	0.86	18.86	± 2.91
	669			+4 to +627		10 to 99			
3.03 x logZPP + 11.86 average)	33	1.9178	82.8	5-462	45.5	25.2-64.0	0.76	61.21	± 5.71
).08 x logZPP + 2.10	33	1.9178	82.8	5-462	46.4	24.2-93.5	0.76	99.48	± 7.28
).08 x logZPP + 1.81	37	1.9725	93.9	2-524	39.5	12-64	0.74	81.60	± 5.98
).47 x logZPP + 18.99 average)	11	2.0040	100.9	35-233	40.0	34.0-46.3	0.71	11.89	± 7.96
51 x logZPP + 24.99	11	2.0040	100.9	35-233	40.04	29.7-47.0	0.42	27.78	± 12.16

ug zinc protoporphyrin/100 ml whole blood with an assumed hematocrit of 42%.
d is in ug/100 ml whole blood.

TABLE V

ZPP and Blood Lead Levels by Work Area

K-W Battery Division
Skokie, Illinois
June 2-3, 1977

TA 77-18

Length of Service				NIOSH STUDY				COMPANY DATA
Mean Years in Current Job	Number with Less Than 6 Months in Plant	Mean ZPP#	Number with ZPP# Greater Than or Equal to 300	Mean Estimated Average Blood Lead@	Mean Observed Blood Lead@	Mean Observed Minus Estimated Blood Lead@	Number with Blood Leads@ Greater Than or Equal to 60	Mean of Individual Average of Blood Leads@ Jan-June, 1977
7.4	0	44.0	0	37.0	23.2	-13.8	0	-
3.1	1	69.8	0	44.7	32.1	-12.6	0	-
eneral								
2.2 (n=4)	0	157.4	1	46.6	41.1	- 5.5	1	-
00, 1426)								
4.5	0	44.5	0	42.2	43.1	+ 0.9	0	-
1.5	0	124.0	0	49.7	40.8	- 8.9	0	*
9, 0200)								
2.5	3	91.7	1	44.3	46.8	+ 2.5	2	42.4
0)								
0.3 (n=14)	8	104.3	2	42.3	55.3	+12.9	5	50.0 (n=14)
nt. 0350)								
3.6	0	132.6	0	42.7	42.3	- 0.4	0	42.3
0)								
0.7	2	65.8	0	39.7	45.6	+ 5.9	0	44.1
ost Cent. 0400)								
0.4	1	296.0	1	55.3	81.8	+26.5	2	53.8
ent. 0400)								
0.7	2	148.1	1	45.6	48.1	+ 2.4	1	50.0
10)								
3.9	0	116.0	1	43.8	40.9	- 2.9 (n=13)	0	39.2 (n=13)
10) & Finishing (Cost Cent. 0650)								
1.7	0	193.3 (n=3)	1	49.2 (n=3)	46.7	+ 0.3 (n=3)	1	42.4
1000, 1647)								
2.1 (n=2)	0	70.7	0	42.1	37.5	- 4.6	0	37.3
1600)								
3.0	0	202.7	1	51.1	63.5	+12.4	2	52.2 (n=2)
maires								
2.5 (n-85)	17	114.3 (n=90)	9	43.8 (n=90)	44.8	+ 1.0 (n=90)	14	45.0 (n=67)
tion 3.7		113.8		8.5	15.4	11.9		11.0
-	-	141.4	1	46.3	46.3	+ 4.5	1	45.3
-	-	116.5 (n=98)	10	44.0 (n=97)	44.9	+13 (n=97)	15	45.0 (n=77)
tion		118.6		8.4	15.0	11.6		11.6

mphumin/100 ml whole blood @Blood Lead in ug lead/100 ml whole blood *Value omitted as only one value

TABLE VI

Blood Lead Distributions, Since 1975

K-W Battery Division
Skokie, Illinois
June 2-3, 1977

TA 77-18

Blood Lead Values*	Company Data 1975 Number	%	1976 Number	%	Jan-Feb 1977 Number	%	NIOSH Study# June 2-3, 197 Number	%
Individual Readings								
0 - 40	54	28.8	90	32.5	11	24.0	43	42.6
41 - 60	83	44.1	123	44.4	12	26.0	43	42.6
61 - 80	38	20.2	54	19.5	17	37.0	13	12.9
81 - 100	10	5.3	7	2.5	2	4.3	2	2.0
101 and over	3	1.6	3	1.1	4	8.7	0	0.0
Total	188	100	277	100	46	100	101	100
High Reading*	140		120		129		93.5	
Low Reading*	17		11		30		15.5	
Average Reading*	53.3		48.3		60		44.9	
Yearly Averages for Individual Workers								
0 - 40	23	28.8	41	37.3	11	30.6		
41 - 60	42	52.5	57	51.8	11	30.6		
61 - 80	14	17.5	12	10.9	9	25.0		
81 - 100	1	1.2	0	0.0	2	5.6		
101 and over	0	0.0	0	0.0	3	8.3		
Total	80	100	110	100	36	100		
High Reading*	92		73		121			
Low Reading*	20		14		30			
Average Reading*	49.1		43.8		56.1			

*Blood Lead values are in either ug/100 grams whole blood or ug/100 ml whole blood The other is the older method of reporting, the latter the current method. Value

TABLE VII

Symptoms as Reported by Questionnaire

K-W Battery Division
Skokie, Illinois
June 2-3, 1977

TA 77-18

Workers with No Complaints		55
Workers with Any Complaints		36
Workers with Possibly Job-Related Complaints		30
Complaints Possibly Related to Lead Exposure		
Headaches	6	
Aching or Painfull Joints or Muscles	6	
Stomach Cramps, Other Stomach Problems, Weight Loss	5	
Kidney Problems	5	
Nervousness, Trouble Sleeping	2	
Weakness	2	
Job Transfer, Possibly for Lead	12	
Treatment Possibly for Lead	3	
Other Symptoms Possibly Lead Related	5	
Other Complaints, Not Lead Related	1	
Non-Job Related Complaints		9
Total		91

TABLE VIII

ZPP and Blood Lead Level by Work History and Medical History

K-W Battery Division
Skokie, Illinois
June 2-3, 1977

TA 77-18

th of ears in nt Job	Service Number with Less Than 6 Months in Plant	Mean ZPP#	Number with ZPP# Greater Than or Equal to 300	NIOSH STUDY Mean Estimated Average Blood Lead@	Mean Observed Blood Lead@	Mean Observed Minus Estimated Blood Lead@	Number with Blood Leads@ Greater Than Or Equal to 60	COMPANY DATA Mean of Individual Average of Blood Leads@ Jan-June, 1977
ead intoxication. No history of transfer for elevated lead. No possible treatment for elevated blood lead levels.								
.7	14	95.6	7	42.3	41.5	-0.7	5	42.3
.0 (n=61)		98.5 (n=61)		8.6 (n=61)	14.1	11.5 (n=61)		9.7 (n=42)
ted.to lead intoxication. No history of transfer for elevated lead. No possible treatment for elevated blood lead levels.								
.4	2	112.0	1	45.4	48.6	+3.3	3	46.7
.1 (n=14)		90.6		6.6	15.3	12.8		10.3 (n=12)
vated lead. No symptoms suggestive of lead intoxication. No possible treatment for elevated blood lead levels.								
.9	1	244.1	3	51.4	61.6	+10.2	4	53.4
=7)								(n=7)
vated lead. Some symptoms possibly related to lead intoxication. No possible treatment for elevated blood lead levels.								
.2	0	161.7	0	47.5	46.9	-0.6	0	56.5
fer for elevated lead, but no other treatment for elevated blood lead levels.								
.0	1	221.6&	3	50.3	57.6*	+7.3*	4	54.4
.0 (n=10)		167.4&		7.8	16.7	11.4		11.4 (n=10)
ated blood lead levels. One with possible symptoms related to lead intoxication. One with history of transfer for								
							0	44.2
.2	0	92.7	0	43.2	45.4	+2.2		16.7
.2		116.6		9.8	15.6	13.4		
ionnaires).								
							14	45.0
.5	17	114.3	9	43.8	44.8	+1.0		11.0 (n=67)
.7 (n=85)		113.8 (n=90)		8.5 (n=90)	15.4	11.9 (n=90)		
nths in Plant.								
							5	45.7
.2	17	67.3&	1	40.3	52.9¢	+12.6*		10.7 (n=16)
.1		81.1		9.4	16.1	11.4		
.1	0	125.2	8	44.6	42.9	-1.6	9	44.7
.0 (n=73)		117.9 (n=73)		8.2 (n=73)	14.7	10.3 (n=73)		11.2 (n=51)

rin/100 ml whole blood
ml whole blood
y different from the rest of the categories, $p<0.05$.
nificantly different $0.01 > p > 0.05$.
y different ($p<0.05$) when log ZPP is used. In the case of workers with less than 6 months in the Plant the p for
05. With the variances between the two groups being, this unequal, the statistical test for significance between
pted with caution.

TABLE IX

Partial List of Month of Treatment for
Lead Poisoning from Company Records

K-W Battery Division
Skokie, Illinois
June 2-3, 1977

TA 77-18

Month	Blood Lead Likely to be Over 60 ug/100 ml*	Probable Blood Lead Not Determinable from Company Records#	Blood Lead Likely to be less Than 60 ug/100 ml@
July, 1976	0	1	0
August, 1976	0	0	0
September, 1976	0	0	0
October, 1976	3	0	1
November, 1976	1	1	0
December, 1976	6	2	0
January, 1977	5	3	0
February, 1977	4	1	0
March, 1977	0	1	0
No Date	1	0	0
Total	20	9	1

*Blood leads recorded for the month indicated or for the month or two before the month indicated were in the upper 50s or higher.

#No blood leads were recorded close to the month indicated or lead values close to the month indicated were not excessively high, but the worker had shown high levels in the past.

@Blood lead levels close to the indicated month were so low as to suggest that an excessively elevated level would be an isolated finding, at most, which would not be sustained on a repeat determination.

Table X

Summary Record of Personnel
Airborne Lead Concentration

K & W Battery Plant
Skokie, Illinois

May 18 - 19, 1977

Date	Period (Hrs)	Volume (Liters)	Location & Description	Lead Concentration (mg/M^3)[1] Actual Exposure	Extrapolated 8 Hour TWA
5/18	6.4	576	Casting Machine Operator	0.11	0.09
5/18	5.8	522	Casting Machine Operator	0.14	0.10
5/18	5.7	513	Casting Machine Operator	0.17	0.12
5/18	6.7	585	Ingot Melting	0.09	0.08
5/18	5.5	495	Ingot Melting	0.09	0.06
5/18	5.5	495	Pasting Department	0.35	0.24
5/18	5.4	486	Paste Mixer	0.51	0.35
5/18	5.3	477	Pasting Department	0.78	0.51
5/18	5.3	477	Pasting Department	0.33	0.22
5/18	5.8	522	Pasting Department	0.52	0.38
5/18	5.7	513	Intermidiate Pasting/Wrapping	0.80	0.57
5/18	5.7	513	Wrapping Department	0.19	0.14
5/18	5.7	513	Wrapping Department	0.33	0.24
5/18	5.5	495	Wrapping Department	0.22	0.15
5/18	6.0	540	Supervisor	0.12	0.09
5/18	5.9	531	Set-up	0.28	0.21
5/18	5.1	459	Group Leader	0.22	0.14
5/18	5.0	450	Burning Line	0.24	0.15
5/18	5.7	513	Trayer in Sealing Area	0.07	0.05
5/18	5.6	504	Sealing Department	0.04	0.03
5/18	4.5	405	Sealing Department	0.05	0.03
5/18	5.2	468	Intercell Connector	0.11	0.07
5/18	5.1	459	Small Parts	0.05	0.03
5/18	5.1	459	Small Parts	0.03	0.02
5/18	3.9	351	Finishing	0.03	0.01
5/18	--	--	Blank	N.D.	N.D.
5/18	--	--	Blank	N.D.	N.D.
5/19	6.9	621	Casting Machine Operator	0.08	0.07
5/19	7.5	675	Pasting Feed Operator	0.37	0.35
5/19	7.7	693	Paste Mixer	0.23	0.23
5/19	7.6	684	Group Leader	0.14	0.13
5/19	7.6	684	Intercell Connector	0.17	0.16
5/19	3.9	351	Sealing Department	0.04	0.02
5/19	7.5	675	Pasting Department	0.76	0.71
5/19	3.5	315	Casting Small Parts	0.03	0.01
5/19	1.3	117	Pasting Department	5.81	0.94
5/19	7.6	684	Burning Line	0.18	0.17
5/19	7.4	666	Pasting Department	0.44	0.40
5/19	7.5	675	Burning Line	0.13	0.12
5/19	7.4	666	Alloy & Melting Department	0.12	0.11
5/19	7.5	675	Casting Machine Operator	0.41	0.38
5/19	7.5	675	Casting Small Parts	0.05	0.05
5/19	7.5	675	Inspection burn Line #2	0.32	0.30
5/19	7.4	666	Burning Line #2	0.12	0.11
5/19	7.2	648	Maintenance Man	0.06	0.05
5/19	3.2	288	Pasting Department	1.04	0.42
5/19	7.5	675	Pasting Department	0.25	0.23
5/19	7.3	657	Pasting Department	2.31	2.11
5/19	7.0	630	Pasting Department	0.90	0.79
5/19	7.0	630	Pasting Department	0.19	0.16
5/19	7.0	630	Sealing Department	0.02	0.02
5/19	7.1	639	Casting Machine Operator	0.12	0.11
5/19	6.8	612	Casting Machine Operator	0.10	0.09
5/19	6.6	594	Slyver Wrapper	0.13	0.11
5/19	6.5	585	Plate Wrapping	0.58	0.47
5/19	--	--	Blank	N.D.	N.D.

1) mg/M^3 - milligrams of contaminant per cubic meter of air by volume
2) N.D. - None Detected

TABLE XI

Summary Record of Airborne Lead Concentration
K & W Battery Plant
Skokie, Illinois
August 11-12, 1977

·s)	Type Sample	Volume(liters)	Location & Description	Lead Concentration(mg/M^3)[1] Actual Exposure	Extrapolated 8-hour TWA
	P[2]	198	Intercell Connector	0.06	0.02
	P	234	Casting Machine Operator	0.01	0.004
	P	243	Casting Machine Operator	0.04	0.01
	P	243	Pasting Department	0.12	0.04
	P	243	Pasting Department	0.30	0.10
	P	243	Pasting Department	0.13	0.04
	P	252	Pasting Department	0.13	0.05
	P	360	Pasting Department	0.28	0.14
	P	585	Intercell Connector	0.03	0.02
	P	594	Casting Machine Operator	0.07	0.06
	P	594	Casting Machine Operator	0.05	0.04
	P	612	Pasting Department	0.16	0.13
	P	612	Pasting Department	0.96	0.82
	P	594	Pasting Department	0.47	0.39
	A[3]	387	Laundry Room	0.04	0.02
	A	279	Lunch Room	0.02	0.01
	Blank	-	-	N.D.[4]	N.D.
	Blank	-	-	N.D.	N.D.

---

igrams of a contaminant per cubic meters of air by volume
sample
ole
etected

Blood Lead Levels by Department 1976-1977
(from company data)

K-W Battery Division
Skokie, Illinois
June 2-3, 1977

TA 77-18

Figure 1

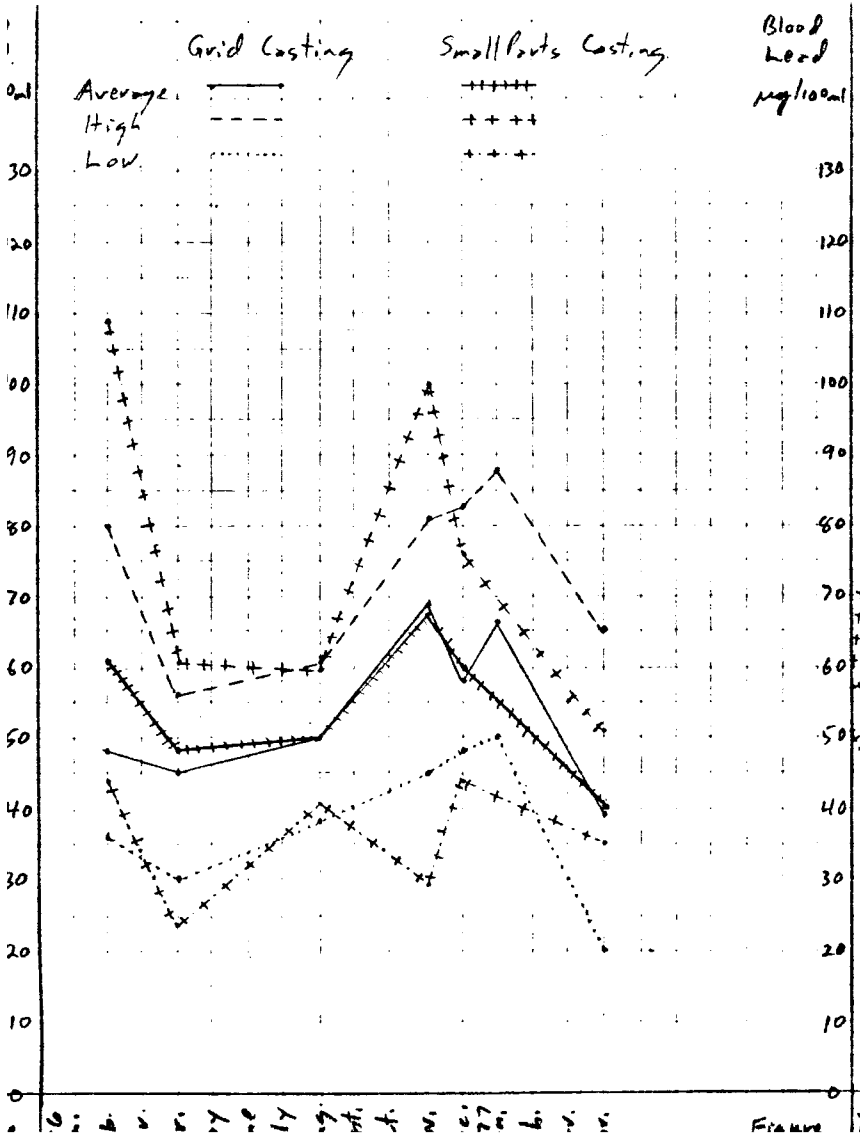
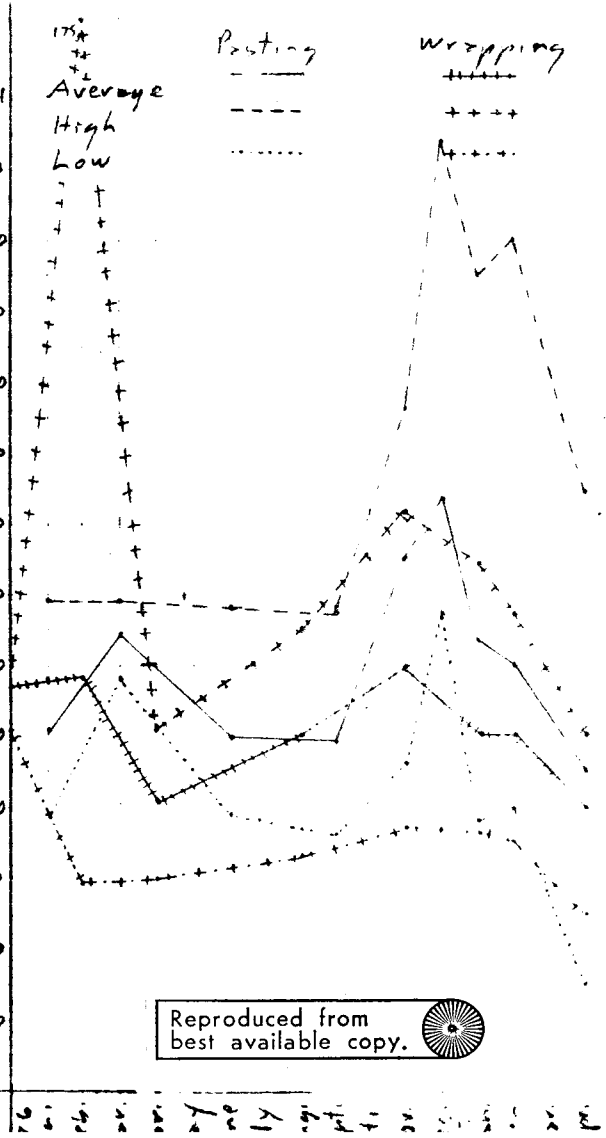


Figure 2



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Blood Lead Levels by Department 1976-1977
(from company data)

K-W Battery Division
Skokie, Illinois
June 2-3, 1977

TA 77-18

Figure 3

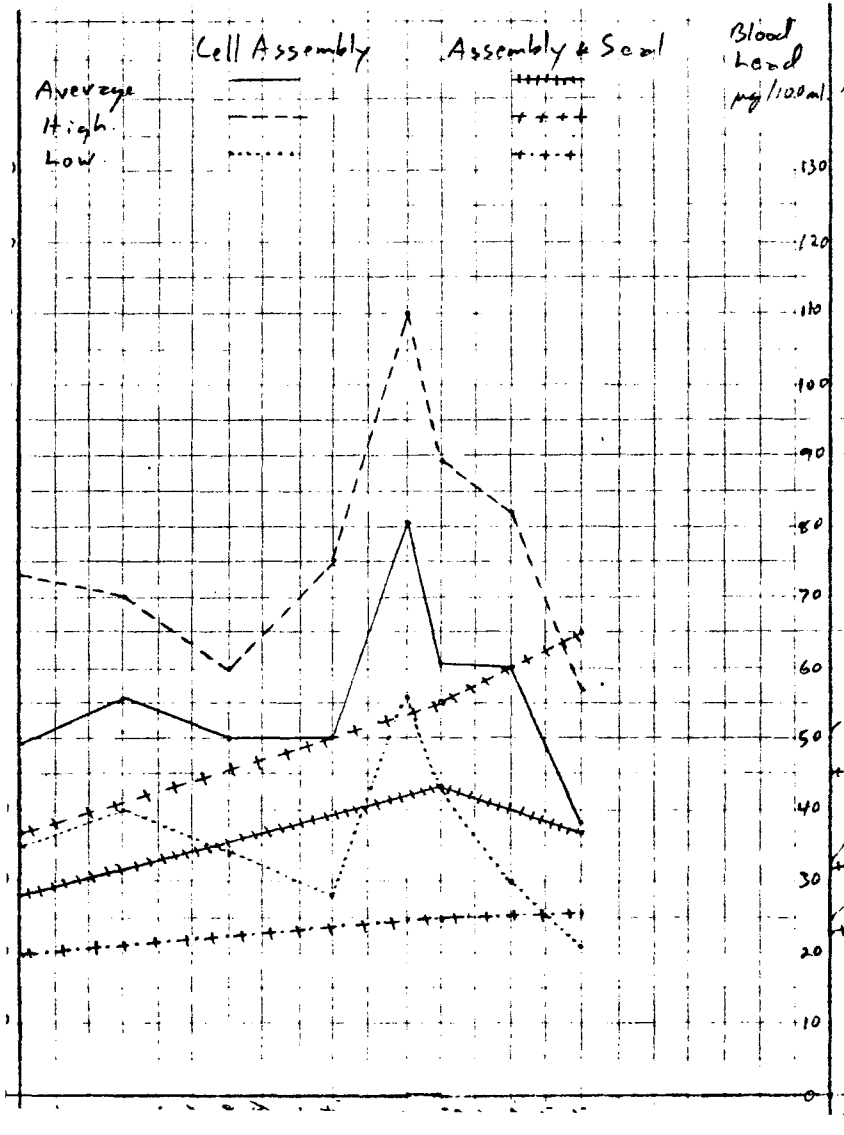


Figure 4

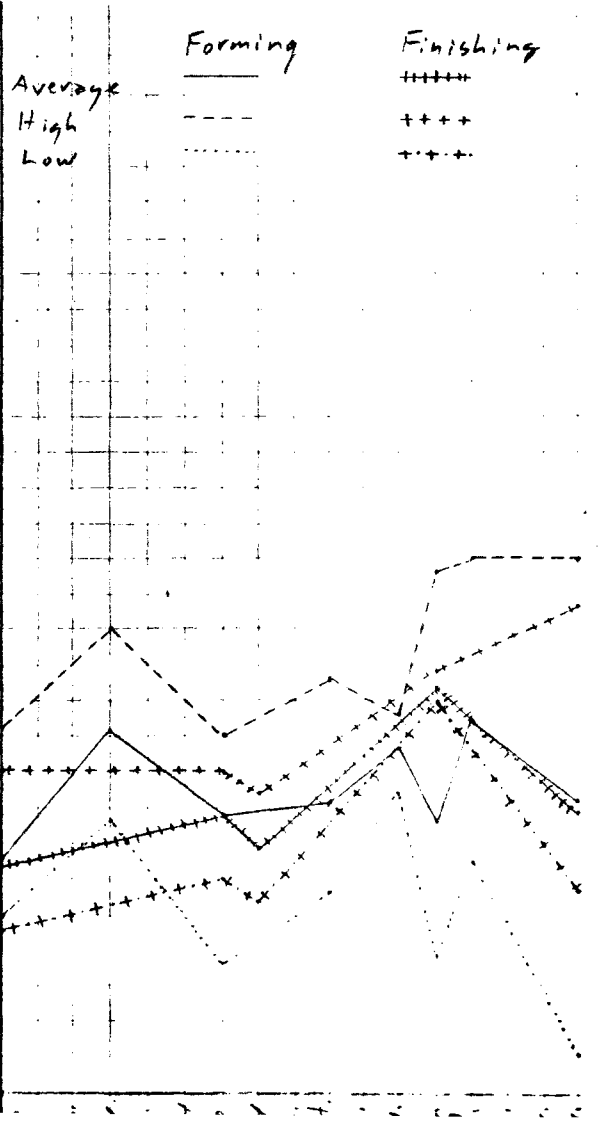


Figure 5

Blood Lead Levels by Department 1976-1977
(from company data)

K-W Battery Division
Skokie, Illinois
June 2-3, 1977

TA 77-18

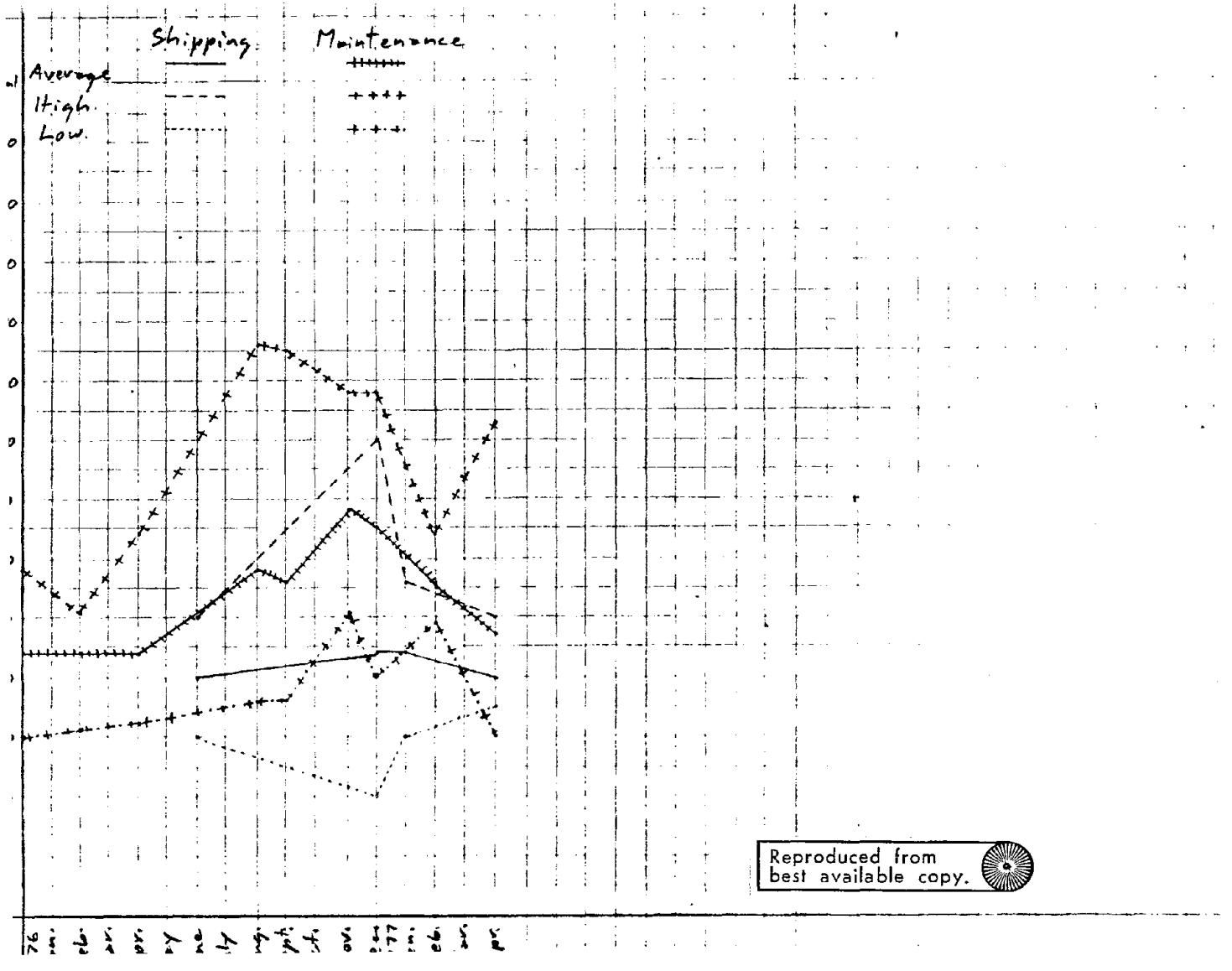
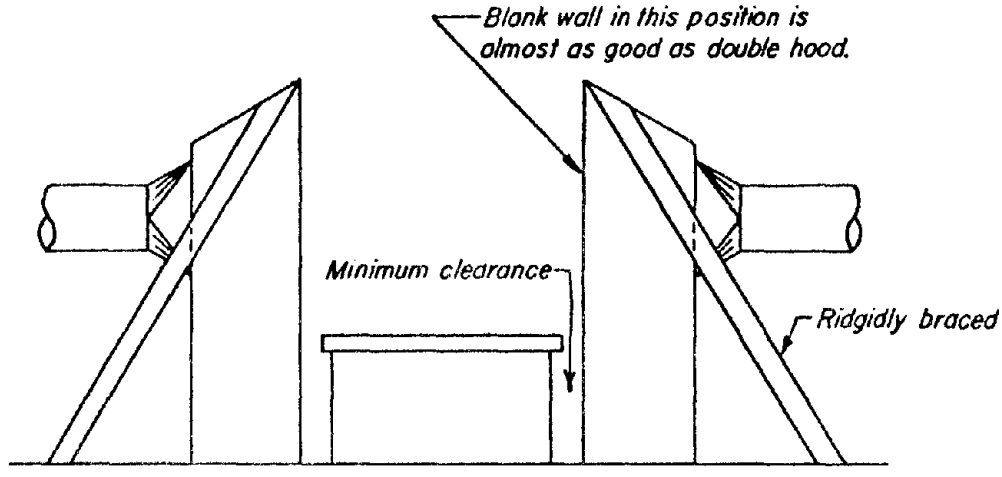


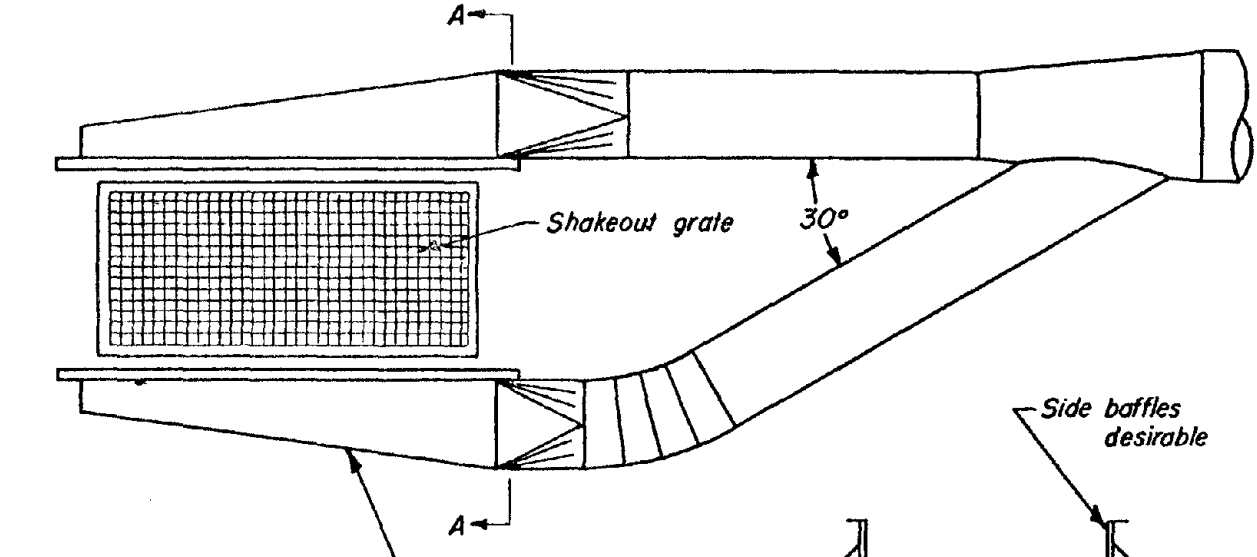
Diagram 1

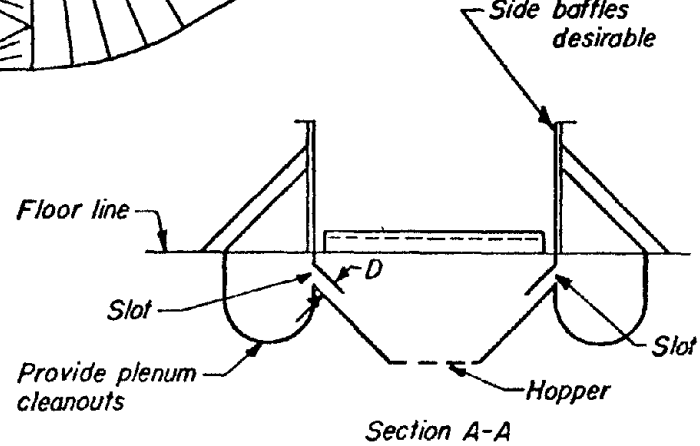
SPECIFIC OPERATIONS



DOUBLE SIDE-DRAFT

Proportions same as single side-draft hood except for overhang.





Section A-A

DOWNDRAFT HOOD

Slots sized for 1500 - 2000 fpm
Duct velocity = 4000 fpm minimum

AMERICAN CONFERENCE OF

APPENDIX A

U.S. DEPARIMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
4676 Columbia Parkway
Cincinnati, Ohio 45226

KW Battery Division
Westinghouse Electric Corp.
Skokie, Illinois

TA 77-18

Consent Form:

I _____, age _____ voluntarily agree to participate in a blood lead evaluation being conducted jointly by the National Institute for Occupational Safety and Health (NIOSH) and the KW Battery Division of Westinghouse Electric Corporation, Skokie, Illinois (KW) to try to resolve a problem of widely differing laboratory results which have been reported on a number of workers at KW. This evaluation is conducted under the authority of section 20(a)(6) of the Occupational Safety and Health Act and in accordance with Federal regulations (42 Code of Federal Regulations Part 85a). I understand that first I will be asked questions about my current and past health and about my work. I understand that I will be asked to provide a small amount of blood which a NIOSH investigator will draw from my arm by a needle. This may cause small discomfort but involves little or no risk to health. The benefit to me is that any blood specimen that I provide will be analyzed by both NIOSH and KW to allow comparison of results, and the results will be sent to me. I understand that at any time during the evaluation I have the right to ask questions of NIOSH and tha I am free to withdraw my consent and to discontinue participation in the evaluati at any time without prejudice to myself.

All information gathered in this evaluation will not be disclosed in a manne which will identify me except with my written permission or except as required by law. The information will be used by NIOSH primarily for purposes of this evalua tion of blood lead levels, and also for occupational health research. The information will be used by KW as part of their ongoing lead monitoring program.

Signature _____ Date _____

____ I do not want to take part in this evaluation, but NIOSH may draw my blood for analysis by KW as part of their lead monitoring program. KW (may ___, may not ___) release my individual results to NIOSH.

Signature _____ Date _____

I want to take part in this evaluation, but do not wish to have NIOSH draw

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
4676 Columbia Parkway
Cincinnati, Ohio 45226

KW Battery Division
Westinghouse Electric Corp.
Skokie, Illinois

TA 77-1E

SUBJECT IDENTIFICATION

CASE NO. ☐☐☐☐ ☐

LAST NAME: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

FIRST NAME: ☐☐☐☐☐☐☐☐☐☐☐☐

MIDDLE INITIAL: ☐

ADDRESS: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

CITY: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

STATE: ☐☐ ZIP CODE: ☐☐☐☐☐

PERSONAL DATA

1. TELEPHONE: ☐☐☐ – ☐☐☐ – ☐☐☐☐
   AREA CODE

2. RACE/ETHNIC CODE: ☐
   1. White, not of Hispanic Origin
   2. Black, not of Hispanic Origin
   3. Hispanic
   4. American Indian or Alaskan Native
   5. Asian or Pacific Islander
   6. Other

3. SEX: 1. Male 2. Female ☐

4. What is your date of birth? (month/day/year) ☐☐ – ☐☐ – ☐☐

5. Do you have any health problems which you think are related to your job:

Yes _____ No _____

If yes, describe what they are, how often you have the problem(s) and anything special which is likely to make the problem(s) better or worse.

_____

_____

_____

_____

Have you seen a doctor for these problems? Yes ___ No ___

Which ones? _____

6. Do you have any other health problems not necessarily related to your job?

Yes _____ No _____

If yes, describe: _____

_____

_____

_____

Have you seen a doctor for these problems? Yes ____ No ____

Which ones? _____

7. Have you ever been treated for lead poisoning or anemia ("low blood")?

Yes ____ No ____ If yes:

Date	Treating Doctor	Hospital (if Hospitalized)	Type of Treatment and how long (pills, shots, etc.)
_____	_____	_____	_____

8. Have you ever taken any pills to prevent lead poisoning or to treat "mild" or "slight" lead poisoning? Yes ____ No ____

How many treatments? _____

When was the last time? _____

Who usually gave you the pills?

The Company Doctor _____

Another medical doctor _____

Soneone other than a medical doctor without you having seen a doctor first? _____

9. Have you ever been treated for kidney problems or been studied by a doctor for kidney problems? Yes _____ No _____

0. EMPLOYMENT HISTORY

a. Date Hired: Month _____ Year 19 _____

b. Current Department: _____ How Long? Months ____ Years __

c. Current Job: _____ How Long? Months ____ Years __

d. Have you ever been transferred to a different job because of a high blood lead? ..... 1 __ Yes 2 __ No

__ Not Sure

e. Please list the jobs you have held in this plant:

	Job Category	Dept.	Dates or number of months and years	Lead Exposure (check one) High	Intermediate	Low	None
Present Job							
Previous Job							
Other Jobs							

f. Please list any work you have done other than in this plant in the past three years:

Type of Work	Dates or number of Months	Lead Exposure (Check one)			
		High	Intermediate	Low	None

g. If you were not working anywhere for more than a month in the past three year please give the dates you were out of work.

_____

_____