MICHIGAN'S occupational health

Volume 10, No. 3

MICHIGAN DEPARTMENT OF HEALTH
Albert E. Heustis, M.D., Commissioner

SPRING 1965

Two Studies of Lead Exposure . . .

Torch-cutting of Leaded Steel Plate—The Casting of Lead-bearing Steel

The torch-cutting of ordinary steel plate has always presented a ventilation problem, as have the various operations involved in steel casting. But when lead enters into the picture, as it has with the increasing use of leaded steel, the problem is compounded even further. The easy-machining properties of the leaded steels are undeniable—so it's not likely that the use of leaded steel will decrease in the near future. We must recognize the health hazards it presents and remain aware of them so we can deal with such hazards realistically. The following two case studies provide some perspective on the problem.

So far as general background on this topic is concerned, the hazards inherent in the manufacture of leaded steels have been reported in the literature[1, 2, 3]. Procedures for ventilation control, and methods for medical supervision of workers with potential exposure to lead fume, have been established for the primary producers of leaded steel. A study involving atmospheric lead levels and the urinary lead levels of workers (in the manufacture of stainless steel with a 0.25 percent lead content) was reported from the state of Indiana[4]. A prior reference to the pouring of leaded steel castings in Michigan was published in an earlier issue[5]. The significance of lead exposure as a hazard to health, as well as recommendations for medical and ventilation control, have been amply presented in the literature.

An article reviewing many of the operations encountered in Michigan, including recommendations for control, appeared in a 1957 issue of this publication[6]. A 1959 issue[7] presented information on the various clinical tests and guidelines necessary for an effective medical control program. No attempt will be made to duplicate any of this information here. An Industrial Hygiene Guide on lead and its inorganic compounds is available[8].

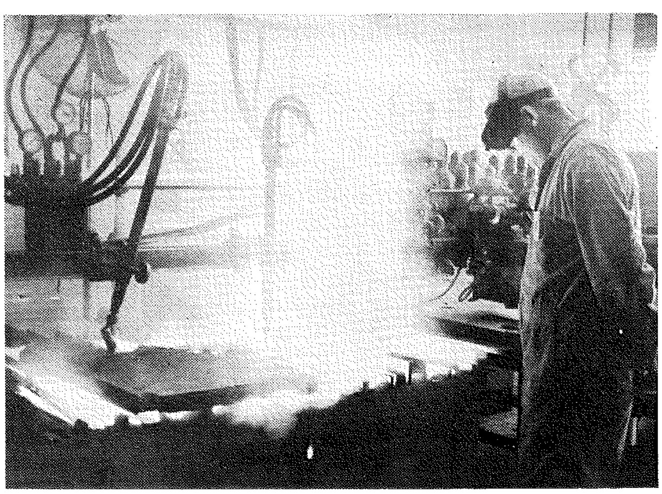
But the purpose of this article is to report on two actual investigations of operations presenting lead-fume exposures. One involves the flame-cutting of leaded steel plate; the other involves the casting of lead-bearing steel. Each investigation will be discussed separately to retain clarity.

FLAME-CUTTING OF LEADED STEEL PLATE

The division was recently requested to evaluate the lead exposure involved in an experimental flame-cutting operation involving leaded plate. The plant visited was that of a company engaged in steel sales and warehousing. Seventeen employees in the plate department were directly or indirectly involved with the possibility of exposure to fumes created at the burning operations.

See LEAD—Page 2

BEFORE



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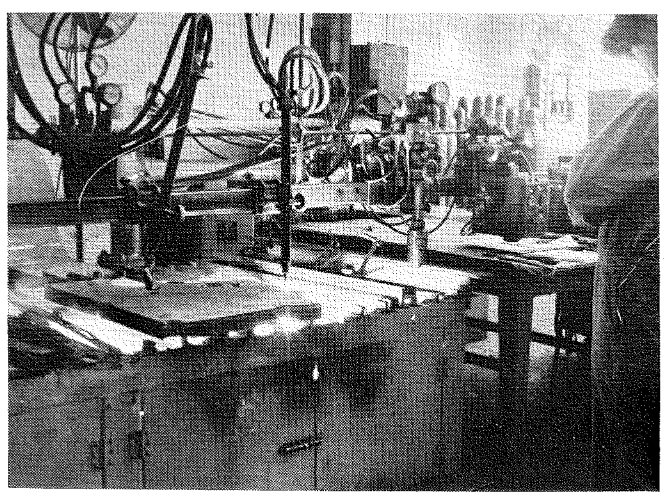


Figure 1.

(A) Leaded steel flame-cutting operation is shown with ventilation turned off, to simulate the pre-ventilation condition.

(B) The leaded steel flame-cutting operation is shown here with down-draft ventilation system in operation.

LEAD—Continued

Leaded steel plate improves the machinability of steel with no loss of the mechanical properties of the base steel. One manufacturer states that the addition of lead increases cutting speeds up to 50% and tool life from 50-300% while improving the finish of the machined part. According to Baumann[2] et al a normal lead content of from 0.15 to 0.35% lead, properly distributed throughout the steel imparts the free machining properties. Leaded steel plate is presently sold under various trade names, such as "E-Z Cut 20 L," "Lectro-Led," and "Ledloy." AISI designations are 4140, 4147/50, 8620 for leaded steels. Such plate may be obtained in thickness from 1½″ up to 8″, and in widths up to 84″ and possibly wider. Length is usually 20 feet. Although the burning or melting of leaded-steel rod or bar stock may present an unrecognized lead hazard (as will be revealed in the steel foundry incident to be related in the second part of this article) it is believed that the major problems may be encountered in the flame cutting of leaded-steel plate.

TABLE II
INTERPRETATION OF BIOLOGICAL LEAD SAMPLES

Urine lead mg/liter		Blood lead mg/100 gm.	
0.01 to 0.06	Non-occupational Normal lead absorption Re-check: 4 to 8 weeks	0.02 to 0.04	Non-occupational Normal lead absorption
0.06 to 0.15	Occupational Normal lead absorption Re-check	0.04 to 0.07	Occupational Normal lead absorption Re-check: 4 to 8 weeks
0.15 to 0.20	Occupational Hazardous lead absorption Re-check: 2 to 4 weeks	0.07 to 0.08	Occupational Hazardous lead absorption Re-check: 4 to 8 weeks
0.20 Plus	Occupational Absorption compatible with lead intoxication Recommend Blood lead test, Hemoglobin and Erythrocyte count Routine urinalysis Physical examination Recheck: 1 to 4 weeks	0.08 Plus	Occupational Absorption compatible with lead intoxication Recommend immediate re-check and removal from lead exposure area and physical examination

The following test procedure was employed to evaluate the operation at this plant.

Using a Number-2 National Cylinder Gas Template burning machine, lengthwise cuts were made in a 4-inch thick plate of #4140 alloy about six feet by seven-and-one-half feet in rectangular dimension. Two to three such cuts were made while air samples were taken at locations which would indicate the extent of exposure to the operator and any others in the immediate vicinity. Simultaneous samples were obtained with an electrostatic-precipitation air sampling device by the health department personnel present and by the industrial hygienist of the company's insurance carrier. Results are reported in Table I.

Inquiry at the time of the study revealed that the flame temperature was 4200-4400° F. Rate-of-travel of the torch was determined to be 6¾ to 7 inches-per-minute. The nominal lead content of this plate was 0.18%.

It is recognized that various uncontrollable factors such as cross-drafts, the employee's visual ability, etc. require his location to be nearer to or farther from the source of the contaminant, and that varying composition in relation to lead content, production volumes, etc. all will increase or decrease the extent of potential hazard in such an operation. But with these factors and the results of the study in mind, the following recommendations were made to the company.

1. Establish a central ventilated area for the cutting of leaded plate.

2. Establish a routine clinical testing program for lead absorption to insure the adequacy of ventilation control. (The relative biological significance of high lead levels may be interpreted from Table II.)

TABLE I
EXPOSURES IN VICINITY OF FLAME-CUTTING MACHINE

Sample Number	Location & Remarks	Lead Concentration Milligrams of lead/cubic meter of air*
1	General air sample — south end of table representative of operator's breathing zone.	1.7
2	General air sample — west side of plate being cut. Representative of fume escaping under the plate and generally contaminating this area.	1.4
3	General air sample — obtained approximately 6′ from the cutting heads performing a double cut. Sampler head approximately 40″ above floor level.	0.45
4	As above — single cut.	2.2
5	As above — single cut.	0.40

* Threshold limit value (Michigan) is 0.15

The management people decided that a properly vented template burning machine and a vented area for the burning of rectangles would adequately control their fume problem. Figure 1 (A and B) dramatically illustrates the "before" and "after" of adequate ventilation at the torch-cutting operation. Figure 2 (on page 8) is a drawing of the ventilation configuration employed. This drawing shows recommended practice[9].

STEEL FOUNDRY – LEADED STEEL CASTINGS

The particular foundry involved has a total employment of 150 men. Thirty-four employees are involved in the leaded steel operations with varying degrees of exposure possibility. Melting is by means of electric furnaces and the primary products are alloy steel castings. Lead is added to certain castings in order to produce a free-machining casting. To obtain a casting with a nominal 0.25% lead content the melt is inoculated with 0.5% lead. The balance of the lead is lost during melting and pouring. In anticipation of their work with lead the foundry management requested advice from the district health engineer in whose area they are located. Production volume was expected to vary from one-day-per-week to one-day-per-month.

Blood lead levels of workers that would be involved in the leaded steel work were obtained in order

TABLE NUMBER III
FOUNDRY EMPLOYEE BLOOD-LEAD SAMPLES BY JOB DESIGNATION

Employee Job Designation	March '61	June '61	October '61	February '62
	Lead concentration in Milligrams of lead per 100 grams of blood			
A Crane operator	0.04	0.07	0.04	0.05
B	0.06	0.06	0.05	—
C Skimmer	0.05	0.05	—	0.03
D Metal pourer	0.08	0.08	0.06	0.06
E Pouring-laborer	0.07	0.03	—	—
F Laborer	0.06	—	—	—
G Skimmer	0.06	0.04	—	0.03
H Laborer	0.04	0.05	—	—
I Pourer	0.06	0.08	0.03	0.05
J Pourer	0.04	0.06	0.02	—
K Pourer	0.04	0.05	—	0.02
L	0.07	—	—	—
M Crane operator	0.05	0.04	0.04	—
N	0.06	—	—	—
O Crane operator	0.05	0.06	0.03	0.03
P	0.04	—	—	—

to have a base-line with which to compare later samples. These results and those of three later blood-lead sampling studies are presented in Table III. Table II again provides perspective in interpreting the data of Table III by indicating the relative seriousness of biological lead contamination in humans. It is interesting to note that the first series of blood level determinations revealed concentrations indicative of "high normal" to "occupational exposure" levels of lead. It is presumed that this lead contamination came from the routine melting of scrap steel.

Table IV reports the lead-in-air concentrations at various operating positions in the plant, right after the start of the leaded-steel casting.

Following the evaluation of this information the recommendations below were presented to the plant management.

1. Provide respiratory protection for all employees involved in handling leaded steel, and any other employees (such as crane operators) who are required to be in the area during the pouring operations.

2. Provide the arc-air operator with a clean air supply to his welding helmit.

3. Provide local exhaust ventilation at the arc-air operation.

4. Establish a regular routine schedule of blood-lead determinations. (At this time it was suggested that the blood samples be repeated in 3-4 months depending on leaded-steel production).

For full-time production volume the inoculating and pouring operations should be provided with adequate exhaust ventilation control.

At the time of the second blood-lead study following application of the suggestions above, many of the exposed workers still showed increased blood levels and two employees were above the 0.08 mg. lead per 100 grams of whole blood. In order to reverse this trend several additional recommendations were made to tighten up on the control program.

1. Make a concerted effort to assure that all employees exposed to lead fume are supplied with clean respirators in good repair.

2. Supervision must insist that all employees involved wear their respirator during the operations offering exposures and for one-half hour following these operations.

These latter measures have proven effective. Blood lead samples obtained ten months after the first series and again at approximately one year following the original series indicated that all samples were below 0.06 mg. lead per 100 grams of whole blood. The arithmetic averages of the latter results (which included some new employees as well as the original study group) were both 0.03 mg. of lead per 100 grams of whole blood.

The following on-going medical control program is now in effect in this plant.

1. All new employees are given blood tests for lead before being placed on a leaded-steel job in order to obtain a base-line before occupational exposure.

2. All employees in the lead exposure area are re-sampled every three to four months, depending on the quantity of leaded steel poured. This interval may be extended to six months if evidence indicates that the respirator program is effectively minimizing lead fume inhalation. Other employees in the area who may breathe lead fume or dust intermittently are sampled annually.

3. It was further recommended that all workers with blood levels equal to or greater than 0.06 milligrams of lead per 100 grams of whole blood should be retested on a monthly basis.

4. When two samples from any worker exceed 0.08 mg. lead per 100 grams of whole blood he is to be removed from exposure, rechecked monthly and returned to his former position only when the

See LEAD—Page 8

TABLE NUMBER IV
LEAD-IN-AIR CONCENTRATIONS AFTER START OF LEADED STEEL CASTING

Operation	Milligrams of lead per cubic meter
Addition of lead to the steel	146.0 (3 min. sample)
Pouring metal into molds	1.6
Cutting sprues & risers	
(a) acetylene-oxygen torch	trace
(b) arc-air cutting	1.0
General air samples	
Crane cab—during pouring operation	0.35
Crane cab—10 minutes after pouring	0.06
Molding area—opposite molds being poured and for 3 minutes following	0.32
Molding area—same location as above. Immediately following to twenty minutes after the pour	0.29
Molding area—45 minutes following pouring	trace
Molding area—60 minutes following pouring	trace
Molding area—105 minutes following pouring	none

Control of Methyl Bromide in Cereal Leaf Beetle Extermination

The morning of July 17, 1962, probably began for members of the Michigan Department of Agriculture as just another hot summer day filled with familiar activities. But that day in 1962 will long be remembered as the day the cereal leaf beetle was found and identified near the community of Galien, in Berrien County, Michigan.

As they say — one thing leads to another. Discovery of the beetle called for a means of fumigating grain crops — and this, in turn, called for control measures for guarding human health against the fumigant. That's what this story is about.

Today, Agricultural regulatory officials of Michigan, Ohio and Indiana, along with United States Department of Agriculture resources, are actively engaged in a quarantine and pest control program involving 33 Michigan counties, 18 Ohio counties and 33 Indiana counties, to control one of the most serious pests of small grains and many grasses ever to be introduced into North America. This insect occurs throughout most of Europe extending into Siberia and the U.S.S.R. It is also recorded in Morocco and Tunisia in North Africa and Iran and Turkey in the Near East. In some areas losses from infestations have been estimated to range from 25% to 50% of the crop. Attacks have been so severe that crops have been plowed under. In fact, early experiences in Berrien County, Michigan, included finding that it was not economically feasible to run a combine through the infested fields because the losses were so great. The task was begun of preventing the spread of the cereal leaf beetle to the vast grain areas of our country, and of eradicating the insect from then-infested areas. Surveys to indicate extent of insect migration, suitable chemical treatment of fields and crops, and quarantine regulations, required not only the cooperation of state and federal departments of agriculture, but also the cooperation of farmers, grain elevator operators, truckers, shippers, and harvesters.

Of special interest to the Michigan Department of Health, Occupational Health Division, was the fumigation of hay, straw, and occasionally other farm products with methyl bromide. Our task was to evaluate fumigation techniques to determine adequate control measures wherever potential health hazards existed.

It is interesting that many of the very qualities of methyl bromide which make it an excellent fumigant, are also qualities which challenge its use without damage to the health of the user. For example, the low weight of methyl bromide gives it a quality of high permeability to bales of straw or bags of grain. However, this same quality increases the hazards of leakage from all but the best enclosures or specially treated "tarps" employed in fumigation. Another desirable characteristic is its toxic effect on all stages of insect life. However, it is also toxic to man and animals, and deaths have been reported both in this country and in Europe from methyl bromide poisoning. Methyl bromide is a colorless, non-flammable gas at ordinary temperatures and pressures, with practically no odor in concentrations sufficiently toxic to present a serious hazard. Exposure to as little as 600 parts-per-million for several hours may be fatal. It should also be noted that effects may be delayed 48 hours following a single exposure.

To accomplish our mission we became concerned with the handling and use of methyl bromide from the time the cylinders were delivered to the Department of Agriculture until fumigation procedures were completed. These activities included storing of methyl bromide cylinders, their transportation and/or storage at fumigation sites, the fumigation procedures themselves, and the handling, transportation, and storage of equipment used in the fumigation process.

Two types of health hazards existed. First, an acute exposure hazard at any point in the system where accidental cylinder release of methyl bromide or spillage could occur and; second, a chronic exposure hazard which would be most likely to occur at the fumigation site. Several such sites are shown in the accompanying captioned photographs. A "tarp" cover secured with sand bags or "snakes" will effectively retain methyl bromide vapors for fumigation. While safe handling procedures had already been established (which conformed with information found in methyl bromide Manufacturers Guides for Fumigation[13] and Chemical Safety Data Sheets printed by Manufacturing Chemists Association, Incorporated[10]) the problem of possible chronic exposure at fumigation sites still remained. Air was sampled at the fumigation sites with a Davis halide meter calibrated to determine methyl bromide concentrations in the air in the range of 20 parts per million (which is the recommended Threshold Limit Value). We found this level exceeded during several steps in fumigation procedure. Consider the following data: (on page 5)

TABLE V
BIOLOGICAL BLOOD FINDINGS IN METHYL BROMIDE EXPOSURE

Bromide Concentration in milligrams per 100 grams blood	Evaluation
<1	Normal level, no bromide inhalation or ingestion
$\geqq 5$	Exposure to bromine containing compounds definite. Where methyl bromide is involved, improved control of operations necessary.
$\geqq 10$	Serious exposure where methyl bromide is involved, determine source and institute control measures
$\geqq 15$	It is likely that serious symptoms of methyl bromide poisoning will appear

These levels of no significance where there is intake of medicinal bromides including alka-seltzer, bromo-seltzer, sodium bromide, etc.

OPERATION	Concentration in parts per million (average)
Threshold Limit Value	20
1. Operator's breathing zone while attaching methyl bromide metering cylinder and accompanying hoses to a methyl bromide tank.	50
2. Operator's breathing zone at tank control valves while shooting of methyl bromide into the boxcar and semi-trailer.	40
3. General area samples taken during the shooting and holding sequence about 5 feet from railroad car. Maximum amount recorded.	10
4. Samples taken to locate leaks and breaks in railroad car door and crack seals.	500
5. General area samples taken during the aeration process. Upwind about 3 feet from open door. Maximum amount found.	40

As a result of our studies, it became clear that respiratory protection equipment already being used by the workers was quite necessary to prevent excessive exposures to methyl bromide during the process.

A flame-type halide gas detector, (which is a standard piece of equipment at the fumigation site) was found suitable for determining areas safe to enter with an approved gas-mask type of respirator, and could also be used as a rough monitoring device in areas where methyl bromide vapors were suspected. An incident in England published in 1961[11] serves to emphasize the need for caution in the use of respiratory protection equipment. Seven men engaged on a home-fumigation project experienced over-exposure to methyl bromide resulting in moderate to gross disability. It was found that the gas mask canisters in use offered virtually no protection. A more reliable make of canister was substituted and found effective in filtering methyl bromide vapors.

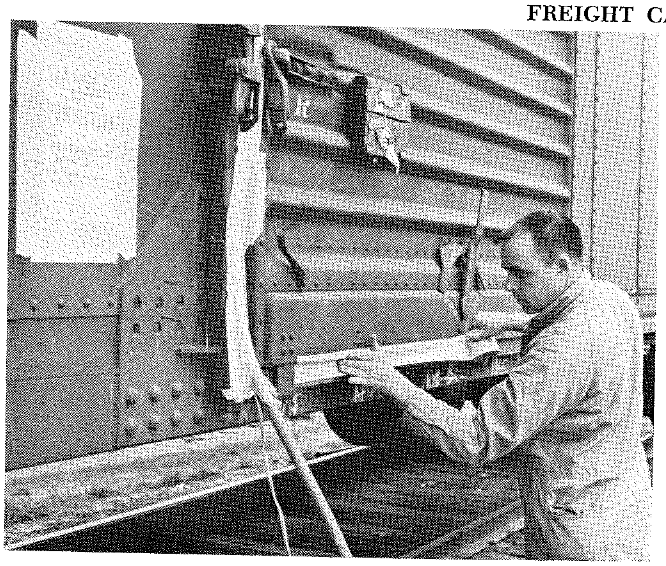
In addition to the health precautions and safety steps adopted by the Michigan Department of Agriculture, a program was instituted calling for determination of bromide levels in the blood of personnel exposed to methyl bromide. This program was not intended as a substitute for rigid supervisory control, but rather as a supplementary measure to insure that adequate control measures had been established.

Normal individuals who have not swallowed or inhaled bromide of any type will exhibit blood bromide concentrations of less than 1 milligram of bromide per 100 grams of blood (1 milligram %). An analytical result of 5 milligrams per 100 grams indicates that exposure to bromine-containing compounds has definitely occurred and this should serve as a warning that the source of the exposure should be sought and controlled. It should be noted here that this level is of no significance if it is due to the ingestion of bromine-containing drugs, while if it is due to inhalation of methyl bromide, there is something wrong with the fumigation procedure. Where the blood bromide levels reach 10 milligrams or more per 100 grams of blood it is a sign that a somewhat serious exposure exists, and at the level of 15 milligrams per 100 grams it is likely that serious symptoms of methyl bromide poisoning will appear. Table V gives some relative biological comparisons.

The toxicity effects of symptoms resulting from the inhalation of organic bromide such as methyl bromide, and those produced by the intake of inorganic bromide such as sodium bromide or other medicinals, are completely different. Where drugs are the cause, a blood concentration can approach 150 milligrams per 100 grams of blood before evidence of a condition known as bromism becomes apparent in most individuals. Levels of 100 milligrams per 100 grams of blood present little, if any, difficulty when the bromide is the result of a drug intake. It can be seen then that in using a blood bromide monitoring program as an assist in evaluating the effectiveness of the control procedures applied to a fumigation task, it is necessary to take into account the contribution of any drugs which may be ingested by the employees. For example, Alka Seltzer taken three times a day for two or three days is likely to increase the bromide blood level by 35 milligrams per 100 grams of blood.

The acute effects of methyl bromide intoxication include nausea,

FREIGHT CAR FUMIGATION



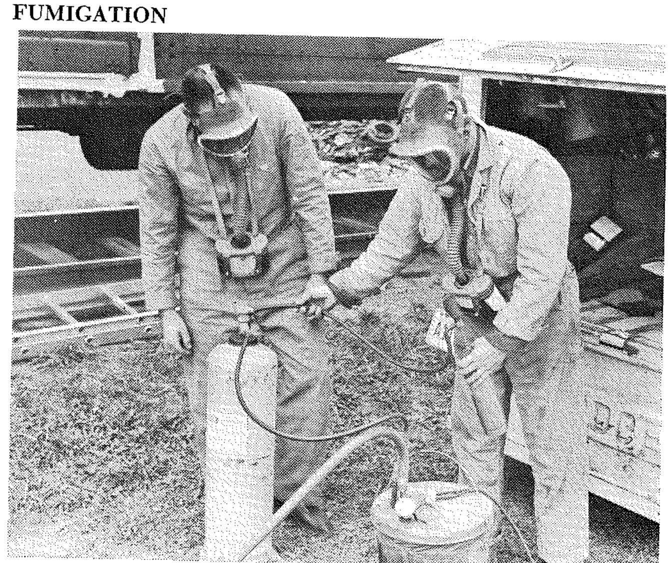


Figure 3.

(A) Railroad freight car is sealed in preparation for methyl bromide fumigation. Note caution sign, and rubber tubing through which methyl bromide is introduced.

(B) Workers wearing gas masks use a halide torch to check heating unit and fittings on methyl bromide cylinder for leaks, prior to gassing the sealed freight car.

TRUCK-TRAILER FUMIGATION

(A) A trailerload of hay is backed into a metal building for fumigation.

(B) Gas-proof tarps enclose trailer. Not shown are fans used at ground level and on top of load to circulate gas within the enclosure.

(C) Worker uses a halide torch to check around sand-snake seals for methyl bromide leakage.

Figure 4.

vomiting, a staggered gait, and blurred vision, and then within one to two hours after the exposure, severe lung edema, and usually death. In chronic methyl bromide poisoning which might be brought on by continuous and prolonged exposure to levels of 30 to 100 parts per million, the resulting symptoms are a staggered gait, blurred vision, and mental disturbances. The mental disturbances are usually transient and the individual can frequently be brought back to normal after removal from exposure and several weeks of treatment. However, if the chronic exposure takes place over too long a period of time and involves too much methyl bromide, the mental changes may not be reversible. Typical of mental changes are paralysis of the extremities and a tremor in the hands.

Gold-chloride method was used for bromide blood level determination, and a level of 10 mg/100 grams blood used to indicate excessive exposure. E. M. Rathus and P. J. Landy[11] advocate Conway's Micro-diffusion Method for estimating blood bromides in methyl bromide poisoning. They feel symptoms of poisoning are possible at levels as low as 2.8 mg/100 grams by this method. It is noted that the data presented involved individuals with acute exposures. Although there are no known cases of clinical symptoms of methyl bromide poisoning which have occurred in the cereal leaf beetle fumigation program, laboratory procedures and methods are now under further investigation.

While a long list of safety and health precautions could be recited to cover specific operations, the shorter list below is intended to emphasize the type of precautions and controls necessary for this and similar toxic chemicals.

1. Check all cylinders for leaks.
2. Treat any damage to cylinders as a potential leak producer.
3. Transport cylinders and equipment on the bed of a truck or in a trailer and not in the cab of a truck or in the interior of an automobile.
4. Observe shipping regulations.
5. Comply with label requirements.
6. Handle cylinders in accordance with safe practices including eye protection (approved gas mask or chemical safety goggles.)
7. Instruct employees in the

use of equipment and the procedure to follow in case of accident. Make them fully aware of the health hazard and toxic properties.

8. Use only properly maintained and properly fitted, approved, respirators. Training in their use is required.

9. Have a satisfactory water supply available for first-aid treatment.

10. Store cylinders only in properly ventilated areas.

11. Do not fumigate in the same building where offices, telephones, emergency equipment, etc., are located.

12. First aid measures include:

A. Clear the area of personnel.

B. Re-enter area only after instrument samples show that safe levels are present, except:

1. When wearing a supply-air type of respirator, or;

2. If levels below 2% by volume are known to exist, an approved gas mask can be used. It is assumed that at least two men are well equipped and can assist each other if necessary.

C. Immediate removal of shoes and other items of clothing which have become contaminated with liquid methyl bromide. Wash affected body areas with large quantities of water.

D. Eye-washing facilities are most important and they consist of a hose with a soft gentle flow of drinking water.

(It should be remembered that methyl bromide can cause severe burns when spilled on clothing or exposed skin.)

A regulatory manual published by the Michigan Department of Agriculture[12] includes instructions and safety precautions in the use of methyl bromide and is an important addition to any list of precautions. It suggests: "—poison antidotes should be readily available. The name and address of local physicians should be immediately available for use in the event of any emergency."

— End —

ON-THE-FARM FUMIGATION

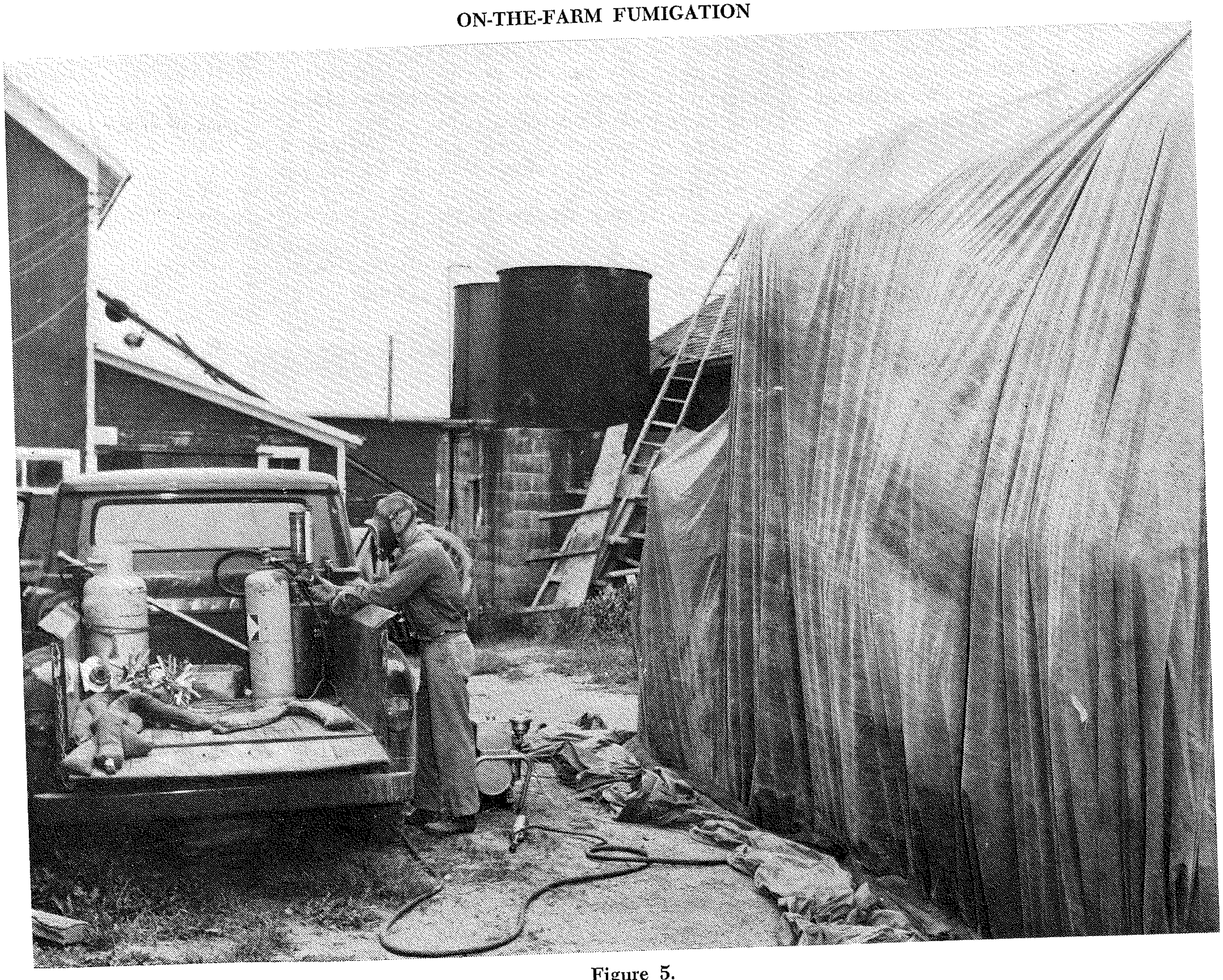


Figure 5.

Hay is fumigated in the field by a worker wearing a gas mask as he operates methyl bromide generating equipment.

ERRATUM:

Please help ease our embarassment by ignoring the "ERRATUM" in our last issue (which only compounded the error it was intended to correct). It should have read as follows: In Volume 10, Number 1 (Fall 1964) of Michigan's Occupational Health — page 4 — center column — should read "Average level (3 bands) $\frac{282}{3} = 94$", rather than . . . "$\frac{382}{3} = 92$". Also, in the last issue of Michigan's Occupational Health (Volume 10, Number 2, Winter 1964-65) — on page 7 — half way down the right column — change the threshhold limit value from "0.01 PPM" to "0.02 PPM".

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(5) Same as above, but January 1 - March 31, 1961.

(6) Lead Poisoning, Volume 2, Number 3, (Spring, 1957) Michigan's Occupational Health.

(7) Effective Medical Control of Lead, Volume 5, Number 1 (Fall, 1959) Michigan's Occupational Health.

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(9) Industrial Ventilation, 8th edition, A Manual of Recommended Practice, American Conference of Governmental Industrial Hygienists, P. O. Box 453, Lansing, Michigan 48902.

(10) *Chemical Safety Data Sheet SD-35, Methyl Bromide,* Manufacturing Chemists' Association, Incorporated, adopted 1949.

(11) Rathus, E. M. and Landy, P. J. "Methyl Bromide Poisoning," Vol. 18, page 53, *British Journal of Industrial Medicine, 1961.*

(12) *Cereal Leaf Beetle Regulatory Manual,* Michigan Department of Agriculture, Revised April 29, 1964.

(13) "Methyl Bromide, Hygienic Guide Series," Vol. 19, No. 2, *American Industrial Hygiene Association Journal,* April, 1958.

(14) Michigan Department of Agriculture, Plant Industry Division & U.S.D.A. Agricultural Research Service, Plant Pest Control Branch, *Cereal Leaf Beetle Program 1963.*

LEAD (from page 3)

blood-lead concentration is below 0.06 mg. of lead per 100 grams of whole blood.

In conclusion, we hope that attention has been called to some new applications and to the problem involved in the utilization of leaded steel. Although the hazards in the primary manufacture of leaded steels have been recognized for some time, little has been said up until now about the potential health hazard faced by the *fabricator*. Torch-cutting appears to be the most significant problem for such a user.

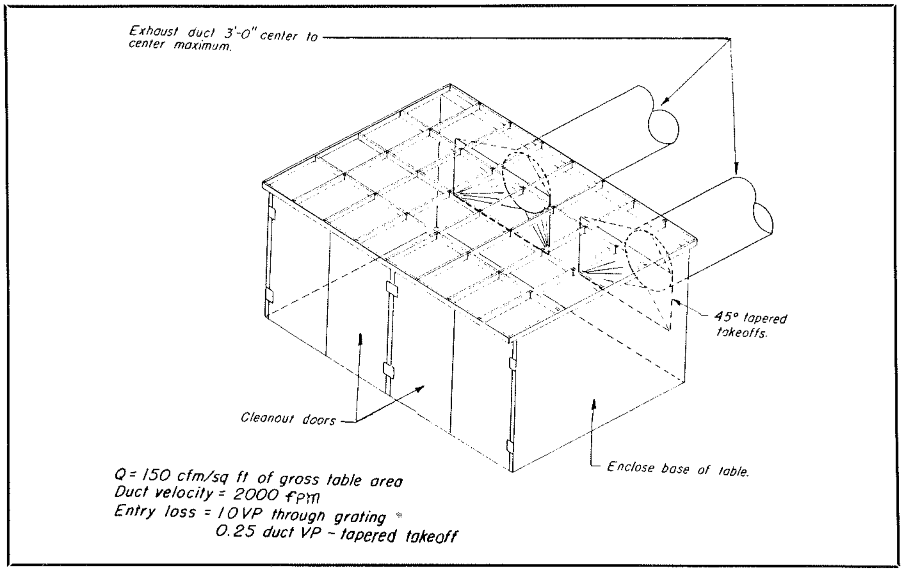

Figure 2.
The down-draft type ventilation unit recommended for torch cutting operations with leaded steels.

Volume 10, No. 3 SPRING 1965

MICHIGAN'S OCCUPATIONAL HEALTH

Published quarterly by the Division of Occupational Health, Michigan Department of Health, Lansing, Michigan 48914.