FILE NAME: National Safety Council (NSC)

DATE: 1941 Oct

DOC#: NSC069

DOCUMENT DESCRIPTION: Transactions of the NSC - 30th National Safety Congress - Part 1

1941

DUST, FUMES, GAS, AND VAPORS pp. 35-40
[illegible]
[illegible]

PERSONAL RESPIRATORY PROTECTIVE EQUIPMENT pp. 46-47

ESSENTIALS OF HEALTHFUL INDUSTRIAL ENVIRONMENT pp. 152-158
[illegible] pp. 152

[illegible] SAFETY-PANEL DISCUSSION pp. 448-452
[illegible]
[illegible]

[illegible] UNDERGROUND METAL [illegible]
[illegible] 77-480
[illegible]

[illegible]

PLAINTIFF'S
EXHIBIT
NSC-62

NATIONAL
SAFETY
COUNCIL

TRANSACTIONS

1941 Pt. 1

NEWARK
N.J.P.L.

TRANSACTIONS

30th
NATIONAL SAFETY ~~CONGRESS~~ Council
Transactions

GENERAL SUBJECT AND
INDUSTRIAL SESSIONS

CHICAGO
OCTOBER 6-10, 1941 - '41

NATIONAL SAFETY COUNCIL, INC.
20 North Wacker Drive, Chicago

Copyright, 1941, National Safety Council, Inc.
Printed in the U. S. A.

1420377

Contents

Council Officers 4
Make Profitable Use of These Transactions 9
Council Purposes and Program 11
Annual Meeting of Members 13
Congress Banquet 29

Subject Sessions—

- Dusts, Fumes, Gases and Vapors 35
- Electric Welding 49
- Elevators 55
- Fire Control and Prevention 65
- Fundamental Causes of Accidents 77
- Governmental Safety Service in Industry 97
- Human Engineering and Safety 117
- Industrial Health 145
- Industrial Nursing 159
- Maintaining Safety Interest in Defense Industries 181
- Sabotage Prevention 195
- Safety Engineering Exchange 207
- Safety Organization and Program 219
- Safety Training 235

Industrial Section Sessions—

- Aeronautical Section 253
- ASSE—Engineering Section 263
- Automotive and Machine Shop Section 269
- Cement and Quarry Section 287
- Chemical Section 301
- Construction Section 325
- Food Section 339
- Marine Section 369
- Meat Packing, Tanning and Leather Industries Section 425
- Metals Section 435
- Mining Section 477
- Paper and Pulp Section 505
- Petroleum Section 563
- Power Press Section 587
- Public Utilities Section 599
- Refrigeration Section 625
- Rubber Section 635
- Steam Railroad Section 655
- Textile Section 675
- Wood Products Section 691

Exposition Exhibitors 719
Index 725

Dusts, Fumes, Gases and Vapors

THURSDAY MORNING SESSION

October 9, 1941

Methods of Combating Industrial Health Hazards

A Symposium

Presiding:—WALTER S. PAINE, Manager, Engineering & Inspection Department, Aetna Casualty & Surety Company, Hartford, Conn., and Vice-President for Industrial Safety, National Safety Council.

Ventilation and Exhaust Equipment

By GORDON C. HARROLD, Ph. D.

Industrial Hygiene Laboratories, Medical Department, Chrysler Corporation, Detroit

It is difficult to give details on the many phases of ventilation and exhaust equipment which are applicable to the problems of protecting the workers' health.

Some general principles of every day usage can be covered however, as well as specific cases.

Thus for gases, less pipe velocities are needed than for fumes, mists or dusts. The lower specific gravity of gases leads to various modifications for their handling. Carbon monoxide gas which is slightly lighter than air could be taken upward. However, when mixed with automobile exhaust gas the apparent specific gravity of the mixture is raised so that it is much more feasible to remove the gas by means of staggered floor grills. Even more important than specific gravity is the temperature of the gas mass as increased temperature causes the heated air to rise.

For this reason numerous exhaust systems are built without forced draft and are suitable particularly in smoke removal where high toxicity is not encountered. Gases such as hydrogen chloride or hydrogen cyanide are of such toxicity that a totally enclosed hood with up-draft exhaust is preferable. The factors of concentration and relative toxicity play an important part in the choice of exhaust systems. Of further interest is the question of whether any cumulative poisons or those leading to chronic illness may be present. The older up-draft exhaust systems have in many cases been replaced with back or side draft ventilation even for gases lighter than air because of the danger of carrying the hazardous material through the breathing zone of the worker. Only in such cases as result from the gas being generated above the breathing zone of the worker should canopy and other types of overhead hoods be used. A combination of back and up-draft will take care of all such situations and should a canopy be open on all sides a solid partition can usually be built in the center of the operation to provide a back wall for both sides of the exhausted operation.

Liquids which give off vapors or mists are both simpler and more difficult to treat. Since the liquid is usually confined in a tank, the focal source only need be considered to prevent local spreading of the contaminant. The difficulty comes in devising simple and inexpensive systems which will not interfere with the worker. Recent tank studies have shown a number of facts which either have not been generally understood or have not had experimental proof offered to substantiate the belief of individual experimenters.

It seems necessary to caution against careless use of formulae. Thus the formula developed by Brandt seems to indicate that as the tank becomes wider the amount of ventilation required per unit becomes less. The author points out that the work of Battista, Hatch and Greenberg proves that increased width results in increased power losses and inefficient operation. Silverman emphasizes the importance of flanges which increase tank velocities from 20 to 33 percent. When the height of the flange is equal to the width of the tank the ventilation requirement is reduced 20 percent. While this is not always practical it is shown through his calculation that maximum efficiencies are obtained as the flange angles are increased and that the ideal situation is found when a completely closed hood may be used.

The width of slot openings is not very important where we have flanges. This is not true of unflanged hoods where the reduction of slot width will give lower velocities at the remote corners. As shown by Dalla Valle and Brandt, the slot velocity exerts rapidly decreasing influence as the distance from the face of the exhaust hood increases, and that two slotted openings, one on each side of the tank, are more efficient than the one slot due to the higher velocity obtainable at the most remote part of the tank from the exhaust slots. It is pointed out in nearly all these papers that disturbances of work operations, extraneous air currents, and vapor turbulence must be overcome by a sufficiently high velocity at the most remote portion of the tank. For this reason, the formulas are not a true criterion unless all outside conditions are evaluated.

It was pointed out that with flanged slots, decreasing the depth of the liquid below the slot reduced the air required by about 15 to 20 percent. This is probably due to decreased turbulence as an unflanged hood is not affected by the depth of liquid. It is also pointed out that a single long tank suitably partitioned is more efficient than several small tanks. Also of interest is an efficient manifold system to deliver equal quantities of air to all parts of the slot. Silverman has shown that ventilation requirements vary with the physical characteristics of the liquid substance in the tank. Thus in one instance he shows that flange slots increase efficiency with decreasing depth of liquid but that highly volatile liquids will be lost through entrainment and evaporation so that the depth would have to be increased for efficient operation with such substances.

A case of this kind is thoroughly discussed by Witheridge et al in regard to the ventilation of trichlorethylene degreasers. They showed that vertical slot ventilation caused the lowest solvent loss increase but was least efficient in reducing solvent exposures. A round hole system caused the highest solvent loss increase and required approximately twice as much power as the horizontal slot type to reduce solvent exposures to 100 p.p.m. The maximum solvent loss increase due to ventilation during continuous use of this degreaser was 2 gallons per 9-hour day or 12 gallons per square foot of tank area per 100 hours' operation. No significant relation between ventilation rate and solvent loss was shown.

A ventilation rate of 615 c.f.m. around the 20' perimeter of the tank using the horizontal slot or round hole system reduced the average trichlorethylene concentrations in the operator's breathing zone from a maximum of 400 p.p.m. without ventilation to below 100 p.p.m. The vertical slot system required a ventilation rate of 1400 c.f.m. to accomplish the same result.

Dust

When solids in the form of dust must be removed, considerable attention must be given to the collector system, the velocities in the pipes, and the design of the piping system. In addition, the face of the exhaust hood should be so designed as to be close to the source of dust generated.

1. While great emphasis is now being laid on wet collector systems it should be understood that such systems will not remove large amounts of the dust sizes which ~~are signifi~~cant from the health standpoint. Cyclones, unless of the micro variety, which will not handle the larger volumes of air often encountered, suffer from the same handicap.

Cloth or bag filters will collect these small particles but the maintenance costs are high. Electrical precipitation is also very efficient but is often too expensive to install and maintain.

The velocity of air in the pipes should be sufficient to prevent deposition. This velocity may be as high as 4500 linear feet in the case of lead dust. Since too great a velocity is wasteful and results in excessive pipe losses the system should be so designed as to eliminate the need for excessive velocity. Short distances to collectors, coupled with straight sections of pipe with no sharp bends, are aids in this endeavor. When sections of branch pipe are joined to a main pipe the joining angle should be 30 degrees or less.

A corollary of Dalla Valles work is that the exhaust hood should be as close as possible to the source of dust formation. The ideal would lead to a total enclosure to reduce openings to a minimum and thus cause the resultant face velocities to be much higher.

Often gases and fumes are collected together and usually the limit of air requirements is set by the velocity needed to keep the pipes from plugging up. In some cases as in foundry operation, back draft exhaust is resorted to in order to collect the airborne dust. Then a separate downdraft system keeps dust from getting into the air.

Welding of various kinds produces iron fume, fumes from the flux and gases such as nitrogen dioxide and ozone. The iron fume apparently is only a nuisance dust but the manganese, fluorides, etc. resulting from the welding flux are harmful. The gases noted are harmful when in sufficient concentration.

Work performed in the Chrysler Laboratories indicated that this situation would not be harmful in open spaces unless heavily coated rods were used. In tanks and closed spaces, dangerous concentrations of both gases and fumes could be predicted. Various types of exhaust systems have been devised. The most common one depends on a hood attached to flexible metal pipe so that the face of the hood may be placed in near proximity to the work. Other types range from floor grills to hood canopies, each type being adapted to the kind and size of the pieces to be welded.

In closed tanks, the "Airbooster" as made by M.S.A. provides a means of readily exhausting air from each tank or closed space, or if desired, a large volume of air at relatively low velocity may be introduced into the closed space. These units are portable and provide a good answer to jobs which change or move about frequently.

Personal Protection

Another means of providing safety when toxic substances are present is the use of individual air supplied hoods either open about the eyes or closed depending on the efficiency desired. In paint operations, the open type is satisfactory and vision is not obstructed while for more rigid control with more toxic substances the closed eyepiece type is more desirable. The numerous respirator, canister, and self contained breathing types, need no mention here except that the purpose they serve is well understood.

Light Metals

A new problem is now confronting safety and ventilation engineers in the growing use of magnesium and aluminum alloys. These metals are in themselves non-toxic—so much so that wounds inflicted by sharp articles will become infected much easier than those inflicted by heavy metals. They are hazardous in finely divided form due to the fire and explosion hazard. The various hazards and precautionary measures are receiving attention in various periodicals but we wish to emphasize certain aspects relating to exhaust and ventilation systems.

Ordinary type dust collectors should not be used for removing magnesum or aluminum dust. A special dust collecting system which utilizes a water spray nozzle to knock out the dust so that it may be carried away as a sludge is demanded. Good ventilation is necessary to remove the hydrogen which is formed. All piping should be in straight line with no sharp turns and should be smooth on the inside so that no dust remains in the piping system. The sludge should be collected in drums and disposed of at frequent intervals either by mixing with 5 parts by weight of sand and burying in a dump, or covered with oil and burned. It should be noted that this is one of the few cases where magnesium, in particular, can be wetted with water but it should be noted that the sludge should not be allowed to become half wet but should be thoroughly flooded at all times. The parts of the system where work is done should be of non-sparking material. It is not safe to collect this material in filter screen or cyclone collectors, nor should sparking type metals be allowed to get into the ventilation system.

We have pointed out some of the specific items involved in ventilation in connection with health and safety hazards. Some of the limiting factors in a large scale ventilation program should also be dealt with. Indiscriminate installation of exhaust ventilation without a careful evaluation of the extent of the need will lead to extremely high first costs of installation. The engineer who installs a system three or four times as elaborate as needed to control a given complaint may "control" a situation but at an excess cost of thousands of dollars. The next step after this excess air has been exhausted from the plant, must be to supply fresh air which in the industrial north must be heated for eight months of the year. Even with closely controlled systems, this factor of heated air is a real limitation. In many instances, power houses have had to be greatly enlarged because of such programs. The power needed to run motors and auxiliary equipment is also a limiting factor. A system which is too small will not be criticized on the above score but if its purpose is not fulfilled, the entire layout may have to be scrapped.

Always to be considered is whether the installation is to serve the purpose of removing toxic materials or those which may be classified as nuisance contaminants. Both are legitimate requirements but it should be clearly understood that one system is to protect health directly and the other to provide comfort. Proper consideration can then be given to the question of "how much" and "what kind" of ventilation is to be installed.

A common sense program will include exhaust ventilation as one very important aid but only as related to other possible methods of solving the problem involved. When substitution is feasible and economical, or revision of process if possible, these may provide a cheaper, more satisfactory answer. At times, personal protection will best serve the purpose and in some instances a few simple rules of operation and maintenance may be all that is needed. Ventilation often proves the only answer, but indiscriminate ventilation is the poorest and most costly answer that can be devised. A system should be completely designed at one time with no additions without a complete revision of all parts of the system. It is, of course, permissible to completely design a system in such a way that units may be added from time to time but this should be a part of the original consideration. Conversely systems well designed and installed to meet the condition encountered in the degree necessary are major aids in any health program.

Measuring Concentrations of Toxic Substances

By S. W. GURNEY

Laboratory Director, Liberty Mutual Insurance Company, Boston, Mass.

Frankly, on this subject of industrial health hazards we do not know as much in a precise way as we do about guarding belts, gears, points of operation, and the like. That industrial health is an important subject is attested by the fact that we now have a relatively new profession called Industrial Hygiene, which might be defined as a study of working environments including all of the air contaminants as well as abnormal conditions of temperature, humidity and even now of atmospheric pressure. The criterion is the effect upon the health of workers, either immediate or delayed. A few technical schools have started courses in industrial hygiene and the number of chemists and medical school graduates who are going back and taking these courses is a further measure of the increasing importance of this general subject of industrial health.

Not many plants have experienced industrial hygienists on their staffs; in fact it would be impossible for them to do so as there are not enough of them to go around. I believe that there are very few in this meeting this morning who would call themselves industrial hygienists. With this assumption in mind I have tried to plan this paper for the ordinary safety engineer and the safety committee man who doesn't remember his chemistry too well—but who does feel that he should know more about the possible health hazards in his plant. He may also be somewhat worried about claims for alleged health damage that have been submitted and may wonder if there is anything he can do about it himself. It certainly would be fine if every plant large enough to have even one man wholly interested in safety could arrange to have one trained as well as interested in the fundamental problems of industrial hygiene. However, this would take a long time to accomplish and for the present we shall have to get along with what we have.

I should like this morning to try to tell plant safety men what they can do along this line without the benefit of specially trained industrial hygienists. I am assuming that you know the names of, and are familiar in some way with the materials used in connection with the operations in the plants where you are. This includes the dusts, fumes, vapors and gases, the solvents and other chemicals that are used, produced as necessary by-products of, or enter at all into the manufacturing processes in any way. If you do not you certainly should find them out—and perhaps this is the first thing you can do.

We are safe in saying that wherever a toxic substance is used an exposure exists. For example, if you have in your plant a process using benzol you undoubtedly have a benzol exposure. If somewhere in your plant you are melting lead or a lead alloy for any purpose, an exposure to lead exists in that part of the process. This does not mean necessarily that a health hazard to benzol or to lead exists, but we can say that we do have the exposure.

Now over the years by means of animal experimentation, and by the results of human experience, it has been shown that low dosages of these toxic materials which exist as air contaminants are pretty well taken care of by the healthy human organisms. High dosages in the time factor as well as the concentration are not well handled and damage to various organs and tissues may result from continued exposure.

Further, these same studies, both animal experimentation and industrial experiences have shown that the principal way the toxic material gets into the body is through the respiratory system. It is true that some industrial poisoning takes place through swallowing and some through direct absorption through the skin. However, the important thing we have to remember is that most of the toxic materials used in industry get into the system where they can produce their damage through the common process of inhalation.

For some time a number of important committees have been working on the problem of establishing what we might call a threshold dosage of these industrial toxic materials. A number of individual experts have defined threshold concentrations as those below which health damage is very unlikely. State code committees have drawn up tentative thresholds covering most of the well-known industrial solvents and chemicals and suggested that these limits be used to measure the dividing line between what on one hand constitutes a safe exposure and on the other one that may produce definite health damage. The American Standards Association has appointed a sectional committee of well known experts to correlate all of these data and to establish threshold limits or maximum concentrations which we can use as guideposts or benchmarks in determining whether or not our own plant is a safe one to work in.

However, these threshold dosages do not mean that if you maintain a workroom air always below that concentration figure no one possibly can have any harmful health effects at all nor does it mean that if the concentrations are always above that figure that everyone is going to show symptoms of poisoning. They simply mean that below such concentrations most workers will not be measurably affected and that above it some health damage may be expected, given sufficient time. Behind some of these suggested exposure concentrations there is a wealth of experience and an impressive amount of factual data. Behind other figures there is very little in the way of experience and such figures represent what we might call an intelligent guess on the part of people whose intelligent guesses we respect. Thresholds need precise measurements.

Because we need to know what degree of

exposure exists in our plant some reliable way of actual measurement becomes a necessity. Otherwise how are we to know whether these exposures constitute health hazards or do not. Of course, if we have an industrial hygienist in our plant, the answer is easily obtainable. He will proceed to use known techniques of sanitary air analysis, a specialized chemical job usually involving quite a bit of time and fussy analysis. In any event, the job is not impossible no matter what the particular air contaminant may be. Before this section in past congresses excellent papers have been delivered on sampling methods and analytical procedures for the various air contaminants, I believe by Mr. Warren Cook and again by Dr. E. G. Meiter. There is no particular point in going over that ground again. From many sources anyone interested can secure detailed information on procedures for the measuring of any of the common air contaminants.

Many plants which have not felt that they had enough of a problem to warrant the hiring of an industrial hygienist have provided their safety engineers with some of the newly developed measuring instruments which, with a little experience, can be operated by almost anyone. I refer to such devices as the Carbon Monoxide Indicator, the Flammable Gas Indicator, the Mercury Vapor Detector, and certain dust counters. There are a number of such devices on the market which do a perfectly swell job of distinguishing between exposures which may be dangerous and those which are not, for specific contaminants; and you don't have to be a chemist to operate one and interpret the results. A number of instrument manufacturers are working on the problem of extending the application of such instruments to different contaminants. I have no doubt that the next few years will see on the market simple instruments for many more of the air contaminants you are likely to see in industry. Some of these are made automatic in their operation and give continuous readings—or sound a gong, flash a light or turn on additional ventilation when a dangerous concentration is reached. Where we can get such instruments we find them a great help to the safety engineer in providing him an answer to his problem.

However, there are a large number of air contaminants that we cannot yet measure by these simply operated instruments. Most of the safety engineers have to depend upon their own ingenuity to provide the answers. By far the majority of our plant safety men have no industrial hygienist to lean upon, neither have they been able to procure simply operated instruments which will give them the answer they want for the particular air contaminant or exposure that exists in their plant. Such safety engineers are not entirely without recourse and there is quite a lot they can do to get some measure or estimation of some of their plant exposures without outside help.

For example, take visual inspection, which is simply the intelligent use of the sense of sight. Dusts, which have given us more cases, probably than all of the other air contaminants combined, are usually perfectly visible things. Considerable stress has been laid upon the point that it is necessary to know the size distribution of such dust suspended in the air before we can truly measure the hazard that exists. In this it has been my experience that wherever there have been big particles which can easily be seen there are always plenty of small ones which are deeply respirable which cannot be seen. I have never yet made any dust studies in plants where it was obviously dusty by sight that there were not many times more fine particles well down in the so-called respirable range than there were big ones. Conversely you seldom find fine dust without large ones along with it which can be seen particularly near the source of the dust in question. If your plant is a dusty one some evidence of dustiness is visible, even if you have to climb up on the rafter to look for it as settled dust.

I can recall one safety engineer hauling me half way across the continent to take dust counts at a brushing machine in a radiator foundry. So much dust was thrown off into the air by this operation that it was difficult to see from 25 feet away the two men who were operating it. It was obvious to anyone that so much dust could not possibly be beneficial regardless of the silica content and ~~common sense should have~~ told him that here was a situation about which something should be done and promptly. As a matter of interest the dust counts ran up into several billions per cubic foot and the free silica content as quartz was somewhere between 10 and 15 per cent. Such information may be helpful in getting improvements but it seems to me that anyone taking the trouble to view this operation would have immediately recognized the health hazard.

I have often been asked to define or describe by appearance what constitutes too much dust. I'm afraid I have no precise answer to that question. I have often replied to such questions that if you actually can see clouds of any dust produced or disseminated into the air of a working area from any process it is a good idea to enclose and ventilate it, or at least to try to control the dust source in some way.

It has been my experience that most industrial commissions and accident boards are not particularly impressed with dust counts and analyses and discussions of threshold dosages as such. If testimony shows that a plant is dusty, and anyone can see that it is so, the plant is pretty likely to have to accept any claims for respiratory system damage as an industrial case.

The acid vapor which arises from hot acid [illegible] tanks may not be visible but the [illegible] that accompanies it usually is. You can see where it is coming from and get an idea where it is going. The etched or rusted appearance of metal work in the room with these pickle tanks is also visible evidence that acid vapors have escaped into the room.

The fumes from arc welding are perfectly visible—and the 25 mgs. per cubic meter suggested as a limiting dosage in Massachusetts is a very dense cloud. One investigator describes it as so thick you could cut out a hunk with a knife and wrap it up and take it home.

Again, by watching the rebound of spray in a spray painting operation you can tell pretty accurately if the operator is well protected and if the booth has sufficient air to take care of the fumes.

The human nose is probably not a particularly precise measuring device and no [illegible] different people's noses differ widely in their ability to detect and estimate air contaminants by this means. However, many of our industrial vapors and gases do have distinct and characteristic odors and much can be done by a safety engineer by the intelligent use of the good old nose.

In our laboratory in Boston we are fortunate in having a large gas tight chamber for experimental work. In this chamber we can set up easily and quickly almost any concentration of any of the commonly encountered industrial gases, solvent vapors, or dusts.

Some time ago as a matter of interest only we started some rather crude human experimentations. From time to time we would put up in this chamber concentrations of the common industrial toxic volatiles. For one trial we would take the suggested threshold dose. We would then try other concentrations to see how low a concentration could be detected and identified by smell. With six men in the laboratory we acted somewhat as a committee entering the chamber as a group and reporting our reactions individually after varying periods of exposure. This work is not completed and probably never will be as new things are coming into industry constantly. However, it is important to know that the suggested threshold dosages for ammonia, benzene, the acetic acid esters, carbon bisulfide, carbon tetrachloride, in fact all of the chlorinated hydrocarbons, formaldehyde, ether, gasoline, hydrochloric acid, hydrogen cyanide, hydrogen sulfide, methyl alcohol, nitrogen oxide, sulphur dioxide, toluene and xylene are all easily detectable by the human nose and can be identified with a little experience.

In fact the 200 ppm. of trichlorethylene, the common degreasing solvent, suggested as the threshold is distinctly uncomfortable after fifteen or twenty minutes exposure. Personally, I would hate to work in 200 ppm. of trichlorethylene for an eight-hour day. With formaldehyde at 20 ppm. the degree of discomfort is extremely high and I doubt if anyone who was able to escape would remain in that concentration for more than a very few minutes. The irritating acid gases, hydrochloric, sulphur dioxide, are very uncomfortable at the suggested dosage. In fact, I don't believe that it is good policy to ask anyone to work in such concentrations even though no particular health damage below or at it has been proved.

It is interesting to know that most of us can smell benzol or toluol well below the threshold dosage and some of us are able to go down as low as 15 or 20 ppm. With almost anyone of the chlorinated hydrocarbons such as carbon tetrachloride, trichlorethylene, and the like, most people have no trouble in recognizing the contaminant as a chlorinated hydrocarbon as a general class down to around 10 to 25 ppm., although it is difficult to distinguish them apart. I believe that the safety engineer who is willing to do a little sniffing around the plant is going to find out a lot about some of the air contaminants as to their source location and where they go to. There is one thing about the chlorinated hydrocarbons that I should like to mention and that is the fact that nasal fatigue enters into the picture very shortly and after a few minutes in the exposure your nose loses much of its ability to distinguish these solvents. The sense of smell is recovered by a few minutes in the fresh air. The same thing is very true of concentrations of hydrogen sulfide. There is no need to point out that the very toxic carbon monoxide and the very common carbon dioxide gas in the pure state have no odor. However, carbon dioxide in a brewery around the fermenting vats has a peculiar tickling sensation to the nose which is quite characteristic and after a few minutes around 500 or 600 ppm. in that process you begin to have a feeling that all is not quite as it should be.

I know of several instances where the sense of smell has been used as a practical measuring rod. The foreman of a large plating shop doing much cyanide plating uses and has demonstrated the fact that a hydrogen cyanide smell is a sure sign that the electrical system or the plating bath concentration needs attention. Although hydrogen cyanide is extremely toxic it can be detected by smell well below the suggested threshold dosage of 20 ppm.

Many of the solvents and mixtures such as the lacquer solvents in industry are not particularly toxic and exposures constitute more of a nuisance than they do a real health hazard. Nuisances, however, can be real and we do not want to remain complacent just because no real health hazard can be proved. There is also the very real danger of getting into the explosive range with some of these lacquer solvent mixtures of low toxicity.

There is another way of estimating concentrations and I can recommend it to you if you are in doubt as to whether or not some process should be further enclosed, ventilated or otherwise protected to keep down the concentration. It should be used with caution and understanding. Safety engineers often ask me whether or not a coating process or a mixing process or even such things as vapor degreasers should not have something done about them. To such inquiries I frequently ask the safety engineer to go out and stand alongside of the operator of the process in question for as much of the day as the operator does himself. I further ask him to tell me just how he feels at the end of this period. It is remarkable how often after going through this the safety engineer comes to the conclusion that further protection is necessary, or at least very desirable. Now you know that there are lots of smells, irritating gases and the like that workers finally get used to and they will probably affect you much more violently than they do the experienced operator. On the other hand I wonder if we are right in asking people to work in disagreeable atmosphere where they have to "get used to it" before they become reasonably reconciled to their job.

There is one other way we have of estimating exposure that is probably not as good as the three I have mentioned but nevertheless it has its uses. I refer to complaints on the part of the workers themselves. Safety engineers should be close enough to workers in the departments where toxic materials are used so they will get verbal reports of any complaints or objective symptoms that arise.

I recall two fatalities this year allegedly caused by high exposure to carbon tetrachloride vapor. There may have been other cases but these two were such that I had access to the reports of the investigations. They were both rather simple jobs of cleaning metal objects with carbon tetrachloride and the whole operation was by hand. Both operations had been performed occasionally for a number of years, but as a result of large defense orders the time spent at these operations had increased considerably. Both men are on record as having complained considerably. They had been nauseated several times. They complained of feeling tired and restless for quite some time before they finally became really seriously sick. An alert safety man nosing about the plant looking for trouble might well have picked this up and recognized it as a measure of excessive exposure. Both cases terminated fatally and in the medical picture at autopsy showed about what one would expect in an acute case of carbon tetrachloride poisoning. It is interesting to know that afterwards air samples were taken in a number of positions around the operation and concentrations well over 100 ppm., the suggested threshold dosage, were found.

I think if we investigate our plants thoroughly we will find that there are a number of processes and operations involving toxic materials or at least materials with some degree of toxicity that have for years been carried on safely without complaint or symptoms or any other evidence of health damage. The reason for this was the infrequency of the operation or the small quantity used or the short time of exposure. With increase in production a number of these processes have speeded up so that gradually the weekly degree of exposure to the dust, fume, vapor or gas has been increased. As a result of defense orders processes that used to take place every other Thursday are now being carried out every day. What used to be a short time job of 15 or 20 minutes now stretches out over two or three hours. Complaints do not always mean that a serious health hazard exists, but they should be red flags to any safety man that since his original investigation conditions may have changed to render the exposure much more serious than it was. From years of experience in this business I am of the opinion that the average worker does not complain about dust or fume or irritating vapors unless he had a good reason to do so and the wise safety engineer will recognize this and at least investigate.

There are a number of air contaminants that can only be measured by the accepted methods of sanitary air analysis and certainly precision measuring can be done only by such means—but taken all together the safety engineer himself, using reasonably his sight, sense of smell, his own sense of feeling when exposed as the workers are plus a knowledge of what the workers on some of these unpleasant jobs are saying and feeling has at his command several useful measuring rods with which he can evaluate the health hazard in his plant.

Personal Respiratory Protective Equipment

By DR. J. H. STERNER

Director, Laboratory of Industrial Medicine, Eastman Kodak Co., Rochester, N. Y.

The need for personal respiratory protection in many types of industrial operations is now well recognized, but the problem of determining in a specific instance whether a respirator is required, and what type is best indicated, is sometimes not a simple one.

Every type of respirator places some restriction on the wearer, and although it may be only a slight inconvenience and insignificant compared with the protection it provides, it must be recognized as a compromise. Ideally, all operations would be conducted so as not to contaminate the air which must be breathed, or the degree of contamination, would be kept at safe levels by ventilating devices. Only after the primary effort to achieve this ideal has proved to be impossible or impractical should the use of personal respiratory protective equipment be considered. Too frequently the apparent simplicity and the immediate economic advantage in merely providing respirators are the deciding factors in the choice of this type of protection. An understanding of the purposes, operations, and limitations of respirators is essential if respiratory protection is to be safely and intelligently applied to the varied types of hazards which exist.

There are, however, many industrial situations where the use of a respirator is specifically indicated for the protection of workmen; situations where it is impossible or impractical to secure a safely respirable atmosphere by other means. The definition of an irrespirable or unsafe atmosphere is admittedly sometimes difficult. A discussion of the methods for determining if the air is safe for breathing is beyond the scope of this paper, but mention should be made of the recently increased impetus toward establishing safe threshold values—the Maximum Allowable Concentrations which are being determined in increasing numbers for potentially toxic materials which may be volatilized in industrial processes. For this discussion, it is assumed that a respiratory hazard exists, that circumstances make it impractical to eliminate the hazard by other means, and that some form of personal respiratory protective device must be worn to permit the individual to safely carry on his work.

Many types of respirators have been found useful, and since many are commercially available, it is logical to examine them before investigating the factors which should determine the selection of a respirator for a specific hazard. Schrenk of the Bureau of Mines has classified personal respiratory protective equipment as follows:

(1) Those that afford protection by removing atmospheric contaminants ("Air purifying"), and (2) those by which a respirable atmosphere from an uncontaminated source is supplied to the wearer ("Air-supplying, or air-supplied").

The question as to the efficiency of respirators is satisfied in part by the arrangements for testing and approval setup by the Bureau of Mines of the U. S. Department of the Interior. For some years this organization has given an official approval to certain types of respiratory protective devices which pass the rather rigid requirements specified. There are, however, useful respirators which are not included in the approved list and which give adequate protection for many types of exposures. In the opinion of the writer, it is better to choose a respirator with a Bureau of Mines Approval, if a respirator of the types eligible for approval is indicated in the specific exposure. This is particularly pertinent when the opportunity and facilities in the plant for checking the efficiency of respirators are limited. In lieu of official approval, the integrity and recognized qualification of the manufacturer must rank high in the considerations for accepting the specifications given with a particular respiratory protective device.

What are the factors that should be considered in selecting a respirator for a specific hazard?

In many instances the actual selection will not require a step by step examination of each of these factors—the choice will be more or less obvious and made by simple "inspection," but if the selection is to be the best possible one, these principles must be examined, recognized, and applied. In most cases, a standard model of one of the commercially available devices will be satisfactory, but not infrequently the circumstances of exposure are such that some degree of modification gives a more adaptable and useful protection. How these individual factors may influence the choice of a particular type of respirator, or require a modification due to the peculiarities of the exposure, will be considered in some detail.

1. *The oxygen content of the contaminated atmosphere.*

Normal air contains nearly 21 per cent oxygen, but this oxygen content may be greatly reduced in covered tanks, in vaults or cellars without ventilation, and in other confined areas, particularly where fires or explosions may have consumed the oxygen or where large quantities of gases or vapors may have been generated. Although an individual may not be in serious danger as long as 12 per cent oxygen is present, a respirator, giving an adequate supply of oxygen must be used in all situations where there is the danger of an oxygen deficiency.

2. *The exact nature of the specific contaminants.*

It is extremely important to know the exact nature of the contaminating material—not only the chemical properties, but all the physical forms in which the materials may be encountered in the particular exposure. In addition to the respiratory protection, it may be necessary to prevent contact with the eyes and skin, hence the nature of the contaminant also determines the type of face piece or covering which is to contain the respiratory device. Of the two general classes of respirators, it has greater import in the selection of the air-purifying type. A particular absorbent may have a relatively high restraining capacity against one type of physical state of a contaminant and have little or no value against others. For example, a filter which gives effective protection against lead fume may permit the passage of significant amounts of lead in a gaseous form. Or a canister which will satisfactorily restrain the vapors of a chlorinated hydrocarbon solvent may be much less effective against gases accidently generated by the combustion of this solvent, such as phosgene.

There are a variety of absorbing materials which are used to "filter out" the contaminants in air-purifying respirators. There is no one "universal absorbing material." Since there is a direct relationship between the amount of the specific absorbent and the quantity of material absorbed, it is desirable to have as great a quantity of this specific absorber as possible. Occasionally, because of uncertainty as to which type of canister is indicated, the use of an "all-service" type respirator is recommended. This respirator affords protection against practically all types of gases, vapors, fumes, or smokes encountered industrially and would give protection by absorbing the contaminant in one or two of its layers, but its capacity for absorption would be much less than if the container were completely filled with the specific absorber. In contrast to the air-purifying respirator, the air-supplied type gives respiratory protection against all types of contaminants.

3. *The concentration of the contaminants and the duration of exposure.*

These two factors are considered together, for the concentration and duration are both important functions of the total capacity or "life" of a given amount of absorbing material. Theoretically, the air-supplied respirators afford effective protection against any concentration of contaminant as long as the air supply continues. The concentration and the duration of exposure impose very definite limitations upon the air-purifying types. Very little information is available concerning the absolute capacities of the varied types of absorbing materials for the variety of contaminants—even those against which they are most effective. In practice, the point of exhaustion of a given amount of absorbent is obvious if the odor of the contaminant is noted (it is assumed that the face piece is well fitted). Unfortunately some very toxic materials are odorless, for example, carbon monoxide, and other substances vary greatly as to their tendencies to fatigue the olfactory sense as the concentration of the gases or vapors passing thru the exhausted absorber increase gradually and thus may not give an adequate warning. In such cases, the absorber type of respirator must be used with caution, and the exhaustion of the absorbing capacity controlled by limiting the time of use.

Concentration alone places a definite limitation upon the use of air-purifying respirators. The Bureau of Mines has approved canister masks for protection against 2 per cent by volume of acid gases, organic vapors, and carbon monoxide, and 3 per cent of ammonia, and such approval indicates the effective life of the absorber at this level is at least 30 minutes. No published data could be found which gave the absolute upper limits of protection either as to concentration or capacity.

If the respirator has a Bureau of Mines Approval, the efficiency for a given concentration and a given time has been tested. For lower concentrations than the upper approval limit it is probably safe to assume a straight line relationship for the effective life. Thus, a canister effective against 2 per cent vapor for 30 minutes can be assumed to give protection against 1 per cent for 60 minutes, against 0.1 per cent for 600 minutes.

Since the efficiency of the air-purifying (mechanical filter) respirator for dusts, fumes, and smokes increases with use, the effective life is determined not by its failure to restrain the contaminant, but by its increased resistance to inspiration. When this resistance becomes uncomfortable, it is not uncommon for the wearer to relax the fit of the mask, and while he then can breathe more easily, the protection is lost.

4. *The character of the work to be done and of the work space.*

Here must be considered, whether the work is of an emergancy or non-emergency type, the amount and rate of physical exertion that must be done, the movements required in performing the work, the distance to be covered in the operation, the shape, size, and restrictions of the working space, and the time permitted for putting on the device. It is essential that devices for emergency situations give complete respiratory protection, and that special provision be made against failure of the device and the resultant exposure to an immediately dangerous atmosphere. Emphasis is on complete protection, with comfort and convenience important, but secondary. In non-emergency situations it is assumed that the individual could escape from the harmful atmosphere without any protection. Devices for these situations usually give more consideration to the comfort and convenience of the wearer. To illustrate how ore or a combination of the above factors have required the modification of standard equipment, the following examples are given.

In one manufacturing operation large quantities of a variety of solvents are evaporated in a completely inclosed apparatus, and the workman, on the outside of the machine, has not appreciable exposure. Occasionally it is necessary for him to place his head inside the machine, with a consequent exposure to high concentrations of hot solvent vapors. The work inside the machine is of such a nature that it must be started within a few seconds when the need arises, and the exposure may continue from a few seconds to many minutes. The workman *must have protection for breathing and for* the eyes. Because of the high concentrations, an absorber type respirator unless supplied with a prohibitively large amount of absorbing material would be quickly exhausted. Standard air-line models equipped with a full-face piece were tried, but required too long a time for the operators to put them on. Finally one of this type was modified by attaching the face piece to a spring type head-band in such a manner that the respirator could be put on in a few seconds. The short hoseline can be plugged in at any one of the numerous convenient terminals around the machine, and the simple insertion initiates an adequtee flow of air. The mask and hose attachment can be removed as quickly and easily as they were applied. This respirator has proved to be a very satisfactory solution to a difficult problem.

In this instance the high concentrations encountered favored the choice of the air-supplied mask over the absorber type, but the expense and difficulty in obtaining and maintaining a satisfactory air source seemed to outweigh this first indication. Other factors, the ease and speed of applying and removing the mask determined the final selection, since the positive pressure of the air-supplied respirator permitted this modification much more readily and safely.

In another instance it was found that the use of a small cartridge absorber type respirator was giving inadequate protection against the high concentrations of vapors encountered in spray painting the interiors of buildings. The alternatives in supplying additional protecion were to increase the quantity of absorbing material, or to use an air-supplied type. The relatively large volume of absorbent necessary to give complete protection for an eight-hour exposure to the high concentration of vapors, required either an inconventiently larger container or frequent refilling of a small one. A valid objection to the standard air-line models was that when it was necessary to move scaffolding or to perform other work in the room being sprayed, the painter must, to retain his air source, carry the supply line wherever he went, an inconvenient and even dangerous impediment to climbing on and off scaffolding and ladders. If he cut loose from the airline ,he was exposed to the residual concentrations of five to ten thousand parts per million, an appreciable cumulative exposure during the course of a day.

An airline respirator was modified to include a charcoal cartridge and automatic shutoff valves on both sides of the connection between the supply line and the respirator line. Thus when the airline connection is severed, the intake of air begins automatically thru the cartridge and continues until the reconnection with the airline again automatically closes the small valve in the base of the cartridge. These modifications frequently require considerable experimentation until a satisfactory result is obtained, but the protection and safety afforded is adequate compensation.

5. *Other environmental factors, such as temperature and humidity.*

Temperature and humidity may influence the selection in at least two ways since (1) they have a definite effect on the capacity of certain types of absorbents, and (2) they affect the comfort of the wearer. The effect of moisture on the life of activated charcoal against gasoline vapors has been shown in studies by the Bureau of Mines. The capacity of the dry charcoal (0.35% moisture) was six to twelve times as great as that containing 21 per cent moisture (in equilibrium with air at 25 degrees C and 85 per cent relative humidity, and showing no sensible moisture). The efficiency of hopcalite an absorbent (actually a catalytic agent for changing carbon monoxide to carbon dioxide) is readily destroyed by moisture. It is frequently difficult to control the temperature and humidity of the air for air-supplied respirators. The lines carrying the compressed air for general plant purposes even though the latter may be pure for respirator use, frequently parallel steam lines or pass thru hot areas, resulting in uncomfortably high temperatures at the terminals. Otherwise satisfactory compressed air may have had the moisture removed because of certain operating requirements, and the relative humidity values below 10 or even 15 per cent may cause discomfort and dryness in the respiratory tract.

6. *Personal factors: comfort, sex, age, physical condition, intelligence, cooperation, etc.*

Most of the respirators now available, if in proper working condition, can be worn, even for long periods of time, without appreciable discomfort if the wearer has become psychologically adjusted to the situation. It is probable that the chief cause of failure of protection in exposures where respirators are provided is the mental and physical discomfort due to faulty operation or maintenance—the clogging of filters, the unclean condition of the face piece, the unsatisfactory fitting to the contour of the face.* Unless the workmen are exceptionally enlightened the uncomfortable protection will seem worse than the hazard of the exposure. In general women adapt to the wearing of respirators less easily than men, and this relation increases with the size of the face piece or covering and the amount of equipment involved. Age and physical condition must be considered, especially when devices such as the self-contained oxygen breathing apparatus is to be worn in emergency operations. The intelligence and cooperation of the workmen are obvious factors.

7. *Control of personnel exposed—education, supervision.*

Too frequently the employee is merely handed the respirator with the order to "go ahead and use it." Instruction as to the reason for the protection, the exact situations under which he shall wear the respirator, the signs of faulty operation and what he shall do to correct them, and the care and cleaning of the device, must depend upon the particular circumstances, but it is better to err on the side of too much rather than too little. The education must include the supervision, and the supervision of the supervision. Rarely, the enforcing of protection cannot be accomplished by securing the cooperation, and altho it should be the last resort, compulsory measures may be required.

8. *Facilities for the care and cleaning.*

This very important condition to the proper functioning of respiratory protective equipment deserves more consideration than it usually receives. In plants where a number of respirators are used, provision should be made for the collection, cleaning, repair, and return of the respirators. In this connection, it should be stressed that, if possible, each man should have his own respirator, suitably marked, so that it is returned to him after cleaning. If it is impractical to provide each individual with his own respirator, provision must be made for thorough cleaning and repair if necessary before it is used by another workman. Where an individual is responsible for the cleaning and maintenance of his own mask, there must be systematic supervision to insure its being done. Yant, in the article previously referred to, suggests several methods for cleaning and sterilizing different types of equipment.

It is unfortunate that a simple formula cannot be derived which might be applied in every instance to indicate the most effective type of personal respiratory protection. For the majority of hazardous industrial exposures, the selection of a satisfactory respirator is a relatively simple one, but the factors discussed above must be recognized and applied if the choice is to be the best one. When the conditions of the hazard are unusual, it may be necessary to examine in considerable detail each of the factors, to weigh the advantages and disadvantages, and to repeatedly modify the device until a practical, safe, and comfortable form of protection is obtained.

ADJOURNMENT

Essentials of Healthful Industrial Environment

By MYRON A. SNELL

Supervising Engineer, Hartford Accident & Indemnity Co., Hartford, Conn.

In 1940 occupational accidents were responsible for 17,000 killed, 16,000 permanently disabled, and 1,350,000 temporarily disabled.

Although the recognized diseases of occupation are responsible for only a comparatively small proportion of these industrial injuries, many other factors in industrial environment are partly responsible for them. The personal habits of the individual as well as the nature of his home environment must also be charged with their share of this responsibility.

It is known that the incidence of the common diseases of life which are not due to the occupation is higher among industrial workers than among the balance of the population. Consequently, the life expectancy of the individual employed in industry is approximately eight years less than for the non-industrial worker. There is no doubt but that considerable improvement would result through the elimination of all of the unsatisfactory conditions to which workers are exposed in industry.

The Metropolitan Life Insurance Company conducted a study which revealed that approximately 2 per cent of all workers are incapacitated all of the time on account of illness. This means that the estimated 50 million workers in the United States lose four hundred million days annually on account of injury and illness, resulting in an average direct loss of wages at $5.00 per day of two billion dollars.

The Air Hygiene Foundation of America are engaged in a study of "Sick Absenteeism in Industry." Their records show that more than eight days are lost per male wage earner per year and more than twelve days per female wage earner per year because of sickness. A considerable proportion of this cost is assumed by the employer through lower production and poorer earnings.

Many companies have already discovered that a large proportion of the employees with poor health records also had poor safety records. These employers are spending money to improve the health of the employees through the elimination of unhealthful conditions at home as well as on the job. They receive a large return on the investment, not only through the reduction of time lost from the job through sickness but also from the reduction in the cost of industrial accidents and diseases.

Industrial Health

Although progressive employers recognize the importance to them of healthy, satisfied employees, it is unfair and unjust to impose upon them the legal liability for any illnesses or diseases among the employees that are not actually caused by the employment. Occupational disease laws should be carefully enacted and justly administered so that the employer will not be expected to provide general health insurance for his employees. The industrial environment is actually responsible for only a small proportion of the time lost from the job by employees.

Every employer should, of course, be required to provide his employees with a safe and healthful place in which to work. Such an environment can be achieved only through a study of every condition of industrial life followed by an adjustment of these conditions to the health requirements of the industrial worker.

Atmospheric Contaminants

Employees should not be subjected to the inhalation of atmospheric contaminants in sufficient concentrations to cause disease or poisoning, nor even in concentrations sufficient to cause any marked degree of discomfort. Polluted air is undesirable even though the foreign material in the air is not present in harmful quantities. Workers who are satisfied and contented with the working environment are not only happier and more efficient but healthier as well. Many individuals imagine all sorts of ill effects even from trivial industrial exposures, and may even worry themselves into an actual case of illness which was not caused by the environment but from the mental attitude of the worker.

Industrial Environment

A. SNELL

...ent & Indemnity Co., Hartford, Conn.

...ployees through the elimination of unhealthful conditions at home as well as on the job. They receive a large return on the investment, not only through the reduction of time lost from the job through sickness but also from the reduction in the cost of industrial accidents and diseases.

Industrial Health

Although progressive employers recognize the importance to them of healthy, satisfied employees, it is unfair and unjust to impose upon them the legal liability for any illnesses or diseases among the employees that are not actually caused by the employment. Occupational disease laws should be carefully enacted and justly administered so that the employer will not be expected to provide general health insurance for his employees. The industrial environment is actually re...sible for only a small proportion of the ... lost from the job by employees.

Every employer should, of course, be required to provide his employees with a safe and healthful place in which to work. Such an environment can be achieved only through a study of every condition of industrial life followed by an adjustment of these conditions to the health requirements of the industrial worker.

Atmospheric Contaminants

Employees should not be subjected to the inhalation of atmospheric contaminants in sufficient concentrations to cause disease or poisoning, nor even in concentrations sufficient to cause any marked degree of discomfort. Polluted air is undesirable even though the foreign material in the air is not present in harmful quantities. Workers who are satisfied and contented with the working environment are not only happier and more efficient but healthier as well. Many individuals imagine all sorts of ill effects even from trivial industrial exposures, and may even worry themselves into an actual case of illness which was not caused by the environment but from the mental attitude of the worker.

Atmospheric contaminants in industrial plants may consist of solid dispersoids, liquid dispersoids or gases or vapors. Solid dispersoids may be divided into dusts, fumes and smokes. Liquid dispersoids may be divided into mists and fogs.

Dusts

Industrial dusts are mechanically generated by many different processes and operations. Typical examples are drilling, blasting and crushing in mining and quarrying; polishing, buffing and grinding in metal finishing and stonecutting, polishing and abrasive blasting in the granite and monument industry. The dust generated in every case is of the inorganic or mineral variety. Animal and vegetable dusts are known as organic dusts and are generated by such operations as the processing of cotton, the working of wood, or the polishing of skins.

From the health standpoint, industrial dusts of above ten microns in size are of no importance because they are too large to be inhaled into the lungs themselves. Dusts below ten microns in size are not visible to the naked eye but can be seen with a microscope down to about two-tenths of a micron in size. Dusts containing sufficient percentages of free silica and asbestos may cause diseases known as silicosis and asbestosis if inhaled in sizes below ten microns in sufficiently high concentrations over a great enough period of time. Other dusts, with the exception of the metallic dusts, do not result in diseases, but many of them do result in certain changes in the lungs which are evidently not of great importance. Nevertheless, workers should not be allowed to inhale high concentrations of any kind of dust, regardless of its composition.

Permissible limits or maximum allowable concentrations for these dusts have been established by various organizations, but as yet there has been no complete agreement for dust concentrations in workroom atmospheres. The American Standard Safety Code for the Protection of Heads, Eyes and Respiratory Organs recommends "that no worker be continuously subjected without a protector to an atmosphere containing any form of mineral dust in quantity exceeding 5 million particles per cubic foot of a size less than 10 microns." The National Silicosis Conference in 1937 suggested that the maximum permissible concentration should be found by multiplying the percentage of free silica by the total dust count. If the result is under five million, the condition may be considered permissible. If the result is over five million, the condition may be considered too high.

California, Connecticut and some other states allow no more than five million particles of dust running high in free silica. New York State, in the Industrial Code adopted September 1, 1941, for the control of silica dust in the stonecutting and stone finishing industry, allow five million particles if the dust contains more than 70 per cent free silica, 10 million particles if it contains from 10 to 70 per cent, and 100 million particles if it contains less than 10 per cent free silica. The State of California has established a permissible limit of 5 million particles per cubic foot of air for asbestos dust.

Metallic dusts may also be generated mechanically in such operations as weighing and mixing red lead and litharge in the manufacture of paints or storage batteries. The permissible limits for such toxic dusts are the same as for the fumes of these metals.

Fumes and Smokes

Inhalation of the freshly formed fume of any metal in sufficient concentrations may cause the condition known as "metal fume fever," also known as zinc chills or shakes. Although this condition causes a great deal of discomfort and may be alarming to those who are not familiar with it, it is actually not a disease and has no permanent effect on the individual. The inhalation of the dusts or fumes of the toxic metals can also cause systemic poisoning if inhaled in sufficient quantities.

As yet there are no definite standards established for most of the toxic metals. The American Standards Association's Sectional Committee on Allowable Concentrations of Toxic Dusts and Gases is developing standards for cadmium, chromium, lead and mercury. They also propose to develop standards for antimony, arsenic, manganese and zinc. All of these standards will probably be available in the near future.

The Journal of Industrial Hygiene and Toxicology in the June, 1940, issue published a "Code for Safe Concentrations of Certain Common Toxic Substances Used in Industry." This code was prepared by a group of five expert industrial hygienists and contained a list of suggested permissible limits to be used as a guide until the time that the American Standards Association's committee had completed the standards for the substances mentioned. The maximum allowable concentrations for certain of the toxic metals were as follows: Cadmium 0.1 mg. per cu. meter; Chromium 0.1 mg. per cu. meter; Lead 0.15 mg. per cu. meter; Mercury 0.1 mg. per cu. meter, and Zinc 15.0 mg. per cu. meter.

Very little work has been done on maximum concentrations of smoke which can be tolerated without impairing efficiency or causing marked discomfort, and no limits have as yet been established.

Mists and Fogs

Mists are formed by the mechanical disintegration of a liquid by such processes as spray coating of paints or vitreous enamels. They usually range in size from about 50 to 100 microns.

Fogs are formed by the condensation of vapors. They vary in size from 5 to about 50 microns. Wherever hot alkaline cleaning or pickling vats are operated in a workroom in which the temperature is quite cool, the water vapor is apt to condense in the form of a fog in the room in the same manner that ordinary fog is formed in the outdoors. A mist which may be inhaled in spray coating operations may be rather complex in nature. In the case of spraying paints, it usually consists of a mixture of organic solvents of a varying degree of toxicity together with solid matter in solution or in suspension. These fine droplets in the form of mist may hold in suspension lead oxide as a pigment or other particulate matter of a toxic nature. In the spray coating of vitreous enamels a water vehicle is used but the particulate matter in suspension may contain toxic metals in the form of oxide, such as cadmium, lead and manganese. In addition, they sometimes contain finely divided particles of free silica in the form of quartz or flint.

The maximum allowable concentration in inspired air containing mist is the same as that for the vapors, fumes or dusts of the substances contained in the mist.

Vapors and Gases

While vapors are composed of the gaseous phase of substances which usually exist in the form of liquids under ordinary conditions, gases exist only in the gaseous state under ordinary conditions.

Vapors and gases are frequently but incorrectly termed "fumes." For example, "nitrous fumes" instead of nitrogen oxide gases. A liquid organic solvent such as carbon tetrachloride will evaporate from an open tank in a workroom and the vapors of carbon tetrachloride collect in the surrounding atmosphere. Thus the carbon tetrachloride can exist under the ordinary conditions of the workroom either as a liquid or a vapor. On the other hand, the oxygen and carbon dioxide gases in the air of the workroom cannot exist under such normal conditions in any other state.

There are a vast number of organic solvents in use in industry and the number is increasing each year through the discovery of new and better solvents in the industrial chemical laboratories. The extent of damage to the health of workers through the inhalation of the vapors of many of these solvents is not known.

American standards have been established this year for benzol of 100 parts per million parts of air, carbon disulfide 20 parts per million, carbon monoxide 100 parts per million and hydrogen sulfide 20 parts per million. The American Standards Association's Committee on Allowable Concentrations are at present engaged in the development of standards for acetone, carbon tetrachloride, diethyl ether, formaldehyde, hydrofluoric acid, methanol, nitrous gases, detrachlorethane, tetrachlorethylene, toluol, trichlorethylene and xylol. Tentative suggested standards for these as well as for about 20 additional gases and vapors are given in the June, 1940, issue of the Journal of Industrial Hygiene and Toxicology, as already mentioned.

Atmospheric Pollution

The only definite method of determining whether or not a concentration of atmospheric contaminants exists in the workroom that constitutes a health hazard is by means of collection and analysis of air samples.

These atmospheric pollution stud[...] the services of trained industrial [...] and the use of proper field and equipment. Many private compan[...] as individuals are equipped to do [...] for themselves or for others.

In addition, there are at the pr[...] 31 industrial hygiene units loca[...] many different states, who are p[...] do this work for industrial concer[...] request. In all but New York a[...] chusetts these units are operate[...] Departments of Health in cooper[...] U. S. Public Health Service. In [...] supplying the plant owner with [...] of the health hazards in this p[...] units make invaluable suggestion[...] correction or elimination through [...] proper engineering control method[...]

Ingestion of Toxic Substa[...]

The vast majority of cases o[...] poisoning occur through inhala[...] toxic substances rather than by i[...] by absorption through skin, for t[...] In the first place, the principal [...] toxic substances in industry is [...] halation and not ingestion or abs[...] the second place, in those few c[...] poisonous substances are swallow[...] almost entirely eliminated throu[...] mentary tract without being ab[...] the bloodstream and a large p[...] the small amount absorbed into [...] stream is further eliminated [...] liver. Consequently very little [...] gested poison gets into the gen[...] tion to cause damage to the vita[...]

In the case of an employee wh[...] with lead oxide in the manufactu[...] battery plates, he is inhaling any [...] may contaminate the working [...] rate of 16 times each minute du[...] tire day. On the other hand, he [...] but once a day on the job. In [...] may swallow at other times dur[...] an amount of lead which in itse[...] cause poisoning.

Skin Contact

A few of the organic liquids s[...] ethyl lead used in leaded gasoli[...] may cause poisoning by absorp[...] the skin. Such cases, howev[...]

These atmospheric pollution studies require the services of trained industrial hygienists and the use of proper field and laboratory equipment. Many private companies as well as individuals are equipped to do this work for themselves or for others.

In addition, there are at the present time 31 industrial hygiene units located in that many different states, who are prepared to do this work for industrial concerns at their request. In all but New York and Massachusetts these units are operated by State Departments of Health in cooperation with U. S. Public Health Service. In addition to supplying the plant owner with an analysis of the health hazards in this plant, these units make invaluable suggestions for their correction or elimination through the use of proper engineering control methods.

Ingestion of Toxic Substances

The vast majority of cases of industrial poisoning occur through inhalation of the toxic substances rather than by ingestion or by absorption through skin, for two reasons. In the first place, the principal exposure to toxic substances in industry is through inhalation and not ingestion or absorption. In the second place, in those few cases where poisonous substances are swallowed, they are almost entirely eliminated through the alimentary tract without being absorbed into the bloodstream and a large percentage of the small amount absorbed into the bloodstream is further eliminated through the liver. Consequently very little of the ingested poison gets into the general circulation to cause damage to the vital organs.

In the case of an employee who is working with lead oxide in the manufacture of storage battery plates, he is inhaling any dust which may contaminate the working area at the rate of 16 times each minute during the entire day. On the other hand, he usually eats but once a day on the job. In addition he may swallow at other times during the day an amount of lead which in itself could not cause poisoning.

Skin Contact

A few of the organic liquids such as tetraethyl lead used in leaded gasoline and benzol may cause poisoning by absorption through the skin. Such cases, however, are comparatively rare and most of the known toxic substances do not readily enter the bloodstream by skin absorption.

Approximately two-thirds of all occupational disease claims, however, are for dermatitis and other skin affections. Industrial employees come in contact with a considerable number of substances which invariably result in the development of a dermatitis condition. In addition, there are a great many other substances used in industry which cause abnormal skin conditions to develop in certain few individuals but not in others. This highly specialized subject has been given a great deal of attention in recent years and much information has been published about it.

There are two methods of prevention available. The first involves the use of skin tests to determine individual reaction to substances which are generally known to cause dermatitis. This is done before employment in the exposure, and employees who show a positive reaction are placed in other jobs.

The second method consists of preventing contact between the individual and the harmful substance through complete enclosure, exhaust ventilation, the use of rubber gloves or other protective clothing, or protective skin cream. Personal cleanliness also is an extremely important factor in the prevention of industrial dermatitis.

Infectious Diseases

A considerable number of industrial cases of anthrax, glanders, undulant fever and tularemia are reported every year. These diseases of animals are invariably contracted by man through ignorance or negligence on the part of the employees or their supervisors. Industrially they are easily contracted through contacts with infected hair or hides or the diseased animals themselves. Practically every such case could have been prevented either through sterilization of the animal parts themselves or through the use of protective clothing on the part of the employees.

Miscellaneous Diseases

There are miscellaneous conditions to which industrial workers may be exposed which are responsible for a considerable number of actual cases of disease. Com-

pressed air illness or caisson disease results from too rapid decompression after working under pressures greater than one atmosphere. Time and pressure tables have been established for maximum rates of compression and decompression which should be followed in all cases. In some states this is required by law.

Radiant energy when used in industry may result in serious consequences if adequate safety precautions are not taken. Workers should not be exposed to harmful amounts of radioactive substances or X-rays. In every case the protective measures published by the National Bureau of Standards should be religiously followed.

Both ultra-violet and infra-red rays have certain beneficial effects on human beings if they are absorbed by the body in moderate amounts. Light rays produced industrially, however, may have a serious effect upon the health of workers if proper personal protection is not provided. Cataract may result from exposure to the heat and glare of molten glass. Serious eye and skin burns may result from undue exposure to the bright arc produced in electric welding. The use of goggles with properly colored lenses, face shields, gloves, and proper clothing afford adequate protection.

Pressure, Motion and Shock

Synovitis, or tenosynvitis, or bursitis, or cellulitis of any of the joints of the body may result from any occupation involving continual or repeated trauma, vibration, pressure or friction. Examples are the diseases suffered by workers who spend many years in handling pneumatic tools used in such operations as riveting and drilling. If possible the employees of concerns engaged in such operations should be rotated so that no one individual is exposed to the harmful effects of conditions such as these for long periods of time.

Temperature and Humidity

The average comfort zone in the wintertime is from 63 to 71° E. T. (Effective Temperature). 66° E. T. is the most popular effective temperature as adopted by the American Society of Heating and Ventilating Engineers for individuals at rest wearing customary winter clothes living in the broad geographical belts across the United States in which heating of the convection type is generally used during four to eight months of the year. It doesn't apply to rooms heated by radiant energy, rooms with excessive glass area or those with poorly insulated or cold walls. In densely occupied spaces somewhat lower temperatures may be necessary. Satisfactory comfort conditions for men at work have been found to vary from 40 to 70° E. T. depending on the rate of work and the amount of clothing worn. In hot industries 80° E. T. is considered the upper limit compatible with efficiency and whenever possible this should be reduced to 70° E. T. or less.

In the summertime the average comfort zone is from 66 to 75° E. T. with 71° E. T. as the popular average. This is 4 to 5° higher average than in the wintertime.

The temperature differential between indoors and outdoors which should be maintained depends on a number of factors. A drop in temperature of 10° F. or more may be extremely harmful if it occurred suddenly, especially when the skin and clothing are wet with perspiration.

No standard has been established for the proper amount of humidity. It may vary from 30 to 70 per cent without discomfort. The air should be dry rather than damp. The common belief that dry air in itself exerts a harmful effect on the skin and mucous membranes has never been proved by convincing evidence, although there have been numerous investigations on the subject. The addition of moisture to the air of occupied rooms by any practical method has not been shown to have any beneficial effect upon health and comfort. Experiments have shown that the respiratory membranes of industrial workers exposed to hot, *moist* air are distinctly more abnormal than those of workers exposed to hot, *dry* air.

The maximum air movement should be [illegible] feet per minute with not less than 10 cubic feet per minute per occupant of the room taken from an outdoor source. Mr. Yaglou states that "an air movement of not over 40 f.p.m. is permissible under present engineering practice, when the temperature of the air current is 2° F. or less below ordinary room temperature. Current velocities as high as 200 f.p.m. may prove desirable in hot industries, but velocities much higher than this are uncomfortable and irritating and may blow dust off the floor."

Work in the hot industries may be responsible for a number of physiological derangements, the best known of which is heat exhaustion or heat cramps. The conscientious use of salt tablets by the employees in such industries has largely eliminated the disability and discomfort which were prevalent a few years ago.

Since the amount of rise in body temperature of employees in hot atmospheres has been shown to indicate disturbances in physiological equilibrium, the American Society of Heating and Ventilating Engineers has suggested an average "temperature rise of one-half degree in the average worker qualified by physical makeup and experience to work in hot industries, or a one- and one-half degree rise in an occasional worker" as the limiting factor.

The A.S.H.V.E. state that "the thermal environment cannot be properly adjusted to the requirements of human health and comfort without control of all the four basic factors concerned—temperature (true air temperature free from radiation effects) movement of the air, humidity of the air, and mean radiant temperature of the surrounding surfaces." Their research laboratories are at the present time engaged in a research program with the aim of establishing minimum requirements for air conditioning for industries which would be acceptable to everyone concerned.

Miscellaneous Conditions

Abnormal noise levels have a profound effect upon industrial workers and may result in deafness or other pathological ear conditions. The A.S.H.V.E. 1941 Guide contains a table giving the acceptable noise levels under various conditions. These noise levels vary from 10 to 100 decibels depending on the source and location. Dr. Knudsen reported that "long exposure to sounds above a level of 80 to 90 decibels or a brief exposure to more intense noises invariably impairs hearing. Other results are vestibular disturbances, mental fatigue, loss of efficiency, and extreme nervousness which can be traced to excessive noise. Some persons are more susceptible to excessive noise than others, but no one is immune to long continued intense sound. Noise has become more than a nuisance—it is a menace impairing the hearing of millions, robbing them of quiet leisure, restful sleep and taking a toll of the general nervous system of mental workers, neurotics, hospital patients and others who are noise sensitive." Noise reduction at the source may be accomplished by insulation, absorption or by reducing the noise from machinery and equipment. Most employees object to wearing ear stoppers but Dr. Knudsen has devised an ear defender providing an insulation of 35 to 40 decibels which is very effective.

Tobacco Smoke and Body Odors, with the exception of toxic atmospheric contaminants, are the principal factors to be considered relative to comfort and efficiency. Such odors are not harmful but nevertheless have a profound effect on individuals. In the same manner other disagreeable odors adversely affect the efficiency of workers.

The amount of outdoor air needed for body odors should be somewhere between 10 and 30 c.f.m. per person depending on age, socioeconomic status, air space in cubic foot per person, outside and inside temperatures and humidity. The minimum air change requirements for tobacco smoke has not yet been definitely determined but probably should be in the neighborhood of 5 to 15 c.f.m. per person. These air requirements are in addition to those needed for indoor recirculation in order to maintain the humidity and temperature at the proper levels.

Space Allotments for industrial workers are of questionable value and minimum requirements for them cannot be given at the present time because this factor is so closely associated with many others, principally that of the ventilation problem.

Illumination of the proper intensity for the type of work to be performed should be provided for all industrial workers. The equipment providing illumination should be of the proper type and installed so as to give maximum efficiency with a minimum amount of glare, eyestrain, or other adverse effects. Improper lighting may be responsible for actual diseases of the eye in addition to eyestrain and eye fatigue. Improper illumination may not only result in poor efficiency but also in a high accident frequency. The number of foot-candles for proper industrial illumination varies up to a point beyond 100. They are published in table form for various occupations in Safe Practices Pamphlet No. 22 on "Industrial Shop Lighting."

Other Factors which should be considered in the subject of industrial health are working postures, and the proper kind of floor covering. Standing or walking on concrete or other hard surfaces produce fatigue and may even be harmful to some individuals in prolonged exposures. The Gilbreth International Committee on Industrial Fatigue place great stress on the harmful effects of improper posture among industrial workers. The use of proper chairs eliminates fatigue and greatly improves efficiency.

The comfort and efficiency of industrial workers are also affected by the color scheme of the environment, the length of the working hours and the rest periods used in connection with them, the general housekeeping conditions and cleanliness of the plant, locker, washroom, sanitation and eating facilities, medical facilities, and by proper provisions for recreation. Most of these, however, have little or no important effect upon the actual health of the industrial worker.

ADJOURNMENT

TUESDAY AFTERNOON SESSION

October 7, 1941

Presiding: H. S. SIMPSON, Safety & Sanitation Engineer, Caterpillar Tractor Company, Peoria, Ill.

CHAIRMAN SIMPSON: I shall first introduce the speakers on this panel, as follows:

C. A. Sholly, Safety Director, Sibley Machine & Foundry Corporation, South Bend, Ind.

M. W. Dundore, Production Manager, Beloit Iron Works, Beloit, Wis.

J. P. Boaden, Safety Director, the Union Malleable Iron Company, East Moline, Ill.

W. H. White, General Superintendent, Pittsburgh Rolls Division, Blaw-Knox Company, Pittsburgh, Penn.

J. William Fehnel, Chemist of the Industrial Hygiene Laboratory, Metropolitan Life Insurance Company, New York City.

C. J. Brinkworth, Foundry Superintendent, Link Belt Company, Indianapolis, Ind.

As you will note on the program, we have some six questions which are more or less tentative questions. In the case of several of these questions, we shall probably talk around them rather than talk directly on them. The first question is:

"How can you interest a foundryman in safety?"

We have assigned this part of the program to Mr. White.

Foundryman Safety Interest

W. H. WHITE: Being an operating man, my time and efforts have been spent mostly in the technical end of industry. But having had training in the United States Navy years ago, and having gone through the period of the last war, my first lesson was brought home to me when one of the admirals called me into his office one day and said, "White, we need more *thinking* mechanics." In analyzing that statement, we find that what the admiral really meant was that no matter how humble a man's job may be, he must think and perform that task to the best of his thoughts. We are not all created equal in so far as ability is concerned.

So industry, I believe, stands guilty today in not doing a better job of training than it is doing. I want to quote you a concrete case. Our production recently, like everybody else's, has jumped forward. In our small roller shop, which has something like 30 lathes, our CIO contract requests us to promote men from the labor gang to the machine. A year ago we used to put these boys in and then let the immediate foreman do the training. This year, however, through the Personnel Association of Pittsburgh, I learned something about that. They advocate putting one man, who is relieved of all production responsibilities, to take over this training responsibility.

It worked like a charm. In two weeks, by assigning a man who was truly adapted to the work and relieving him of his own work and responsibility for production, he turned out 15 men for us who were able to operate these machines efficiently. The foreman went along with his usual duties—kept his records, reports up—supervised the shop—and I could see the vast difference.

Now, a foundryman can be interested in safety. At breakfast this morning I asked Mr. Simpson whether he meant the supervisor or the employee when asking this question. Of course, he takes for granted the fact that the supervisor is interested in safety, as he should be. So we begin with the employee. There are many methods which you can use to interest him. I wonder if it is really too much trouble for the general superintendent of a plant—even of one that employs as many as 3,000 men—to take about thirty seconds' time to shake hands with a new employee and say to him, "We hope you will be happy with us, and please be safe for your own benefit as well as that of your family"? I do that. I think I would do that even if we had 5,000 employees. We have used psychology in our contract with the CIO; at least two members of the CIO are on the Safety Committee, our idea there being to make them safety conscious.

I don't know of any other way to interest the man—the foundryman—in safety other than to have the man highest up in the company, the one who is most respected, together with the safety engineer, who is supposed to do that as a duty, wish him well and tell him that he is expected to be careful in obeying safety regulations.

The thought I am trying to bring out is this: I don't care whether you work for a little company or a big one, I have come to the conclusion that you should stand four-square to the wind, raise your head, and go right into the front office on an equal footing with any man in any mill anywhere. You are very valuable today and becoming more and more so as time goes on. It is our task to teach the higher-ups that they must take a little time to listen to the safey engineer; to let them know that they are not only dealing with dollars but that they are dealing with human lives.

The way to interest a foundryman in safety is to live it—think it—and talk it yourself; and to have the president of the company come up to him, when he starts to work, and say, "I welcome you to this company, and I hope you will be a safe and satisfied employee."

CHAIRMAN SIMPSON: Mr. White has come pretty close to the crux of the situation. If you do what Mr. White has suggested even once, things are going to be pretty well in your favor as you go along.

CHARLES T. LINDSEY (Carnegie-Illinois Steel Corp., Gary, Ind.): Mr. White stated that he thought a safety inspector or engineer would feel the responsibilities more keenly than even the general management of the plant. I would like to have him explain that.

MR. WHITE: I know that if you are a manager of a plant and a fatal accident occurs in your plant, you don't like it; I know that you feel bad about it; but you get over it in time. The safety engineer feels just as bad about it; but when he is making a summary of plant experience, the thing flares back at him and hits him in the face more definitely than it does the manager. It is always before him. It remains with him longer than it does with the management.

MR. LINDSEY: You say that it would reflect more upon the safety engineer than on the management?

MR. WHITE: I didn't mean that. There is no reflection on him—not at all—but I think that he is the man who feels the brunt of the thing more than the management.

W. E. LEAVITT (Cincinnati Milling Machine Co.): We have inaugurated a system of meeting all new employees and giving them a safety talk for a matter of perhaps half an hour before they are ever permitted in our shops. We have found that extremely valuable, not only in making a new contact with the men but in getting them started off right.

W. R. TOTHILL (Grand Rapids, Michigan): Our foundry is one of several departments. We feel that while it is very necessary to introduce a man properly, our accident record shows that most of the accidents happen to the older employees. I believe it is true of foundrymen, as of other workers, that the best work in safety is done when a man can be taken away temporarily from his active duties—either during working hours, if that is best, or after the work shift changes—and taught something about safety.

CHAIRMAN SIMPSON: I don't think there is any arguing that point. Look at it this way: we hire engineers to study which machines we should purchase; and then sometimes just reach in, almost as though it were a kind of grab-bag affair, with our eyes shut, and put men on those machines and expect the two to balance. A lot of us have learned the hard way. If we steered men correctly along the way, why it would save all of us a lot of trouble, if not fingers.

We will pass on to the next question. "When is a Foundry Safe from a Health Standpoint? What is Safe Atmosphere?" I will ask Mr. Fehnel to answer that.

Safe Foundry Atmosphere

J. W. FEHNEL: Perfection in the study and correction of industrial health hazards is most difficult because the processes are mostly changing; and new substances are being used, producing more problems to study.

I cannot help but reflect back to 1931 when I made an extensive foundry study in the Milwauke district. At that time, when it was proposed to put in, for instance a program of housecleaning, the idea was considered ridiculous. Castings had to be found every-where in a dirty shop. When you told them about putting in a permanent type of flooring, it just couldn't be done because the hot metal would splash around and would do damage to anything but a dirt floor. When you suggested cleaning off the accumulated dust on the rafters and pipelines, they simply laughed at you and that's about as far as you got.

All foundries faced the silicosis scare—and it was a scare—we got panicky. After completing a comprehensive study, sponsored by the Manufacturers Association of Milwaukee, which included not only the study of the pollution but also physical examinations and x-rays on the older employees, what were the findings? Ten per cent of the older employees showed that they had fibrosis, but not to any serious degree. That made us feel a little better. But in the meantime some of us took the attitude that, "Well, it's better to let a sleeping dog lie. We are not going to x-ray the younger men."

The legal aspect of silicosis was far greater than the true health hazard, and it still is today. First of all, in a hand-operated foundry it is less prone to be an extensive hazard than in a mechanically operated foundry. However, in the program that is speeding up increased production, we have very few small hand-operated foundries. Today, if you will make a study of your foundry, you can do a lot as a first step; which is the adoption and practice of a good housecleaning program. Use a broom and use it diligently and often. Get rid of that pile of accumulated old glass and old core sand and what not that so often seems to be found in the middle of a foundry.

Then pick out your dust-producing operations, one at a time, and eliminate them. That can be done by proper study and proper application of methods. It is not always a case of putting in an elaborate exhaust system which is expensive to install. Often the application of good common sense will cure the offending dust-producing operation.

However, there are a lot of other hazards associated with foundry operation which are far more serious than the silicosis hazard. Recently I had occasion to study a foundry that had been operating under a process of adding lead shot to the ladle before casting. After about 14 months, they had two definite cases of hospitalized lead poisoning.

Now in this method of the addition of lead shot to the ladle, at least 90 per cent of the lead was vaporized immediately, polluting not only the immediate area around the cubicle but apparently throughout the whole foundry area; and we found a lead concentration during this pouring operation which was far too great for a continuous exposure.

Of course, the use of various metals added to the ladle today is a common practice. I would also like to warn you against the use of saline, which produces extensive kidney damage and is to be avoided. At least any of these substances that produce incapacitation or illness should be used in such a way that the fume or vapor does not get into the general foundry atmosphere. Some people might think that it is impossible to add lead to the ladle without dispersion of vapor into the air; but it can be done under a hood.

In the steel industry, for instance, one process, producing tremendous gas bubbles, is to add carbon tetrachloride to the mold at the time of pouring. Carbon tetrachloride under those conditions breaks down and liberates or generates a type of chlorine. I saw one installation where there was an exhaust right under the platform, which was very effective in removing those fumes.

We come now to the question, "What is a safe atmosphere in a foundry?" Well, I would like to tell you just what is safe; but I really don't know. I have seen foundries with dust concentrations extremely high which had no silica content. When I say high, I mean that it was somewhere between 80 to 100 per cent. Theoretically, that is a safe atmosphere, although free silica content is way below 25 per cent. But I would say this: I would attempt to eliminate the dispersion of any substance or any dust or fumes or gas into the general atmosphere that is harmful to the men, in order that they may not develop industrial incapacitation or illness.

CHAIRMAN SIMPSON: Any questions?

QUESTION: I would like to ask the gentleman what he would suggest as a precaution against asphyxiation in the case of molders who use salamanders during the winter months—open salamanders? My company has experienced several cases where artificial respiration has had to be employed. Yet these salamanders are necessary in a at a minus pressure, which dissipates the heat, and the fumes are exhausted out of the building. That tunnel runs the length of the conveyor from the pouring station to the shakeout; and at the shakeout some of our units have the automatic tripoff; the shakeout and everything else is completely housed. Some of the shakeouts have the cross-flow type of ventilation; that is, up high to one side from the point where the work is being carried on; there is a heavy draft of fresh air across the breathing zone and it is evacuated on the opposite side.

SAME QUESTIONER: Ours works on the same system, but you are bound to get a lot of dust in that shakeout and also from your mixers. Our mixers are right in the center of the unit and not above it. Also, on that type of unit it is necessary to use a metal mold. After all, you are going to spray your mold with something; and you have the vapors that arise from whatever spray you are using. What do you do about your spray men there and the men working on the molds around them?

CHAIRMAN SIMPSON: The overall atmosphere is being churned around quite a good deal by a central system. We have extremely high roofs in the building, and we do use a lot of coal to heat that building, and we use a lot of energy to ventilate it. But, by George, we are ventilating it. Bill really likes to visit it. Will you finish that story, Bill?

MR. FEHNEL: Well, line casting is a common practice in a lot of large foundries. One of the first that I ever saw controlled, was that of the Buick foundry in '31 and '32; and it was being effectively controlled by means of tunnels and exhaust shakeout drafts. Several methods have been experimented with and used at different times. If all these things fail, however, you know the solution: the thing to do is to apply good general ventilation. In other words, when an atmosphere has a harmful effect, you can make it safe by an increased dilution; you can bring it down to a safe concentration. That may be necessary in many cases where an excessive supply of fresh air is introduced at the floor level and creates an updraft. It also may be necessary in some installations to have a combination of exhaust and forced drafts; that is, the area at which you are exhausting may be too wide to pull across effectively, and so you blow it in from the other side and blow the dust to the exhausted side. We have done that very effectively in some shakeout operations.

MEMBERS (Birmingham, Alabama): In the Southwest we use a steel frame building usually with a sheet iron siding, if any, and it is rather open at times. Can you tell us whether there is a hazard there as compared with the brick building that you use in this section of the country?

MR. FEHNEL: I'm glad you brought that up. I have had some experience in gas with the Republic Steel. Incidentally, that steel mill in general is free of health hazards from dust and fumes due to the construction of the building and the natural atmospheric conditions. I made a few notes on some of my work. Here is one on a foundry in Los Angeles. This was made in 1936. It is too good to believe. The general air in the foundry averaged .8 million; and the squeezer molding, which was the highest count, was 8.8 million; but in the machine shop we had 40 million at the milling operation.

The construction of a building with open sides would be a type that would have good, natural chamber-effect ventilation. However, a machine shop is a typical factory brick building, totally enclosed and with steel sash windows. So we have a far more hazardous condition, so far as the concentration of dust in a machine shop is concerned, than we do in a foundry.

RICHARD M. BAKER (Baltimore, Md.): We have been trying to use incinerators. We have about 350 trucks working in Baltimore which carry all sorts of trash and rubbish, including powders and paints and undertakers' powder of some sort; but unfortunately we haven't been able to do very much with the ventilation of our incinerators. We have one large pit where a crane goes down into the pit, picks up a load of this stuff, and lifts it onto the conveyor after the trucks drop the trash into the pit. Of course, we get a lot of dust. I wonder if you could tell us about some chemical which we might use that would be helpful in this regard?

MR. FEHNEL: I do not know of anything that you could apply to the operation you have described, except possibly to use water. If it is an intermedial operation, then maybe you can give these men a certain type respirator. If it is a constant ope... you may have to apply some ... just method.

Respirator Problems

...HAIRMAN SIMPSON: Our ...ker, Mr. Brinkworth, is going ... the question: "How can you ...rkman to Wear a Respirator All ... Weather when he is Perspiri... Difficulty Breathing?"

... J. BRINKWORTH: Of all t... ...ive equipment available for foundr... the respirator, largely because ...nfort to the wearer, particularly ...ather, is probably the most diff... to employees. The chief reaso... the factor of discomfort, is ... done very little in a tangible ...monstrate to the worker the need ...rection.

In many cases we have had exper... ...ese of protective masks by our cu... in the use of this particular ...sk it should be remembered that ...ation of the respiratory passage ...ed, it is only partially efficient, so ... is only partially efficient, so that a... dust is concerned, it does not ...100 per cent type of protection.

With the scarcity of labor toda... ...ich makes for a more independen... the part of our employees, our ... selling use of an approved typ... ...ator is going to be far more ser... was five years or so ago. Until s... effective but far more comfortab... ...pirator is designed, our efforts ...be devoted more than ever befo... ...sk of selling this type of protectio... ...oyees and to the job of selling o... ...ry staffs on the need of far bett... ...ing ventilation and exhausting ...ous dust.

MEMBER: We have found th... ...ere are enough respirators in use ... servicing is an important facto... ...n't wear a respirator today if ...ed to become dirty and in a me... Where there are a large ... ...pirators being used, a central ...vice station is a valuable asse... ...tion the respirators could be c... ...viced, if necessary, sterilized, of respirator. If it is a constant operation, then you may have to apply some sort of exhaust method.

Respirator Problems

CHAIRMAN SIMPSON: Our next speaker, Mr. Brinkworth, is going to answer the question: "How can you get a Workman to Wear a Respirator All Day in Hot Weather when he is Perspiring and has Difficulty Breathing?"

C. J. BRINKWORTH: Of all the protective equipment available for foundry workers, the respirator, largely because of discomfort to the wearer, particularly in hot weather, is probably the most difficult to sell to employees. The chief reason, other than the factor of discomfort, is that we have done very little in a tangible way to demonstrate to the worker the need, for such protection.

In many cases we have had experience in the use of protective masks by our employees. But in the use of this particular type of mask it should be remembered that while irritation of the respiratory passages is reduced, it is only partially efficient, so that as it is only partially efficient, so that as far as silica dust is concerned, it does not serve as a 100 per cent type of protection.

With the scarcity of labor today, all of which makes for a more independent attitude on the part of our employees, our problem of selling use of an approved type of respirator is going to be far more serious than it was five years or so ago. Until something as effective but far more comfortable than a respirator is designed, our efforts will have to be devoted more than ever before to the task of selling this type of protection to employees and to the job of selling our supervisory staffs on the need of far better housekeeping, ventilation and exhausting of dangerous dust.

MEMBER: We have found that where there are enough respirators in use, the care and servicing is an important factor. A man won't wear a respirator today if it is allowed to become dirty and in a messy condition. Where there are a large number of respirators being used, a centrally located service station is a valuable asset. At this station the respirators could be cleaned and serviced, if neessary, sterilized, and spare parts kept at all times, so that when a respirator became out of order, it could be properly put back in shape again.

In some places they use a system whereby each respirator is kept in a paper bag and when a man reports for duty, he can specify which respirator is his.

C. J. BRINKWORTH (Link Belt Co., Indianapolis, Ind.): Do your employees wear respirators all the time?

SAME MEMBER: We have some cases where they do, but we are not proud of the fact that they have to do so. The day is coming when those conditions will be eliminated and when men will be working in more comfortable and safer conditions.

JAMES NEWKIRK (Allis-Chalmers Company, Milwaukee, Wisconsin): We have covered this question of keeping the respirators clean quite well. Every respirator is returned to the department from which it was originally issued. Every eight hours it is sterilized, washed in hot water and placed in an oven warm enough to dry it thoroughly without hurting any of the rubber parts.

But we still have a lot of difficulty, especially in hot weather, in getting the men to wear them. However, by the use of these cotton facelets which the various respirator companies put out, it is a great relief to the men when wearing their respirators over it. Whereas the dust as a rule, especially in foundries, will stick to a man's face and the rubber will irritate it, these cotton facelets or pads will absorb a certain amount of the sweat and dirt.

MR. BRINKWORTH: Do you mean the band around the forehead?

MR. NEWKIRK: No, you are thinking of the sweat pad.

MR. DUNDORE: In Beloit we have quite a few employees who have hay fever and they wear respirators from five o'clock in the morning until the evening all summer long without any complaints at all.

MR. BRINKWORTH: That is a very good thing to hear. Are they forced to wear those in anyway?

MR. DUNMORE: No, they just do it for their own comfort.

MR. WHEELER (Niagara Falls Metallurgical Company): We have a lot of men wearing respirators at our plant. They are quite fussy about having their own respirators. We bought some large cans—somewhat larger in size than a one-pound coffee can—nicely enameled, and printed the names of the employees on them. By placing their respirator in this can, it becomes a personal affair and that goes a long way with them. These cans are picked up every night and taken to the service department, where they are serviced. The men realize that, because of the work they do, it is really essential, that they wear these respirators; and we do have men who wear them eight hours a day.

MR. BRINKWORTH: Do they wear them full time, summer and winter?

MR. WHEELER: Yes.

MR. CRANE (Erie, Pennsylvania): For a number of years we have been having trouble getting our men to wear respirators. We found that by trying different kinds of respirators to fit the job instead of trying to use one particular kind for the whole plant, we could get the men to wear them. We use a type that is not very heavy and yet approved by the Bureau of Mines, and we also use the sweat pads with them. The sweat pad over the head collects the moisture and dirt which streams down the worker's face.

MR. DUNDORE: We try to fit the respirator so that it will enhance the physique of the man who has to use it. Years ago I had a lesson taught me by a negro workman, to whom we gave a respirator to wear. He complained that it made a Ubangi negro out of him, for which reason he wouldn't wear it in spite of anything we could do. So we shopped around, got something that enhanced his physique, and he was then proud to wear it.

MR. BRINKWORTH: In other words, use psychology.

MR. FEHNEL: A respirator should not be applied as a cure-all. In a lot of industries the first solution to a dust problem is to put a respirator on a man; they think that after they have purchased a respirator, their concern ends.

Mention has been made here about personal respirators. One of the larger manufacturers has a system like this. A man comes to work in the morning and receives a personal respirator which has been serviced during the night. He likewise receives a new fiber pad, clean and sterilized, and the whole thing is handed to him in a closed container. He uses this during the morning shift. At lunch time he turns that in and after lunch receives another clean one. In other words, he uses two respirators which have been serviced at night, wearing each one four hours. Therein lies an important consideration: the proper service on these things and the proper maintenance. Another big factor, although somewhat expensive and perhaps inconvenient at times, is that of having several types of respirators on hand and letting the man select the type which he likes best.

CHAIRMAN SIMPSON: In summing up this respirator problem, first of all, a very careful survey should be made of the foundry. First find out what the problem is; not just one grab sample; but study it for a week or so and get some definite idea as to what it is; then decide what you are going to do. Are you going to ventilate the place, or will you have the men use respirators? If you have the men wear respirators, then you must keep on selling them with the idea of the importance of wearing them by keeping them in individual containers and washing them and so forth.

Well, we will next hear from Mr. Sholly, who is going to tell us something about the types of goggles that he has used.

Types of Goggles

C. A. SHOLLY: I shall, of course, only give you a statement of our own experience in the Sibley foundries. Our foundry is a small one. The men in our shop do not wear goggles to the extent of 100 per cent. It is not necessary in all of our operations. However, wherever goggles are used, one thing is certain: they have hard lenses. We use only one type of lens—the very best obtainable—and the reasons for that are obvious.

Getting our men to wear goggles came pretty easy after we had a sad experience in our plant. One of our men lost both of his eyes. After that happened, the management decided to change its tactics. Instead of saying, "We will try to get the men to wear goggles," they said, "We will try to educate them so that they will see the necessity of wearing goggles." Although at one time we had difficulty in getting the men to wear

hich has been serviced
le likewise receives a new
. sterilized, and the whole
him in a closed container
g the morning shift. At
s that in and after lunch
ean one. In other words,
irators which have been
wearing each one four
s an important considera-
ervice on these things and
iance. Another big factor,
t expensive and perhaps
ies, is that of having ser-
rators on hand and letting
type which he likes best.

SIMPSON: In summing
problem, first of all,
y should be made of the
nd out what the problem
grab sample; but study it
and get some definite idea
then decide what you are
you going to ventilate the
u have the men use respir-
e the men wear respirators,
ep selling them with the
rts of wearing them by
individual containers and
d so forth.

next hear from Mr. Sholly,
tell us something about the
that he has used.

es of Goggles

Y: I shall, of course, only
nent of our own experience
undries. Our foundry is
men in our shop do not wear
xtent of 100 per cent. It is
all of our operations. How-
oggles are used, one thing
ve hard lenses. We use only
—the very best obtainable—
for that are obvious.

men to wear goggles
we had a sad experience
of our men lost both of his
happened, the management
nge its tactics. Instead
ll try to get the men to wear
aid, "We will try to educate
ey will see the necessity
." Although at one time
n getting the men to we

goggles in many instances, today our goggle problem is practically whipped.

Our experience has shown us that you can't use just one type of goggle throughout the entire shop. Starting with the cube-type goggle, which is well ventilated, we used a medium colored green lens. This same lens is used elsewhere and we found that it was quite satisfactory. However, we started a little from that recently in one of our hot places where we have three cupolas, so that a man is troubled by perspiration; we permit him to use a face shield with a monel screen, and he is getting along nicely.

Our ladle men are supplied with spectacle type goggles, with insulated nose piece and sight shield. They also use a medium green lens. We find that that is the safest, because when a man looks over the ladle and then looks about him, he doesn't have that glare of the ladle and he can get along much better.

In the case of our molders, we have several problems. We gave them just an open spectacle type of goggle, and we had our old-timer problem there also. But following an eye injury to a molder, it became necessary for all of them to wear goggles. We gave all of them a pair of goggles to wear, and then we issued instructions to the effect that if any molder didn't wear his goggles while working, he should not be given any iron.

We started out with the spectacle type of goggle until we found that sometimes molders would get splash backs. Burning particles would strike the back side of the lens and rebound in the eye. Such a man was in line, of course, for another type of goggles almost invariably. So we are encouraging wherever we can the wearing of a ventilated cup-type goggle or the goggle with the screen. The spectacle goggles are turned in, having become obsolete, and they are replaced with these side-screen goggles, and we find that these are giving excellent results.

With regard to the lens, the older men claim that they cannot judge the heat if they have colored lenses. Therefore we give them a clear lens. Among our men we find that many of them prefer medium-shaped lenses. We are permitting some of our molders who wear the spectacle type of lens to use a cover glass, although others prefer to use the monel screen.

In our shakeouts, this same screen disk was the happy solution to a great problem. We have some floors which contain a large number of molds, and the molds are quite large, and there is an excessive amount of heat and steam rising from those molds; and the perspiration falling on the lens was a constant hazard. Our solution was in finding these monel screens, which we put into cup-type goggles. However, all the men do not have to use this type of goggle, as long as they wear some sort of goggles while they are working.

Last summer during the heat we were faced with a problem. Some of our men who were not wearing goggles continuously were approached by their foremen in a sort of rough way and he insisted that they wear goggles. Consequently, they went to a certain committee, and that committee came back and said that our men didn't have to wear goggles. As a substitute for the goggles, therefore, we thought we would try face shields, using a monel screen, and the men who objected to wearing the goggles are now using those.

In the case of the chippers, we have never had any trouble with goggles. We thought we had that problem whipped by a deep-cut type goggle, but then we introduced the high grinders and we found we had to fit the thing over again.

We also are confronted with this persiration problem. We have found that we can secure an extension ring which sets the lenses a little further from the eye. When we do this, we have less trouble, of course. It cuts down the range of vision a little bit, but nevertheless I think the additional safety is there because they do not have a steaming goggle.

Our cover-type goggles, of course, are worn in all cases by men who have had corrective lenses made. I really don't see, just considering this matter from our past experience during the last few years, how the goggle situation, if attacked properly, should turn out to be a very hard problem.

B. S. CORNWALL (Insurers Service Corp., St. Lous, Missouri): Our aluminum workers work in front of a small oven. They take their ladle of aluminum, turn around while in front of the oven, lean over, and pour it into a die. They are right over that heat all the time. Our experience has been that when they wear goggles, their face around the eye becomes tender, and they are rebelling against wearing goggles, especially of the closed type. I wonder if anybody has had any experience with close work of that sort?

MR DUNDORE: On all hot metal work in our plant we insist that they wear, and we provide the men with, asbestos lined goggles, which does away with the transferring of the heat, and these have a bakelite molded frame. I believe you will find that these are on the market commercially, and you will get a lot of satisfaction from that type of a goggle in preference to any other kind of a frame—a metal frame particularly.

CHAIRMAN SIMPSON: While Mr. Dundore is on his feet, I would like to ask him this question: "When does safety education stop or start?"

Safety Education

MR. DUNDORE: When does safety education stop? I can sum it up in one word: when the operator is dead!

I think it would be well if you reported to all employees that the country today is largely concerned with this subject of eyesight; that once you have an eye injury or lose an eye, nothing can be done to replace it; and that is one lesson you can get over to your employees.

Safety education, so far as I am concerned, starts with the management and probably ends with the employee. I don't think it should ever end.

I believe that safety education can be carried on very nicely in the average plant by the utilization of safety slogans printed on the back of the time cards, so that as the employees punch their time in and out four times a day, they will be confronted by this slogan as a safety reminder. The cards and the slogans could be (as they are in our plant) changed every week. At the same time that the name is printed on the clock card, this safety slogan could also be put on it.

Every inter-office envelope bears a slogan on the top of it saying, "Safety is everybody's business." Those envelopes are continually passing around throughout our plant. We have 19 different departments, and we have one mail boy making a route every sixty minutes. Those loads of departmental envelopes containing orders, instructions, copies of letters and what not, are always face up, on the foreman's desk—always in transit throughout the shop—and whoever opens these envelopes is first confronted with this slogan, "Safety is everybody's business."

I think the management is also lax to a great extent in not fitting goggles individually. I don't know of any two individual's faces which are exactly alike. It's a job. The education must be done. I don't think we are getting our young men young enough as regards this matter of being educated along the line of what to expect in the problem of safety in industry. In Beloit I have been trying to institute a safety program in the schools. I started out with it last year in high school, and I am glad to say that at the present time no youngster matriculates from the Beloit High School unless he has taken up and received credit for a course in first aid.

Also, the manual training departments in the high school are being furnished with goggles, not by the apathetic school board but by my own company, free of charge. Our education in Beloit is starting in the schools and not starting in industry, where I sometimes think it is a little bit too late to begin.

One of the previous speakers said something about talking to an employee about safety after he is hired. We speak to an applicant before he is hired. He can think the matter over that night. If he doesn't like what we prescribe to prevent accidents after he starts to work, he does not have to show up the next day. We would rather not have him. It doesn't cost us a dime at that time, but it costs us a great deal of money after we have hired a man, he has worked with us for a time, and we then find out that he doesn't like the arrangement we have made.

I also believe that a lot of employers throughout the United States miss a good bet by not starting and keeping up a safety paper. I find that you can sell more safety in a shop paper than you can by talking to a thousand employees once a year at an annual meeting on the subject.

I find also that a review of all accidents which occur in the plant once a month

...g it drawn to the attention of t...
...who in turn hands it over to...
...re involved, is a good safety r...
...her words, talk it over with...
...ee after the accident has happe...
...it has been investigated.

I also believe that it is poor polic...
...men to work in your plant wh...
...has not been checked or correct...
...t least three years. A good ma...
...are due to the fact that men ar...
...with the glasses which they bou...
...store 20 years ago; or they...
...enough to be examined after...
...fear that they will have to wear...
...result is that numerous acciden...
...se of bad eyesight.

If these things, I say, can come f...
...down. It is a wonderful place...
...rate a safety program. Any fur...
...ion is up to the individual the...
...is up to you to bring these thin...
...by pointing out to manageme...

WEDNESDA...

...ding:—R. H. Ferguson, Mana...

Environment—

B...

...perintendent, Safety and Welfa...

All will agree that environment...
...portant part in our lives. We a...
...ed by our frame of mind and...
...dings. If a person is in fear...
...ment, his health, or his safety,...
...ble and unhappy, which is a...
...to himself and management. S...
...ering includes any and all thi...
...be done to promote the worker...
...th, comfort, and well-being.

What can management do to im...
...ment especially as it pertains t...
...environment can be improved...
...keeping. As a housewife is j...
...appearance of the home, so is...
...judged by the appearance of

[illegible] it drawn to the attention of the fore- [illegible] who in turn hands it over to the em- [illegible] involved, is a good safety measure. [illegible] other words, talk it over with the em- [illegible] after the accident has happened and [illegible] it has been investigated.

[illegible] also believe that it is poor policy to al- [illegible] men to work in your plant whose eye- [illegible] has not been checked or corrected once [illegible] at least three years. A good many acci- [illegible] are due to the fact that men are work- [illegible] with the glasses which they bought in a [illegible] store 20 years ago; or they haven't [illegible] enough to be examined after 10 years [illegible] that they will have to wear bifocals. [illegible] result is that numerous accidents occur [illegible] of bad eyesight.

[illegible] these things, I say, can come from the [illegible] down. It is a wonderful place to in- [illegible] a safety program. Any further ed- [illegible] is up to the individual themselves. [illegible] up to you to bring these things to a [illegible] by pointing out to management some of the things. But above all, don't miss the chance of taking the boys into your confidence. They are entitled to know.

CHAIRMAN SIMPSON: It is getting late, and I would like to run the next two discussions together. Mr. Boaden, is going to discuss just what particular phases he thinks we ought to concentrate on. He heard one of the previous speakers say: The United States Government found that they can make soldiers in about 10 weeks but that it took a darn sight more than a year to make an officer. I think that is true.

MR. BOADEN: All I have to say is this, fellows: that as far as we are concerned, we believe in concentrating on certain things, and this is what we found from our experience: that it pays to concentrate on goggles and glasses and leggings and safety shoes and respirators, as well as on safety bulletins; and we also like to get suggestions from our employees.

WEDNESDAY AFTERNOON SESSION

October 8, 1941

Presiding:—R. H. Ferguson, Manager of Safety, Republic Steel Corporation, Cleveland, O.

Environment—Management's Responsibility

By P. C. KAUFFMAN

Superintendent, Safety and Welfare Department, Jones & Laughlin Steel Corporation

Pittsburgh, Penn.

All will agree that environment plays an important part in our lives. We are motivated by our frame of mind and our surroundings. If a person is in fear of management, his health, or his safety, he is unstable and unhappy, which is a hindrance both to himself and management. Safety engineering includes any and all things that can be done to promote the workers' safety, health, comfort, and well-being.

What can management do to improve environment especially as it pertains to safety? That environment can be improved by good housekeeping. As a housewife is judged by the appearance of the home, so is management judged by the appearance of the plant. That which is orderly and well-kept has a definite appeal to all of us. In the same way, we note the unclean, untidy, slipshod business, and seek to avoid it. It is repulsive to our senses and arouses our suspicion as to its management.

By nature, some businesses are clean and others are dirty. This we know and accept, but there is no excuse for poor housekeeping, whether in a kitchen or steel plant. Good men are attracted to companies which clean up and paint up, and strive to keep their plant that way. The safety department can play an important part in helping management maintain high standards.

:y Congress

:-1942†

:lather & Co., Duluth, Minn.
:irginia State Dept. of Mines, Charleston
:ke Mining Co., Lead, S. D.
: Bituminous Coal Corp., Indiana, Pa.
ARINGTON, U. S. Bureau of Mines, Wa
UTCHER, Republic Steel Corp., Ironwoo
, JR., Mine Safety Appliances Co., Pitt
U. S. Bureau of Mines, Pittsburgh, Pa.
ES, U. S. Bureau of Mines, Pittsburgh, P
ER EVANS, JR., The Hudson Coal Co.
U. S. Bureau of Mines, Washington, D. C
S. Bureau of Mines, Pittsburgh, Pa.
pper Co., Calumet, Mich.
Tennessee, Mascot, Tenn.
:th, Minn.
., F ont, W. Va.
C. Butte, Mont.
mes, Ltd., Schumacher, Ont., Canada
tsburgh, Pa.
Lead Co., Texarkana, Texas
Montreal, Wis.
. Pa.
Hill Publishing Co., Inc., New York, N.
Hill, Tenn.
Ariz.
. Pittsburgh, Pa.
Cleveland, Ohio
Kirkland Lake, Ont., Canada
Scranton, Pa.
City, Utah
Rock Springs, Wyoming
Min, N. J.
rre, Mo.
Smelting Co., St. Louis, Mo.

ON SESSION

1941

EVANS, JR., Vice-President & General M

Methods of Allaying Dust in Underground Metal Mine Operations

By C. M. FELLMAN

Safety and Ventilation Engineer, The Montreal Mining Co., Montreal, Wis.

The source of fresh air whether it is from separate ventilation shaft, hoisting shaft or other mine openings connected with surface, should furnish clean fresh air, low in dust count. The amount of fresh air furnished per man underground varies considerably in different mines but it should not be less than 300 C.F.M. and it will be found distinctly advantageous to provide two or three times this amount.

Distribution of the air currents through the mine should be carefully planned. In the iron ore mines, the fresh air current is usually carried in on the lowest main-level, thence to the mining sub-levels and stopes above through timber raises, ore raises, manways or separate ventilation raises. The used air from these working areas then passes through special rock ventilation raises driven in the footwall or other openings connecting with the abandoned level above, from where it is routed to surface through ventilation or secondary shafts.

In mines which have ore bodies of considerable length, it is possible to divide the ore body into blocks for ventilation purposes, with each block having its own fresh air supply and return air outlet, which prevents the passage of dust and air contamination through the entire territory.

Auxiliary fans varying from 2 to 15 H.P. are used in mining and development places which cannot be ventilated by primary fresh air currents. The air is carried to the working place through 12 or 16 inch galvanized metal pipe or ventube.

Rock Work

Methods for allaying dust are of prime importance in the rock development headings of the iron ore mines, due to the fairly high silica content. These headings are usually ventilated by 10 or 15 H.P. fans set in a fresh air current with 12 or 16 inch metal pipe and ventube carried within 20 or 25 feet of the breast. It has been found that dust counts in headings during drilling and mucking are in direct proportion to the amount of fresh air delivered to the breast. If the return air current from these headings contacts other workers, the provision of a pair of water curtains or a water blast to settle dust and fumes has proved effective. During drilling and mucking the miners wear approved respirators. In some properties air line respirators are used during drilling. To settle dust and gases produced by blasting, a cross connection between the air and water line is used. Muck piles, breast, back and walls are wet down with water.

General Procedure Under Ground

All drilling is done wet, including ore.

Everyone going under ground including captains, bosses and officials are furnished with approved respirators. Clean filter pads are furnished daily as required. The men wear respirators during drilling, mucking and on entering working places after blasting.

Shaft stations, haulageways, travelways and air passages should be kept clean and if there is a tendency to dry out, such places should be wetted down periodically.

Daily inspections are made to check on matters pertaining to ventilation and dust prevention including changes in working places, use of respirators and condition of equipment. Inspection and close contact with the work plays an important part in the dust prevention program.

Dust Samples

Dust samples covering every phase of the operations are taken periodically, using either the standard or the midget impinger as the collecting medium. The samples are counted by the method recommended by the U. S. Public Health Service. The dust counts have pointed the way for improvements in the ventilation systems and dust prevention methods and provide a constant check on dust conditions.

Samples are taken periodically in all rock headings covering the complete cycle of operations. A record is kept of each rock heading on which is noted location, kind of rock encountered, silica content, dust counts for each operation, length of time required by each operation, types of drills, respirators, fan and dust prevention methods used. A record is also kept of each man working in rock which sets forth number of shifts worked, location of the working place and reference is made to the rock data sheet covering conditions in that place. From these records, the total exposure in rock of any employee is readily available for correlation with his physical findings.

Surface Operations

Dust hazards in surface operations have had attention. The dust produced by crushers located in the head frames is removed by suction fans. As an added precaution men working on the crusher floor wear respirators.

Many of the miners change houses are equipped with fans, filters and exhaust piping systems to remove dust from locker rooms which is produced by the men when changing between shifts. Dust counts taken at this period are surprisingly high when not controlled.

Laboratory crusher rooms are equipped with dust collectors, fans and suction hoods at crushers, rolls, pulverizers and bucking boards.

Fans and suction hoods are installed in the shop welding rooms to carry away fumes.

Mine service roads and streets in company housing locations are oiled or macadamized.

The generally accepted standard calls for a dust count of not over 5 million particles per cu. ft. of air in ore or rock. Most mines meet this standard without difficulty.

TUESDAY AFTERNOON SESSION

October 7, 1941

Symposium on Problems in Mine Safety

Presiding—L. C. CAMPBELL, General Manager of Mines, Koppers Coal Company, Pittsburgh, Pa.

How to Induce Men to Wear Goggles

By C. E. McKNIGHT

Safety Director, Lake Shore Mines, Limited, Kirkland Lake, Ont., Canada

The first question to be answered is, of course, "Are goggles needed in mining, and if so, how much protection should they give?"

Through the courtesy of the Ontario Mining Association I have been able to study the records of eye accidents in Ontario Mines during 1937 and 1938. For 210 random compensation cases the operational causes and occupational classes affected, have been put down in Table 1. The points I wish to make are these: that the causes are many, and the classes affected include almost everyone around the mine. It is not just the man with the sledge hammer who has eye trouble; he is expecting it and in fact is less troubled than the man who believes he is safe. A third point is that these accidents are expensive.

Table 2 shows the time lost due to these 210 accidents, and in studying this we must remember that these are "Compensation" cases, or those in which the injured man is off work seven days or more. Far more cases occur in which the time lost is less than seven days.

Tables 3, 4 and 5 show the complete eye-injury picture for the Ontario Mining Industry in 1938; Table 3 giving the ratio of eye injuries to total injuries reported; Table 4 giving the compensation cost of those injuries, and Table 5 showing the mechanical

Safety Exposition Exhibitors

Alphabetical List of Exhibitors of Industrial Safety Equipment

Acme Protection Equipment Co., Inc., Pittsburgh, Pa.
Gas Masks, Hose Masks, Supplied Air Respirators.

A. S. Aloe Co., St. Louis, Mo.
Manufacturers of Surgical, Hospital and Laboratory Equipment and Supplies.

American Abrasive Metals Co., Irvington, N. J.
Safety Flooring, Treads, Stair Treads, Abrasive Paint.

American-LaFrance-Foamite Corp., Elmira, N. Y.
Fire Protection Equipment.

American Optical Co., Southbridge, Mass.
Head and Eye Protection Products, Safety Clothing.

American Safety Tank Co., Kansas City, Mo.
Automotive Fuel Supply Tanks.

Arntzen, Inc., Chicago, Ill.
Emergency Ambulances and Stretcher Equipment.

Automatic Canteen Co. of America, Chicago, Ill.
Confection and Bulk Carbonated Beverage Dispensing Machines.

Bauer & Black, Chicago, Ill.
Manufacturers of First Aid Kits and Dressings.

Bausch & Lomb Optical Co., Rochester, N. Y.
Safety Goggles and Safety Goggle Lenses.

Bear Manufacturing Co., Rock Island, Ill.
Motor Vehicle Inspection and Correction Equipment.

The Boyer-Campbell Co., Detroit, Mich.
Industrial Safety Equipment.

Bradley Washfountain Co., Milwaukee, Wis.
Washroom Equipment.

Brown Shoe Co., St. Louis, Mo.
Industrial Safety Shoes.

Stewart R. Browne Manufacturing Co., New York, N. Y.
Safety and Special Purpose Lights and Lamps.

Buffalo Fire Appliance Corp., Buffalo, N. Y.
Fire Extinguishers.

R. H. Buhrke Co., Chicago, Ill.
Safety Equipment for Construction and Maintenance.

E. D. Bullard Company, San Francisco, Calif.
Personal Protective Equipment.

Burroughs Wellcome & Co. (U. S. A.) Inc., New York, N. Y.
First Aid Kits and Medical Equipment.

Cambridge Rubber Co., Taneytown, Md.
Safety Soles for Shoes.

Cardox Corp., Chicago, Ill.
Fire Extinguishing Systems.

Chicago Eye Shield Co., Chicago, Ill.
Head and Eye Protection Equipment.

H. Childs & Co., Inc., Pittsburgh, Pa.
Industrial Safety Shoes.

The Cleveland Overall Co., Cleveland, Ohio.
Safe Industrial Work Clothing and Uniforms.

Coca-Cola Co., Atlanta, Ga.
Beverage Dispensing Equipment.

Columbus McKinnon Chain Corp., Tonawanda, N. Y.
Alloy Steel Sling Chains and Safety Hoists.

C-O-Two Fire Equipment Co., Newark, N. J.
Portable and Wheeled Type Fire Extinguishers.

M. E. Cunningham Co., Pittsburgh, Pa.
Safety Steel Stamps and Tools.

Davis Emergency Equipment Co., Inc., Newark, N. J.
First Aid and Industrial Safety Equipment.

A. B. Dick Co., Chicago, Ill.
Mimeograph Duplicators and Mimeograph Brand Products.

Dockson Corp., Detroit, Mich.
Head and Eye Protection Equipment.

The C. B. Dolge Co., Westport, Conn.
Floor Finishes, Disinfectants, and Hand Soaps.

Dugas Engineering Corp., Chicago, Ill.
Fire Extinguishing Equipment.

Duo-Safety Ladder Corp., Oshkosh, Wis.
Safety and Fire Ladders, and Ladder Shoes.

E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Neoprene, Hand Cream and Cellulose Sponges.

Elliott Service Co., New York, N. Y.
Promotion of Safety and Efficiency.

J. H. Emerson Co., Cambridge, Mass.
The "Iron Lung."

Employers Mutual Liability Insurance Co. of Wisconsin, Wausau, Wis.
Workmen's Compensation, Fire and Casualty Insurance.

Ex-Cell-O Corp., Detroit, Mich.
Pure Pak Paper Milk Containers.

Fairway Laboratories, Inc., St. Louis, Mo.
Salt Tablets and Dispensers.

Finnell System, Inc., Elkhart, Ind.
Electric Floor Maintenance Equipment and Compounds.

Ford Good Drivers League, Dearborn, Mich.
Good Driving Educational Campaign.

Franklin Research Co., Philadelphia, Pa.
Floor Maintenance Materials.

The General Fire Truck Corp., Detroit, Mich.
Fire Extinguishers and Allied Products.

Great Stuff Products Co., Inc., West New York, N. J.
Industrial Hand Soaps, Protective Creams, Dispensers.

Hanovia Chemical & Manufacturing Co., Newark, N. J.
Sun Lamps and Ultraviolet Quartz Lamps for Every Purpose.

Harley Davidson Motor Co., Milwaukee, Wis.
Police Motorcycles and Related Equipment.

Holcomb Safety Garment Co., Chicago, Ill.
Protective Clothing.

Hoof Products Co., Chicago, Ill.
Motor Vehicle Speed Control Governors and Brake Eyes.

Hynson, Westcott & Dunning, Inc., Baltimore, Md.
Mercurochrome First Aid Antiseptic.

Industrial Gloves Co., Danville, Ill.
Industrial Safety Clothing.

International Business Machines Corp., New York, N. Y.
Electric Accounting Machines, Time Recording Devices.

International Shoe Co., St. Louis, Mo.
Hy-Test Safety Shoes.

Junkin Safety Appliance Co., Louisville, Ky.
Safety Devices for Power Presses.

Justrite Manufacturing Co., Chicago, Ill.
Safety Cans and Fittings, Electric Safety Lanterns.

Juvenile Wood Products, Inc., Fort Wayne, Ind.
Automobile Seats for Babies.

Karel First Aid Supply Co., Chicago, Ill.
Industrial First Aid Supplies, Hospital Equipment.

Keystone View Co., Meadville, Pa.
Industrial Visual Testing Equipment.

Walter Kidde & Co., Inc., New York, N. Y.
Fire Extinguishing Equipment.

The Kimball Safety Products Co., Cleveland, Ohio.
Industrial Safety Products.

sau, Wis.

Walter G. Legge Co., Inc., New York, N. Y.
Floor Polishes and General Floor Maintenance Compounds.

Lehigh Safety Shoe Co., Inc., Allentown, Pa.
Leather and Rubber Industrial Safety Shoes.

Liberty Mutual Insurance Co., Boston, Mass.
Compensation and Public Liability Insurance.

Lightfoot Schultz Co., New York, N. Y.
Toilet Soaps for Industrial Washroom Use.

The Lima Cord Sole and Heel Co., Lima, Ohio.
Non-Slip Soles and Heels.

Macwhyte Company, Kenosha, Wis.
Wire Rope, Braided Wire Rope Slings, and Allied Products.

Marks and Fuller, Inc., Rochester, N. Y.
Identification Cameras and Equipment.

The Martindale Electric Co., Cleveland, Ohio.
Stretcher Cots, Safety Road Signs, Respirators for Non-Toxic Dusts.

Masury-Young Co., Boston, Mass.
Materials for Finishing and Maintaining Safe Floors.

Thom McAn Safety Shoe Co., New York, N. Y.
Thom McAn Safety Shoes.

B. F. McDonald Co., Los Angeles, Calif.
Industrial Safety Equipment.

Medical Supply Co., Chicago, Ill.
First Aid Kits, Refills, Surgical Dressings and Pharmaceuticals.

Melflex Products Co., Akron, Ohio.
Industrial Safety Flooring, Steps Treads, Mats and Matting.

Mer-Kil Chemical Products Co., Chicago, Ill.
Disinfectants, Germicides, Deodorants and Fungicides.

Metropolitan Life Insurance Co., New York, N. Y.
Life, Health, Accident, Pension and Group Insurance.

Milburn Co., Detroit, Mich.
Protective Creams for the Prevention of Occupational Skin Diseases.

Mine Safety Appliances Co., Pittsburgh, Pa.
Safety Appliances and First Aid Materials.

Minnesota Mining and Manufacturing Co., St. Paul, Minn.
Reflective Sign Material.

Mir-O-Lite, Inc., Lincoln, Nebr.
Reflecting Traffic Signs.

National Conservation Bureau, New York, N. Y.
Safety Education, Traffic Enforcement and Industrial Material.

National Highway Supply Co., Chicago, Ill.
Reflectorized Highway Traffic Signs.

National Photo Identity Corp., Chicago, Ill.
Monroe Double Action Identification Camera.

National Safety Council, Inc., Chicago, Ill.
Posters, Bureau of Information, Research and Education Division.

National Society for the Prevention of Blindness, Inc., New York, N. Y.
Services and Education Materials on Preventing Industrial Eye Injuries.

Onox, Inc., San Francisco, Calif.
Prevention of Athlete's Foot.

Owens-Corning Fiberglas Corp., Toledo, Ohio.
Glass Insulating and Sound-Absorbing Wools, Air Filters, Glass Textile Fibers.

G. H. Packwood Manufacturing Co., St. Louis, Mo.
Safety Hand Soaps for Industrial Plant Use.

Panther-Panco Rubber Co., Inc., Chelsea, Mass.
Safety Soles and Heels.

The Patent Scaffolding Co., Chicago, Ill.
Safety Ladders and Scaffolds.

The Phister Manufacturing Co., Cincinnati, Ohio.
Fire Extinguishers and Allied Equipment.

The Prosperity Co., Inc., Syracuse, N. Y.
Valves, Cylinders, Air Controls, Safety Controls for Presses.

Protectoseal Co., Chicago, Ill.
Safety Cans, Drum and Barrel Fittings.

Pulmosan Safety Equipment Corp., Brooklyn, N. Y.
Industrial Safety Equipment.

Pyrene Manufacturing Co., Newark, N. J.
Fire Protection Equipment.

Reece Wooden Sole Shoe Co., Columbus, Nebr.
Wooden Sole Safety Shoes, Boots and Sandals.

Rose Manufacturing Co., Denver, Colo.
Industrial Safety Products.

Safety Clothing and Equipment Co., Cleveland, Ohio.
Industrial Safety Clothing, Equipment and Supplies.

Safety Engineering, Alfred M. Best & Co., Inc., New York, N. Y.
"Safety Engineering," Insurance Publications and Reports.

Safety First Shoe Co., Holliston, Mass.
Safety Shoes.

Safway Steel Scaffolds Co., Milwaukee, Wis.
Scaffold Equipment and Safety Ladders.

W. H. Salisbury & Co., Chicago, Ill.
Linemen's Rubber Protective Equipment.

The Sanitary Institute of America, Chicago, Ill.
Sterilized Industrial Wiping Cloths.

A. Schrader's Son, Brooklyn, N. Y.
Pneumatic Power Press Safety Control Devices.

Scotch Flasher Display Co., Wichita, Kans.
Animated Direct Light and Reflectorized Warning Signs.

The Sealtex Co., Chicago, Ill.
Self-Sticking Bandages.

Sellstrom Manufacturing Co., Chicago, Ill.
Industrial Safeguards for Head and Eye Protection.

A. Smith & Son, Inc., Philadelphia, Pa.
Hospital and Ambulance Cots.

The Spencer Turbine Co., Hartford, Conn.
Industrial Vacuum Cleaners and Dust Collection Equipment.

Sperry Top-Sider Footwear Division, U. S. Rubber Co., New York, N. Y.
Safety Footwear.

Standard Safety Equipment Co., Chicago, Ill.
Industrial Safety Equipment.

Steel Scaffolding Co., Inc., Evansville, Ind.
Steel Scaffolds, Trestles, and Accessories.

Stonehouse Signs, Inc., Denver, Colo.
Accident Prevention Signs and Tags.

The Surty Manufacturing Co., Inc., Chicago, Ill.
Point of Operation Machine Guards.

G. H. Tennant Co., Minneapolis, Minn.
Equipment and Supplies for Dry Cleaning Industrial Floors.

Trimont Manufacturing Co., Roxbury (Boston), Mass.
Safety Steel Pipe Tools.