TRANSACTIONS

30th
NATIONAL SAFETY CONGRESS

GENERAL SUBJECT AND
INDUSTRIAL SESSIONS

CHICAGO
OCTOBER 6-10, 1941

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

Foreword

THE Transactions of the 30th National Safety Congress and Exposition of the National Safety Council are published in two volumes. Volume I contains the General Subject Sessions and the Industrial Section Sessions. Volume II contains the Street and Highway Traffic, Commercial Vehicle, Transit, Child Education, Home Safety and Farm Safety Sessions.

Volume I is distributed automatically to the industrial members of the Council. Volume II is sent to those members who are believed to be interested chiefly in the sessions it contains. However, other members of the Council may obtain Volume II upon request.

All types of Council members have found it advantageous to distribute these Transactions volumes to foremen, supervisors, executives and other officers of their organizations, who make use of the information they contain in organized accident prevention programs. On page 9 of this volume some practical suggestions are made for the profitable use of these Transactions.

Extra copies of Volume I may be obtained by Council Members at the following rates: 1 to 10 copies at $2.00 each; 11 or more copies at $1.75 each. Extra copies of Volume II may be had at 75 cents each.

The Transactions are a condensed record of the proceedings of the Congress, reproduced here for reference purposes. The papers, addresses and many of the discussions have been edited to delete extraneous matter and emphasize those parts which outline ideas of particular usefulness in safety organization and all other accident prevention procedures. The volumes are, therefore, a somewhat abridged version; the original manuscripts, however, are available in the files of the National Safety Council.

The National Safety Council, at its Congresses, seeks to eliminate from discussion matters which are not pertinent to the aims of the Congress, or which may be contrary to the Council's policies. However, it cannot accept responsibility for all the views expressed, either in the matter presented or in the discussions based upon these papers.

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20 North Wacker Drive

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Make Profitable Use of These Transactions

The Transactions of the Congress are published in two volumes for day to day use in the prevention of accidents, Vol. I dealing chiefly with industrial problems, and Vol. II public safety problems. The papers and discussions reproduced in this volume contain the experience of safety men, business executives, health directors and others who have organized and conducted industrial safety programs that reduced their accident losses.

Do not be dismayed by the size of this volume. There are simple ways of finding what you may want. The material has been organized, arranged and indexed so that any given subject, speaker or session can be located easily.

Plan of Arrangement

Note, first, that there is on page 3 a Table of Contents. This lists the session divisions in three groups; (a) several General Sessions; then (b) the Subject Sessions; and (c) the Sessions of the Industrial Sections of the Council.

The fourteen Subject Sessions will immediately challenge your attention, for they were selected to cover subjects of great interest to all safety men, and were planned after many consultations with safety leaders.

However, you will find in many of the Industrial Section Sessions similar discussions on general safety subjects that will prove valuable reading.

Note that each group of sessions is arranged in alphabetical order by subject; also that where there are more than one session (as in the Industrial Sections) the sessions are arranged in order by day of the week and calendar date.

Now, nobody has to read through a whole session, or even an entire formal paper or discussion, to find a given safety problem or outstanding safety idea.

In the back of the volume there is a comprehensive, but simple index, also arranged alphabetically. There are three ways in which the material in the volume is indexed:

(a) By General Subject or Minor Subject Discussed.

(b) By name of Author, in the case of Formal Papers.

(c) By Industry, as in the case of the Industrial Section.

Ways to Use the Transactions

There are a great many ways that you, as a safety inquirer, can make profitable use of this storehouse of information on accident prevention and good health practice. Here are just a few of them:

Solutions to Your Accident Problems.—You have such problems: every plant or business organization has them. Very probably you can find here the solution to the problem that is troubling you. You may look first in the sessions of your industry; or you may scan the list of Subject Sessions.

Is it a problem where dusts or poisonous gases are encountered? Three papers by experts in the session on "Dusts, Fumes, Gases and Vapors" cover this general subject thoroughly. There is also the session on "Industrial Health," and that on "Industrial Nursing," where health and first aid problems are presented.

It is a problem on accident causes, or better organized accident prevention? Look in the interesting panel discussion on "Fundamental Causes of Accidents"; or the "Safety Engineering Exchange" or the session on "Safety Training." And don't forget the morning lectures of Dr. Victor L. Short on "Human Engineering and Safety," parts of which are outstanding suggestions on the psychology of handling men.

New Safety Ideas and Plans.—Accident prevention methods and procedures are still not perfect. New developments in safety ideas, devices, safeguards, "stunts," and safety equipment are being made all the time; delegates have told about them in this Congress. In addition to the discussions in the "Safety Engineering Exchange," you may find interesting ideas in the panel discussions in the

Congress Banquet

WEDNESDAY EVENING SESSION

October 8, 1941

The Annual Banquet for members and guests at the Thirtieth National Safety Congress was held in the Grand Ballroom and also the Boulevard Room of The Stevens Hotel, being one of the largest in the history of the Council. While occupying two very large rooms, necessitating the removal of tables after serving the repast and the re-assembling of the guests in the Grand Ballroom for the later program features, all of these arrangements were carried out smoothly and with the greatest satisfaction to all guests.

Music and other entertainment features marked the progress of the banquet in both the serving rooms. Upon reassembling, President John Stilwell called the meeting to order. He then requested the Chairman of the Nominating Committee, Mr. Walter S. Paine, to announce the official list of newly elected officers of the National Safety Council. Mr. Paine complied as follows:

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Managing Director and Secretary: W. H. Cameron, Managing Director, National Safety Council, Inc., Chicago, Ill.

ployees to observe safety rules when off-the-job just as they do when at work. Try to influence a reduction in traffic accidents, the nation's number one killer and the probable cause of the loss of forty thousand American lives in 1941 long before we ring in the New Year less than three months from now!

We must intensify our efforts to get people to drive at reasonable speeds. We must bear in mind that a skilled employee is just as much dead and just as much a loss to America if he is killed on a Saturday night or a Sunday afternoon in a traffic accident as if he is killed in the shop. Actually he is two men lost—for in addition to our loss of production due to his accident, the Nazi egoists are relieved of the necessity of keeping some man over in tyranny-ridden Europe or at work to offset his production. Let's remember that.

The President's proclamation was a plea for cooperation. The National Safety Council's acceptance of the task assigned to it, and its call upon you to assist, also partook of the same nature; it was a plea for assistance. In the procedure that has been set up, in the free cooperation that has been asked and that will be forthcoming, we see an example of democracy working at its best. We see exemplified the principles of unity in dependence and independence in unity that made this nation the greatest and the freest civilization that ever evolved on the face of this earth—a civilization which, with your help, will endure long after the blot of Naziism has been wiped forever from the face of Europe and even the threat of any future dictatorship of a few mad minds over all the earth rendered an absolute and an eternal impossibility.

ADJOURNMENT

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 pre-

vent 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 affecttd 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 1.2 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 significant 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

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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 pickle tanks may not be visible but the steam 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 doubt 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 hydro-

carbons 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 or 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, 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

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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 or 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 com-

fort 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

Safety Engineering Exchange

FRIDAY MORNING SESSION

October 10, 1941

Presiding: H. J. GRIFFITH, Manager of Safety and Welfare, Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

CHAIRMAN GRIFFITH: This meeting is one of the last of this Congress, and it is going to be your meeting. Probably there are a number of questions that have come up during the conference that you haven't had a chance to discuss with anyone, so we are going to give you a chance this morning to discuss them. We also have several questions here to start with. If any of you gentlemen have any particular question that you wish to have answered, write it down and pass it up here and we will try to get you an answer.

The men whom we have here on the platform do not profess to be experts. They are just common, ordinary folks like ourselves. I shall take just a minute to introduce them:

C. M. Allen, Staff Supervisor of Safety, The American Rolling Mill Company, Middletown, Ohio.

C. N. Rakestraw, Secretary, General Safety Committee, Cleveland Illuminating Company, Cleveland, Ohio.

G. A. Kuechenmeister, Personnel Manager, Dominion Forge & Stamping Company, Walkerville, Ontario, Canada.

J. Howard Myers, Director of Safety and Fire Prevention, The Atlantic Refining Company, Philadelphia, Pennsylvania.

Paul C. Lamb, Safety Engineer, Lever Brothers Company, Cambridge, Massachusetts.

R. P. Blake, Senior Safety Engineer, United States Department of Labor, Washington, D. C.

Now, gentlemen, we are going to start out with the questions listed in your program. We will ask the men on the platform here to give their answers to these questions. We will then go on to any other questions that may be asked from the floor.

Now then, to get started, here is the first question: "What Types of Pre-Employment Eyesight Examinations Are Most Effective? Why?"

Mr. Blake, would you mind expressing yourself on that?

Types of Eye Examinations

R. P. BLAKE: I am not quite sure what the question means. What is most effective? If I may change that to "What type of examination is needed?" I should say it depends entirely upon the kind of work the person is doing. For instance, in a mechanic, acuity is the first thing to consider. If in some other job he is required to do very close work, that will determine the type of test needed. In other words, determine the sight qualities needed on the particular type of job and have the examination put particular emphasis on that. Can someone else add something more to it?

One of the most important reasons for preemployment examination, particularly in a plant where there is considerable eye hazard, is to determine the need for prescription lenses in goggles. I find that one of the most frequent reasons many men object to wearing goggles is that they hate to put on the glasses. It is a human failure. You hate to admit that your eyes are failing, that your vision is failing enough so that you need glasses; and the result is that in any group of workers you will find a large percentage

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The Nature and Properties of Polarized Light

By DR. MARTIN GRABAU

Director of Technical Sales, Polaroid Corporation, Cambridge, Mass.

The most important fact about light waves is that they are tranverse. The meaning of this expression must be explained in some detail, and in this connection a simple mechanical analogy that of a rope wave—is very instructive. Imagine, for example, a rope agitated by hand at one end and tied to a post at the other.

As the end of the rope is agitated with a to-and-fro motion, crosswise to itself, a wave travels along it lengthwise.

In order to emphasize the crosswise, or transverse, nature of this wave, imagine a knot tied anywhere in the rope. As the wave travels along, the knot moves to and fro in a sidewise direction. It obviously does not move lengthwise along the rope.

A light wave is made up of such crosswise vibrations having some sort of an electric and magnetic character; and the central theme of this survey concerns the control of the directions of these crosswise vibrations, irrespective of the direction of travel of the light.

Ordinary light radiation, such as we receive from the sun or an incandescent lamp bulb, comprises an amazing and bewildering mixture of vibrations lying in all possible directions crosswise to the beam of light. These many crosswise directions of vibration are represented by the many different directions (vertical, horizontal or inclined) which the person agitating the end of the rope may choose for the motion of his hand.

Polarized Waves

Again suppose the rope is fed through several picket fences. Let the end of the rope be agitated with a rather complicated motion, involving vibrations in several directions mixed with one another. A similarly complicated wave will travel along the rope, until it reaches the first picket fence.

The slot between the palings of the first fence is vertical. Consequently, only vertical vibrations pass through. The fence sifts all the vertical components of vibrations from the originally complicated mixture. Since the palings of the second fence are also vertical, the vibrations transmitted by the first will also pass through the second.

slots between them. Consequently, the vertical vibrations of the rope wave are brought to a dead stop when they reach it. We are led to conclude that two mechanical polarizers whose slots are crossed are "opaque" to a rope wave we might try to send through them.

Polarized Light

Polaroid glass is a transparent material that polarizes light waves, just as the picket fence, polarizes rope waves. When ordinary unpolarized light, with its helter-skelter arrangement of vibrations in all crosswise directions, comes through a piece of polaroid glass, the transmitted light comprises vibrations in only one crosswise direction. Furthermore, as you rotate the piece of polaroid glass, the direction of vibration of the transmitted light rotates likewise.

Except in the rarest of cases, the unaided human eye does not distinguish between polarized and unpolarized light. This explains why, prior to the availability of commercial light polarizing materials and development of their application, we remained unaware of much polarified light round about us.

Most polaroid light polarizing materials are made with polaroid J-sheeting, a flexible polarizing material only 0.003 inch thick. To protect it from damage, polaroid J-sheeting is always bonded between protecting layers of either glass, to form polaroid J-glass or sheets of clear cellulose acetate safety-film, to form polaroid—J-film.

Polaroid J-sheeting is also a film of cellulose acetate, but it has imbedded in it innumerable little needle-shaped polarizing crystals. These crystals are invisible, even in an ordinary microscope: their girth diameter is approximately one wavelength of visible light. They are also so numerous that they lie in many overlapping layers; no clear spaces can be seen among them, even under a powerful microscope. Finally, and most

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MONDAY AFTERNOON SESSION

October 6, 1941

Presiding:—General Chairman V. I. Trotter, Supervisor of Safety, Plymouth Division, Chrysler Corporation, Detroit.

What Contribution Can the Plant Protection Man Make From the National Defense Aspects?

By E. T. ADAMS

Superintendent, Plant Protection, Linden Division, General Motors Corp., Linden, N. J.

A few days ago I received a call from an officer in the army. He wanted me to recommend to him all the men I knew about with plant protection qualifications. I attempted to give the names of several fine appearing applicants from my files, but as I read their histories and other qualities he would stop me, saying "Sorry, but that man does not meet our qualifications."

I asked him what the qualifications were. He replied: "We would like them to have had army or navy experience, although that is not as essential as having been a member of an organized police force. If possible they should have had plant protection experience with some company which gives a good training. Above all they should be fine investigators and be able to write full and comprehensive reports."

Sorrowfully I told him that all men such as he described were on steady payrolls at salary figures with which he could not hope to compete with his offer of $1320 per year. He did not mention intelligence and loyalty, though those two very essential qualities are implied within the framework of the duties of the desired men.

Recent weeks Post has an article by Garet [illegible] in which he states that new plants in the United States financed by the U. S. government, the British government and private capital, now built, building or pending, total 3,429, at a total cost of $3,930,000,000. Figures have come to mean little, but the fact is that every one of those plants must be protected against all manner of influences and forces that could lessen their productivity. This does not take into consideration any of the thousands of existing plants now being operated for the government or producing other necessities. They also have to be guarded.

A moment's consideration of the foregoing allows the deduction that there is soon to be a greatly increased demand for trained and experienced plant protection men, and a corresponding shortage of them.

It follows that the qualified plant protection men of existing industry can and must make contributions to further national defense activities. Such contributions may take two main forms: one, the training of thousands of new men for the job; and, two, the assistance in the planning of plants to permit the job to be done with fewer men.

An axiom of training plant protection men which has been forcibly impressed on me, is that only a plant protection man can train another one *in all* the many phases of the job. You may get better safety training from good safety engineers; you may get better fire prevention training from good firemen, and employee relations training from personnel men, but only the experienced pro-

to us that we can have a safe department only by constant vigilance and instruction. In our class-room work, early lessons are devoted to safety. The cause and effects of accidents are thoroughly discussed, and our factory rule book is thoroughly studied, and tests are given on them to make as sure as we can that the safety rules are understood. We also use numerous safety posters from the National Safety Council and have talks on safety by our various safety engineers who give the apprentice a thorough talk on the different phases of their own jobs.

We also have talks by our firemen on fires and their extinguishment, how to prevent fires, the different types of fires, the different types of extinguishers and how to use them.

All of our apprentice instructors are careful to point out accident hazards to new and old apprentices. They make constant inspections to see that loose sleeves are rolled up and other loose garments are fastened securely. The instructors also warn employees about the wearing of finger rings. They check the floors for spilled oil and try at all times to maintain a clean and orderly department which is in itself a stride toward safety. Our apprentices are advised to wear safety shoes at all times. These shoes are on display and can be purchased within our shop. The use of goggles, the different types, are demonstrated and their use explained. The apprentices are told how easy it is to obtain goggles for any purpose, and it is explained to them how hard it is to try and replace lost vision, or partial lost vision.

Dovetailing safety in the apprentice division of the youth of America is discipline. If discipline is maintained we have found that the safety measures are more easily controlled.

Safety with discipline can be applied effectively with kid gloves. I do not think it necessary to say "put on your goggles", but sell them on the idea that it is to their advantage to wear them. Tell them that our best airplane pilots carry parachutes not because they are expecting accidents, but being prepared in case they do have an accident. And for the same reason, they should use and adopt all of our safety clothes or appliances pertaining to the particular job.

We discourage the use of gloves except in very necessary cases, such as leather gloves in welding, or rubber gloves in washing machines.

Health is another phase that should be given careful consideration at all times. I think that it is one of the foundations of safety, as no one with a chronic ailment or ailing in any way can be one hundred per cent alert nor safety-minded. If in our apprentice school the youth shows signs of sickness or complains, he is immediately sent to our hospital, and the doctor's report decides whether he stays on the job or goes home.

We see that every apprentice knows the location of the hospital and insist that every injury, however minor, be treated by doctors or nurses.

The inexeprienced or new apprentice is confronted with many new and sometimes confusing problems. He may have a lack of self-confidence, or on the other hand he may be over-anxious. We have found that at times it is necessary to curb the speed with which some of our boys work, for in their desire to please their instructor or sell themselves they become careless in their attempt to gain speed and lose sight of the safety angle which we are trying to impress on them.

We carry our safety into the interviews held when selecting our future apprentices, watching for the alert, snappy type. We have rejected applicants 5 feet 7 inches tall, weighing over 200 pounds from the safety angle alone.

I mentioned the Chrysler Library of tools. This is exactly what the name implies. It is a library of tools where boys between the ages of ten and sixteen, sons of employees, may check tools out to take home and use the same as they would a book from the library.

This library of tools was started some years ago with approximately 250 tools. Classes for instruction are held five hours per week and Saturday morning, the instruction period being two hours each.

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S. W. STAUFFER, National Lime Assn., Washington. D. C.
L. P. WARNER, JR., Warner Co., Philadelphia, Pa.
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*Past General Chairman

WEDNESDAY AFTERNOON SESSION

October 8, 1941

Presiding—GENERAL CHAIRMAN R. A. DITTMAR, Plant Manager, Universal Atlas Cement Company, Hudson, N. Y.

Cement and Quarry Accident Experience

By IVAN F. LeGORE

Cement and Quarry Section, NSC, October 8, 1941

Last year in this meeting we discussed the place of industrial safety work in the national defense program and the effect the national defense program might have on safety work. We spoke of the magnified problems of labor turnover and shifts of personnel within the plant organization to be expected, and of the much greater attention that would have to be given to the placement, training and education of new workers, transferred workers, and old-timers.

As anticipated, the period has been one of tremendous readjustment. Well under way is migration of labor to defense centers. It is said not to be as broad as World War migration and is not yet drawing heavily from [illegible] areas and non-defense centers. But the movement is growing and it is estimated that industry must recruit 500,000 workers in the next 12 months from outside local areas to forestall shortages.

Added to our problem is the problem of priorities which confronts maintenance and repair groups with the necessity of utilizing substitute materials in place of those with which they have been familiar for years. Careful thought and planning will be needed in instructing workmen in the use of substitutes, including the use of lumber in some cases for lack of steel and iron.

Organizations that heeded the storm signals lost no time in reviewing their safety programs and in perfecting their methods of selecting, placing and training employees for safe job performance.

These plants got ready for the storm period also by putting more individual work on the numerous details of the safety program, and they tightened up their inspections of physical properties. Defective environment cause almost as many accidents as personnel faults, and this factor grows in importance when operations are expanded. Old equipment and old sources of supply materials returned to service after partial disuse require especially careful attention and, where necessary, these were brought up to safety standards.

Plants that moved tardily to meet the situation suffered adverse safety records for the most part. While accepting accident prevention work as "a good thing", they failed to take steps to detect and provide for environmental and personnel hazards where accidents could occur. While they gave safety program lip service, they failed to make use of accident prevention tools which are available.

It is hard to believe that after many years of campaigning many industrial executives, supervisors and workmen still do not know or do not believe that accidents can be prevented, but that seems to be the case. And this despite the fact that a great number of companies in their own industries have demonstrated that accidents are unnecessary to production and have been perfectly willing to share with anyone their experience and knowledge of how accidents can be stopped.

National Safety Competition

According to data supplied by W. W. Adams, supervising statistician of the Employment Statistics Section of the U. S. Bureau of Mines, there were 8 per cent fewer man-hours reported for quarries enrolled in the National Safety Competition than in 1939. The 143 quarries enrolled experienced a 6 per cent increase in injury frequency over 1939 and reduced injury severity about 4 per cent. Seventy-three quarries operated without a lost-time accident.

Twenty-seven mines participated in the Underground-Nonmetallic-Mine contest and worked 10 per cent more man-hours than in the previous year. Accident frequency increased 3 per cent over 1939; severity improved 20 per cent. Six of the 27 mines were accident-free during the year.

Forty crushed stone plants enrolled in the National Crushed Stone Association Safety Competition of 1940 saw man-hours operated increase only slightly but accident frequency 17 per cent greater than in 1939. Severity of accidents was reduced 15 per cent, however. Nineteen of the 50 crushed stone plants had a accident-free.

The National Lime Association contest, which worked 14 per cent more man-hours than had been worked in 1939, while accident frequency increased 22 per cent. Accident severity advanced a whopping 77 per cent. Seven lime plants reported no lost-time accidents.

Operations operated by 129 plants participating in accident studies made by the Portland Cement Association were 6 per cent greater than in 1939. Injury frequency was down 15 per cent, and the severity rate was 22 per cent greater than it was the year before. Forty-seven cement plants were accident-free during the year.

Data for all the contests conducted by the Bureau of Mines are compiled annually; consequently no figures for 1941 are available. On the other hand, the accident experience of cement plants is followed closely month by month by the Cement Association's Bureau of Accident Prevention and Insurance, and it is from the picture of what is happening in our industry that we may all get an idea of what is taking place this year.

Experience in 1941

Production and shipments of portland cement are up sharply, approximately 30 per cent greater than last year, while accidents have increased about 22 per cent. A month ago we predicted that at the end of the third quarter of this year the percentage increase in accidents would almost balance the percentage increase in mill activity, making the frequency rate about the same as it was last year at this point. While the reports of September accidents are not all received, it is evident that the forecast was pretty accurate—possibly a bit on the conservative side.

Severity of injuries is slightly greater for the nine months this year, with an average of a fatality and three permanent injuries per month this year compared with eight deaths and slightly fewer permanent injuries in nine months of 1939.

It is clear that the final quarter-year will determine whether 1941 will be as safe as 1940.

Quarries, mines and clay fields have so far this year contributed to the cement industry's total a slightly smaller proportion of injuries than last year or the year before, although these operations still top the list of departments in number of accidents reported. There is no improvement in severity, two fatalities and three permanent injuries having been reported each year.

The greatest reduction in percentage of total injuries has been in the Raw department, from 22 per cent of all accidents reported in eight months last year to only 7 per cent this year. The entire raw side has contributed about 36 per cent of the total accidents this year compared with 52 per cent of the total last year.

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MONDAY AFTERNOON SESSION

October 6, 1941

Presiding—JOHN S. SHAW, Director of Safety, Hercules Powder Company, Wilmington, Del.

How Research Can Assist in Accident Prevention

By R. W. CAIRNS

Director, Hercules Experiment Station, Hercules Powder Company, Wilmington

There are a number of institutions established for the express purpose of conducting research on causes and conditions leading to accidents in various hazardous occupations or industries. These are well exemplified by the Bureau of Mines of the Department of Commerce. In many instances, where hazards are particularly troublesome, cooperative efforts have been made involving a number of individuals or groups. Cooperative efforts of this type have been frequently encouraged by the National Safety Council and related organizations.

However, the fact remains that the great bulk of safety problems connected with American industry fall right in the lap of the engineer or operating manager who is charged with maintenance of safety in a given operation. Every plant and every process represents a combination of circumstances which is specific to it alone. The advice and counsel of the experienced technical staff of institutions devoted solely to research on accident prevention is frequently of the greatest value, and should be sought in every possible instance. However, the great majority of cases involving the study of potential hazards must be handled by safety engineers and research men within the industry in which such hazards occur, and it is primarily these to whom I speak.

As a first step, perhaps I had better define what I mean by safety research. The usual connotation of research simply means to investigate the unknown. As applied to safety problems, research has the initial objective of finding out potential causes of accidents before they happen, and developing ways to avoid such accidents without seriously affecting the useful processes or operations involved. It is the antithesis of the method by which safe practices are developed directly from experience.

The application of research to safety work as to the control of hazards differs from normal research rather markedly. As usually applied, research is pointed toward a rather well-defined objective; whether it be a process, a product, or a new use, the accomplishment of the desired end is pretty clean cut. We know what we are looking for, we can plan a logical program to seek it; and most important of all, we know when we have successfully obtained it. We have only to supply certain missing links in the chain of connecting circumstances leading from unfulfilled wants to the wished-for goal.

Safety research, on the other hand, we find considerably handicapped by the absence of specific objective. Perhaps it would be more precise to say that what we want is not a definite result, but the absence of some undesired result—a purely negative aim.

Let us take a specific example, in order to emphasize the distinction between positive and negative research objectives. The combustion of flammable vapor provides the motivating force for the internal combustion engine. As such, this subject has received widespread attention in many laboratories. Chemists and engineers have sought to improve the efficiency of the process, so as to get more powerful engines and lower operating costs. Certain basic principles have been developed relating to ignition and burning, which have aided greatly in fuel manufacture and engine design. On the whole, the picture of this research effort can be straightforward and readily grasped. The objectives are positive, and it is easy to tell when and how well they have been obtained.

Contrast with this the study of the prevention or suppression of combustion in flammable vapors. Outside of the fact that we usually have certain specific vapors to deal with, there are no other well-defined limitations. One might be specifically concerned with a given process or operation, and thus might be tempted to set up arbitrary limitations of one sort or another, such as temperature and pressure ranges. The application of such limitations is apt to lead to difficulty.

It is easy to get off on the wrong foot in safety research, for the reason that we are not looking for the expected occurrence. What we want to know is what the unexpected circumstance will lead to; what is the worst that can happen. It is necessary, therefore, to keep our objectives general and to resist any tendency to narrow down our channel of thought. While a careful analysis of the whole problem is generally required, there is a great need for imaginative thinking. In this type of thinking we are merely setting up laboratory experiments in our minds. Although the results are not necessarily correct, they are certainly unlimited in scope and are easily obtained. Thus, imaginative thinking is a very vital supplement to actual experimental work, both at its inception and during the progress of the investigation. Although we may frequently suffer from misconceptions at the start of a project, the experimental clarification of such errors will frequently lead to new ways of thinking, which in turn should be explored and will lead to additional experiments.

This habit of thought is practically second

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TUESDAY AFTERNOON SESSION

October 7, 1941

Presiding—GENERAL CHAIRMAN R. J. REIGELUTH, Vice-President, C. W. Blakeslee & Sons, Inc., New Haven, Conn.

The Safety Engineer's Problems in Construction

By J. E. JACKMAN

Safety Director, McCrady-Rodgers Company, Pittsburgh, Pa.

We come here annually, not merely to be told that accident prevention work is important, but to find, if possible, some answer to our problems. It is my opinion that the most important problem is HOW TO GET COMPLETE COOPERATION IN THE ACCIDENT PREVENTION PROGRAM from the top to the bottom of the organization.

Another problem is HOW TO ENCOURAGE AND ASSIST IN KEEPING THIS COOPERATION ACTIVE.

If we safety engineers GET and KEEP this cooperation it seems to me that we will have solved most of our accident prevention problems.

We, of course, must assume that some interest in our accident prevention work has been shown by the management. Just how much is shown will depend to a great extent upon the ability of the safety engineer to SELL the idea.

To properly consider the problem of GETTING cooperation, we must first consider what the general attitudes of the average organization are.

First, we ask the laborer. His answer will probably be, "No one wants to get hurt and I do all I can to keep from getti hurt."

Then we will talk to the foreman. H will probably answer, "I do all that I c to keep the men from getting hurt, but g erally I don't get very far because the m are just careless. They don't do what I t them."

Now, we will ask the superintendent wh he thinks about accident prevention, cost accidents, etc., and probably he will s "As long as our insurance rate doesn't too high, I don't think we have much worry about." He will probably add that is very busy and that his foremen are di responsible for the safety of their men.

Then, we will ask the president of company what he thinks about this work, he will probably answer that he doesn't kn anything about the costs of accidents, the secretary or treasurer takes care of insurance—"GO ASK HIM ABOUT IT." He may add that he has hired a safety e neer and that this whole problem is his.

There is something radically wrong all this reasoning, and it's all because misunderstanding of the problem and need for complete cooperation from the borer to the president.

We have assumed that some interest has been shown by the management of the company, and one problem of the safety engineer is to sell the management first. I have often heard safety engineers say that they were disgusted with the lack of support from the management.

What is the most likely cause of this lack of support?

It seems to me, the answer is that it is probably a lack of salesmanship on the part of the safety engineer. When a good salesman is about to approach a tough prospect, what is the first things he does? He becomes thoroughly familiar with his product. He is thoroughly sold himself, and approaches his job with logic and enthusiasm.

The safety engineer must follow exactly the same method. The management generally isn't interested in the exact way that their safety men do their jobs. They are interested in the results. Conversations with the boss about the problems of the safety engineer serve a useful purpose in getting his interest temporarily, but the best results seem to come from written reports, recommendations, etc.

For example, I make a written report to the members of the Board of Directors of the company, showing the number of accidents, severity of accidents, cause of accidents, and cost of accidents, making comparisons with previous years. All the charts and graphs are easily read and understood. They are made that way because executives are busy men and cannot take the time to figure out complicated reports.

I suggest that the safety engineer make a report of his work to the boss. Tell what has been accomplished during the year, but also give due credit to the management. The good record must be shown and the cause explained in plain language. This report should be very impersonal.

When an accident occurs on the job the chief executive should receive a report of what has happened, how the accident occurred, and most important WHAT has been done to prevent a similar accident. We find every accident that requires a doctor's attention should be reported and these reports should go DIRECT to the boss.

Unnecessary data should be kept off the reports. Make the report short and "snappy," but SEE that the boss gets them.

We are still considering methods of getting cooperation.

When someone in the organization has an idea that he thinks will save the company money, he doesn't lose any time in getting to the boss. When something important happens in the production end, the boss is told about it; and as an accident interferes with the production plan, it also should be reported to the boss at once.

When some recommendation is to be made to the boss for expenditure for accident prevention, send a written memorandum, explaining the request, why it is necessary and what it will accomplish.

Be sure that you are convinced that the suggestion will accomplish what is intended. Don't forget that you are promising something to the boss.

If the written recommendation does not accomplish the purpose, then see the boss personally and give him further information to enable him to decide.

ALWAYS remember that it is our job to make the boss SAFETY CONSCIOUS. We cannot do this in one day or one month; it will require considerable time and effort, but if we try hard enough, the job can be done.

Many safety engineers proudly boast that their boss is COMPLETELY SOLD on accident prevention work, when actually the boss may be only VERY MUCH INTERESTED, but not COMPLETELY SOLD.

When we are trying to sell the boss, let's remember that he doesn't have the same "picture" of the job that we have. He has many production problems, and our problem is only one of many. Our problems will be just as important as we make them appear to the boss.

Ninety-five per cent of our human failures are caused by a lack of cooperation. Cooperation of the boss is absolutely necessary.

Shortly after starting on my present job, I heard about the WHITE ELEPHANT to be given to the department with the worst accident record, and if no accident occurred for two months, to be given to the president to keep until an accident occurred. I remember how proud our president was of that

MR. RUDDICK: That is a question which will never be completely answered. I believe that you must establish a policy to begin with and make it well known to everyone in your organization. You will always have cases that are in disagreement with that policy, whichever side you choose.

Our policy in our plant is that we charge the accident to the department of the man who is hurt. We operate on the basis that the supervisor of that man is responsible for his actions, no matter where he is in the plant.

CHAIRMAN WURMAN: Suppose., Mr Ruddick, that I work in a department and I am transferred to another department. I am a very good, safe worker, and the department from which I come has an enviable safety record. The department to which I go has a pretty fair safety record. I use a bit of equipment which on the surface appears to be safe, but I have an accident. To whom would you charge the accident?

MR. RUDDICK: You are from Department A and you are working in another department—

CHAIRMAN WURMAN: I am in Department A and I am a good, safe worker. My boss is a good, safe foreman and we have a very fine record. I am transferred to the eighth floor, which is Department X. On a temporary basis.

MR. RUDDICK: You mean that you are still under the supervision of your foreman in the regular department?

CHAIRMAN WURMAN: When I go up to the other department I am under the supervision of the other foreman.

MR. RUDDICK: That isn't true.

CHAIRMAN WURMAN: Yes, it is true. When I get to this department, which is a fairly safe department, I use a bit of equipment which on the surface is absolutely safe but which turns out to be defective.

MR. RUDDICK: To which department does it belong?

CHAIRMAN WURMAN: To the department to which I went. Who is responsible for that accident?

(The audience said that Department X was responsible.)

CHAIRMAN WURMAN: That is not what you told me a few minutes ago. You people out there said "A."

(From the audience, "You transferred.")

CHAIRMAN WURMAN: I was transferred for a day. I think that we are getting the problem mixed up.

A man from Department B was riding home in a truck driven by an employee from Department A, a company truck. That truck was in an accident, and in the accident an employee from Department B was hurt. To what department would you charge that accident?

How many would charge it to A? How many would charge it to B?

(A larger number of people indicated that they would charge it to Department B.)

ADJOURNMENT

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MONDAY AFTERNOON SESSION

October 6, 1941

Presiding—GENERAL CHAIRMAN FRANK E. AMES, Manager, Safety Department, Lykes Bros. Steamship Company, Inc., New Orleans.

The Why of Safety

By LT. COL. ELLIOTT VANDEVANTER

Executive Assistant, Upper Mississippi Valley Division, Corps of Engineers, U S. Army, St. Louis

Safety work was started about 1910, possibly somewhat earlier. We have been steadily working and earnestly trying to prevent accidents for 31 years. We have made progress, yes, but are any of us satisfied with our results? Why, I ask you, must we fight continually to protect our workers? Why must we coddle them, display posters, have frequent safety meetings on their employers' time, and pay them for lost time injuries, many of which have been caused by their own carelessness, lack of obedience and of interest? Why shouldn't our personnel have enough interest in their own welfare and in their family's welfare to learn all they can about how to protect themselves?

It seems to me that were I in their boots I would first of all learn how to take care of myself. And certainly our supervisors, who have been with us for many years, should accept their responsibility and *really make an effort* to protect the men under them.

As an example, a number of electric cranes are operated on many of our dams. For several years no injury occurred. Then one man grew careless. He was thoroughly accustomed to oiling this unguarded gear and should have realized his danger. His foot slipped and it was badly mashed by a spoke in the gear wheel. Not one of the supervisory force had reported this hazard and did the injured man. It could not be seen from the superstructure and the inference is that not even the foreman had ever been up on top of the crane. After the accident occurred, of course guards were installed.

But why! Oh why! must we wait for the accident to lead us to the danger spot? Why should we not have frequent thorough inspections of all installations, made by responsible men who are well acquainted with the situation, and have the ability to spot hazard and to make the necessary changes, subject, of course, to the approval of the local supervisor? In case funds are required request should be made to the District.

I feel that every "Brass Hat" at District headquarters, when making a trip to the field, should look into the safety situation in addition to attending to the particular matter which is the cause of his visit.

There is nothing new in the organization of safety committees. They have been used successfully for many years. Back in 1932 we found them very helpful. The normal lock crew was 12 men divided into three shifts of four men per shift. One man on each shift and the lockmaster constituted the local Safety Committee. The lockmaster was the head of the committee and personnel was rotated monthly so that everyone had a chance to serve.

I am not claiming that this is a cure all. It does, however, increase the interest which the men take in the work. And if one does find a hazard or a new way of doing his work more efficiently, that man's morale is immediately built up. And the other men begin to look around more critically so that they may offer some new plan, or some improvement. The Committee plan costs nothing. Why not try it?

There are numerous "Why's" of Safety. Human nature being as it is, carelessness creeps into all of our work. Interest drops off, morale weakens and work becomes a drag instead of a pleasure. And it can be a pleasure under proper conditions. A few will always take a chance because they know no better or because they want to show the world how brave they are. Always take a chance *if necessary* but be sure it is absolutely required. As a rule, chance taking doesn't pay.

Most of us have had enough athletic experience to know that teams cannot go on indefinitely as the pressure continually increases. Eventually they go stale—they are trained too fine and what was formerly a victorious team goes to pot.

The same thing happens in safety work. We have your ups and downs. The personnel gets stale. Perhaps some of your men get the jitters and lose their enthusiasm.

Eventually you shake off "Old Man Accident" and everything goes well. The few injuries you gather up are all non-lost time ones. You decide that you've got the "jinx" licked. Now is the time for you to get on the job. Don't wait for a serious injury. Act immediately to tighten up your defenses. Check up on your safety effort. The law of averages is hard to beat, but by strenuous effort you can reduce your accident rate and keep it falling.

Posted on the wall is a chart which you can examine at your leisure, showing the frequency rate of the engineer department. Two years ago a goal of 6 for frequency was set. This chart shows that from January 1, 1941, to July 31, 1941, 8 units had a perfect score; 28 had less than 6 frequency and were under the mark and 27 above it.

From experience I can testify that pressure must be used with caution. After two years with troops in Panama I was ordered to the Upper Mississippi Valley Division as assistant to Colonel Malcolm Elliott, the Division Engineer. After getting oriented I looked into the safety record and found that our division was at the bottom of the list. This was a challenge to us.

Having had some previous experience with safety I felt that I was on the spot and I had to make good. There were four district engineers in our division. I made several trips to the districts and to my mind the safety conditions were growing worse instead of better. So I began writing letters, requiring reports of investigations, etc. Finally the district engineers came to me and said, "Van, we know you're on the spot with this safety business and consciously or unconsciously you're putting the pressure on us. If you will give us a chance to show what we can do we'll do our best, if you'll lay off the high pressure."

I accepted their suggestion with the approval of the division engineer and by the end of that year we were at the head, instead of occupying the cellar. So sometimes too much pressure can be used.

We now have a division inspector who makes the rounds of the four districts. He has had a great deal of construction work and handles men very well. I find I can work through him and so far excellent work has resulted.

The Engineering Department now consists of 55 districts, each headed by a district engineer, 11 divisions, each in charge of a division engineer, and all under control of the chief of engineers.

An officer located in the office of the chief of engineers, is directly charged with safety operations. He heads up the safety activities and all safety reports and correspondence are forwarded by the district office, through

Metals Section

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MONDAY AFTERNOON SESSION

October 6, 1941

Meeting:—GENERAL CHAIRMAN IRVIN A. BRINKMAN, Personnel Director, Mackintosh-Hemphill Company, Pittsburgh, Pa.

Good Housekeeping Program and How to Keep It Effective

By M. W. DUNDORE

Production Manager, Beloit Iron Works, Beloit, Wis.

Good housekeeping in the plant, as in the home, has often been summarized by the phrase, "A place for everything and everything in its place." If management fails to provide the "place," the employee finds adherence to this principle impossible. Provided the "place" should be carried out in the broadest sense. The start of a good program is an analysis of physical plant facilities to determine the adequacy of existing equipment, such as shelves, bins, storage rooms, working places, and the like. Technically, therefore, management has the first responsibility in the good housekeeping program, the employee plays a continuously important role.

The purpose of an industrial good housekeeping program is to promote order and cleanliness throughout the organization. Such a program should accomplish three objectives; first—the elimination of accident and fire hazards; second—the conservation of

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 the 210 accidents, and in studying this we must remember that these are "Compensation" cases, or those in which the injured man was off work seven days or more. Far more eye injuries 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

TABLE 1

210 Random Compensation Cases in Ontario Mines during 1937 and 1938
Operational Causes and Occupational Classes Affected

Operational Cause	Surface Employees		Underground Employees					Total
	Steel Shop	Others	Runner	Helper	Mucker	Chuteman	Others	
Sledging rock	—	4	19	6	9	2	—	40
Picking rock	—	—	8	2	—	—	—	10
Starting hole	—	—	18	9	—	—	—	27
Drilling hole	—	—	14	3	—	—	—	17
Sampling	—	—	7	—	—	—	—	7
Scaling	—	—	9	1	1	—	—	11
Bucking	—	—	1	—	2	—	—	3
Cutting hitches	—	—	6	1	—	—	1	8
Fine particles suspended in air	—	6	4	2	—	—	—	12
Hot scale	4	7	—	—	—	—	—	11
Hammering steel	—	6	5	3	—	—	—	14
Cutting steel	2	2	—	—	—	—	—	4
Cold chisel	—	4	—	—	—	—	—	4
Falling chute	—	—	—	—	5	—	—	5
Handling material	—	—	4	—	—	—	—	4
Sweeping out	—	4	—	—	—	—	—	4
Splash of liquid	—	2	3	—	—	—	2	7
Air pressure	1	1	—	—	—	—	—	2
Chipping bearings	—	2	—	—	—	—	—	2
Crushing	—	2	—	—	—	—	—	2
Not otherwise classified	—	5	7	2	2	—	—	16
Total	7	45	105	29	19	2	3	210

NOTE: "Not otherwise classified" includes blowing holes, threading pipe, cement in eye, dumping muck, eye caught on a nail and eleven other different causes. Samplers are included with runners for brevity.

TABLE 2

Time Lost Due to the Above Accidents

	1937		1938		Total
	Surface	Underground	Surface	Underground	
Total accidents	28	85	22	75	210
Total lost time	447	1,802	423	1,091	3,763
Lost time per accident	16.0	21.2	14.7	14.05	17.9

NOTE: In addition to the lost time, four of these cases are permanent partial disabilities, with pensions ranging from $6.00 to $20.00 monthly.

of those injuries. The statistics shown convince the greatest skeptic that goggles are needed in mining, as by their use of these accidents would have been prevented.

Another major question which will arise is "Are the goggles comfortable and easy to wear?" This will depend to a large extent on the style of goggle used and the care taken in fitting the goggle to the individual. One certain mine decided to install a spectacle-type goggle and issued around 1000 pairs without fitting them. About ten days later they received a call from their safety engineer complaining about the goggles and saying that their men were very much dissatisfied. I asked if the goggles had been fitted when issued, and suggested that individual fitting might eliminate most of their trouble. The 1000 pairs of goggles were called in, and reissued properly, whereupon the complaints immediately declined to a low level, and this mine is now having very good results.

A third major question is "Will the goggles hurt the vision?" A satisfactory answer to this question *must* be found before it is asked by the workers. It may be necessary to issue prescription lenses to various individuals in some cases. This will be governed by the service required of the goggle and

Mining Section

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MONDAY AFTERNOON SESSION

October 6, 1941

Presiding—GENERAL CHAIRMAN CADWALLADER EVANS, JR., Vice-President & General Manager, The Hudson Coal Company, Scranton, Pa.

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 content. The amount of fresh air furnished per man underground varies considerably in different mines but it should not be less than 200 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, advance 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 auxiliary 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 alloying dust are of prime importance in the rock development headings of 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 air is carried within 20 or 25 feet of the face. It has been found that dust counts in the 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

company heads are "safety-conscious," the heads of larger companies being considered more generally so than the heads of smaller ones.

The last question, No. 15, was probably the most important of all. It asked for suggestions as to how the National Safety Council might reach and influence those executives who are not "safety-conscious."

Broadly summarized, the replies stress the need for two things; namely, missionary work among those organizations which are not safety-conscious, and help in the form of ideas, literature, etc., for executives who are safety-conscious.

The ideas suggested for missionary work run along the line of having a representative of the Council personally contact non-members, one reply even suggesting a paid representative who would spend all of his time on missionary work. One reply suggested what would appear to necessitate an organized campaign of coercing to break down the lethargy that surrounds some—calling on State Mine Inspectors and others to use their influence to get the unregenerate and recalcitrant to mend their ways and hit the sawdust trail. This savors too much of compulsion and I doubt its effectiveness in achieving the desired end. It seems to me that the services of the Council must be of such a quality that they can be sold on their merits, if they are going to accomplish their purpose. I think that an organized campaign on the latter basis will be profitable.

The suggestions on how the Council can help those who are already "safety-conscious" point the way to improvement in the quality of our service. The replies received from the Southern Appalachian coal mining men were particularly commendable for interest displayed and constructive ideas offered along this line.

Mr. P. A. Grady, in his reply, points out something which I consider to be particularly fundamental. He admits that the Council stimulates interest among head officials who are already safety-minded, but deplores the lack of up-to-date material for stimulating interest among the workmen. I think he is voicing a very real need, because to be of the highest quality and sufficiently varied, posters and slogans must be produced on an industry-wide scale. I suggest that the Council could profitably sponsor an annual poster and slogan contest for workmen, assistant foremen, and safety inspectors who are the persons in close daily touch with our hazard and should, therefore, be best able to supply such ideas.

If each member company would contribute one good idea—slogan, poster, or briefly written article—each year, that alone would provide a large supply of timely items from which busy safety engineers and safety magazine editors could make selections and adaptations for their own use.

Another suggestion is embodied in a reply what I want to quote: "You cannot bring the Congress to the men, but the men who go to the Congress can certainly bring something back to the men under them." It comes from an executive who sends a number of his foremen, as well as safety inspectors, to the Congress each year. It is, I think, one of the most effective ways of benefiting from membership in the Council.

Another suggestion implicit in one of the replies was that the Mining Section might profit from a study of the activities of some of the other sections of the National Safety Council.

ADJOURNMENT

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MONDAY MORNING SESSION

October 6, 1941

Presiding: D. B. CHANT, Secretary-Engineer, Ontario Pulp and Paper Makers' Safety Association, Toronto, Ontario, Canada, and General Chairman, Paper and Pulp Section, NSC.

CHAIRMAN CHANT: I am happy to see so many of you present at this Thirtieth National Safety Congress.

Our program this year is somewhat less extended complete than in previous years. We have felt that we have at previous Congresses perhaps tried to accomplish too much as a group and that because of the number of papers and the number of papers, many of the Section members were prevented from attending proceedings of other Sections or of the Council as a whole which they would have liked to attend and from which they would have obtained great benefit. So this year our program is shorter. Tomorrow afternoon we have two separate group meetings. One of those is especially set up for members who are interested in paper products and paper specialties manufacturing; the other is for those interested in pulpwood logging operations. Wednesday is a completely open day. On Thursday we have our annual Section Luncheon, followed by the final session. The presentation of the trophies for the Section's safety contest will, as usual, be made on Thursday afternoon following the luncheon.

(The General Chairman then presented his "Progress Report of Section Activities," briefly reviewing the year, and mentioning the good work of the many Sectional Committees.)

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TUESDAY AFTERNOON SESSION

October 7, 1941

Presiding:—GENERAL CHAIRMAN C. A. MILLER, Assistant to Manager, Personnel Department, The Texas Company, Houston, Texas.

Why Company Executives Are Interested in Safety

By J. G. SINCLAIR
Division Manager, Shell Oil Company, Incorporated, Chicago

An executive is interested in safety may be summarized as follows:

He is interested in the welfare of his men and, being interested in them, obviously wishes them to perform their work without injury.

He feels an obligation to the community and, equally obviously, wishes his employees to operate as not to bring unnecessary risk to the community in which they work.

Incidentally, this makes for good customer relations.

Damages to equipment or personnel through injury results in added costs. He is interested in profits.

The employee who is interested in operating safely is also interested in operating efficiently. The employee who is interested in operating efficiently is interested in his equipment. The man who is interested in his equipment is the man who will offer suggestions as to improvements. Improvements mean increased profits as well as increased safety.

When first I became interested in safety, our annual insurance costs were rather appalling, as a result of having had our insurance premiums doubled. In the following five years, costs have been reduced well below the original figure. Over the same period, our automobile accidents have been reduced from approximately one a vehicle per year to one-half an accident a vehicle per year. Compensation injuries for the same length of time have been reduced until they are about one-fifth of what they were. Although we are having one-half the accidents today, our insurance costs have only been reduced one-third, since reductions of insurance premiums are governed by a certain minimum beyond which charges cannot be reduced, we must therefore look further afield for othere benefits which are the result of safer operation.

1. Employee Morale

Employee morale is of primary concern to every executive. Low morale goes further to the breaking of a concern than any other single factor, for unless employees are loyal and believe in their company and its future, the organization cannot realize its full possibilities. Primarily, employee morale depends upon conditions of employment, salary and wage scales, quality of product, equipment provided the men, and general working conditions.

But in addition, it is necessary that thought be given to safety as a builder of morale. When consideration is given to the records of corporations with good employee morale, almost invariably it is found that these companies have good safety records. It seems to follow that a high morale among employees results in a good safety record.

Usually, a safe worker is found to be an employee with interest and pride in his work. Whether the man is driving a truck, handling or dispensing gasoline, building, repairing, and installing equipment, or working in an office, safe performance of his job is part of his duties. If he has pride in his job, it naturally follows that he will perform the work in as fine a manner as possible, which in adddition means as safely as possible.

2. Economic Welfare

An executive is interested in safety because it has a very important bearing on the economic welfare of his employees. This questions has two sides: the humane and the financial. In spite of what our men sometimes think of us, we are still human and we no more wish to see our men hurt than they do themselves. We have all suffered some form of disability at one time or another, and it is never a pleasant thing in retrospect. If through our adherence to safe practice, we can prevent injuries we feel that almost any expense incurred would be well repaid.

In addition, there is the economic loss to the employee. No money was ever made out of a compensation accident. Not only are accidents costly in dollars, time, medical bills and physical fitness, but also they affect a man's standing in his community, with his fellow employees, and with his employer. The man has lost wages—the company has lost his services. Almost invariably this results in the hiring of a temporary workman to fill his

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allow them back on the job, because according to the late releases from the American Medical Association, it is disastrous to turn a man loose on the job who is full of sulfanilamide.

MR. LYONS: My practice has been to make them bring a certificate from the physician that treated them, and then I phone him and ask him if he has prescribed it, and, if so, how long. After I clear that point, I O.K. him to go back to work.

CHAIRMAN HIGHTOWER: I want to thank the members of the panel for their time and for the contribution they have made to this discussion, and I thank the group for your attention.

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TUESDAY AFTERNOON SESSION

October 7, 1941

Presiding—General Chairman V. G. Pendleton, Safety Engineer, West Lynn Plant, General Electric Company, West Lynn, Mass.

Protecting the New Operator in the Power Press Industry—Effective Training Methods

By R. J. GREENLY

Chief, Training Division, Carnegie-Illinois Steel Corporation, Pittsburgh, Pa.

Are accidents really a serious problem in the power press industry? You know the answer to that question or you would not be here today. Last year industrial accidents cost six hundred and fifty million dollars in actual cash outlay. The additional cost due to lost time and to the removal from production of skilled workers would add greatly to this figure. It is undeniable that a large share of this unnecessary loss is due to accidents involving new employees. The figures prove it. During the last year, accidental deaths in industry have been increasing at a rate twice as fast as should be expected from the increasing number of employees. During 1940 deaths were up 10 per cent over 1939, while employment in manufacturing industries increased only 6 per cent. Lost-time accidents have followed the same pattern as deaths. The inexperienced employees clearly constitute a major source of accidental cost and loss.

This is not surprising in view of the many studies which usually show that accident rates during first year of employment are at least twice the rates for subsequent years. We must conclude, therefore, that our new, inexperienced men are largely responsible for the recent disproportionate rise in industrial accidents. This conclusion suggests that substantial results can be obtained from concentrated safety promotion among this high-accident group of workers.

A clue to the answer to this problem lies in a recent study by the National Safety Council. In one industry—the only one for which figures are available—the principal cause of accidents among experienced men was found to be the disregard of instructions. Among new employees, however, the principal causes were (1) deficient knowledge of safe practices and (2) lack of skill. This suggests that the *new men were not prepared to be safe workers.*

at hand and the cooperation of the production department.

4. All materials going into the repair of a punch press must be of the best, making sure that the proper grade of bronze is used for bearings and determine whether a part should be hardened or not.

5. Check over the lubrication system and in places where there are rapidly moving parts or where there is a doubt as to the proper lubrication, change over and use oil. It has been found beneficial in many cases to install one-shot lubrication systems which have proven to be very effective.

6. Have your safety supervisor or foreman in authority sign the inspection blanks after the foreman of the machinery maintenance department has signed them. Inspection and maintenance of punch presses is too important to take any chances on not having it done properly.

7. Have all electrical work done by qualified electricians.

8. Try out the punch press after it has been repaired and have the foreman and assistant foreman satisfied that the machine is in good, safe working condition and is ready to be used.

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TUESDAY AFTERNOON SESSION

October 7, 1941

Presiding:—GENERAL CHAIRMAN CHARLES S. BOWDEN, General Safety Chairman, Ohio Public Service Company, Alliance, O.

The Use, Cost and Preparation of Film Slides for Safety Work

By J. L. McNEALY

Purchasing Department, Columbus & Southern Ohio Electric Co., Columbus, Ohio

I am going to discuss film slides, not glass slides. I intend to give you a brief idea of a simple and inexpensive way whereby any organization, be it large or small, can effectively transmit by means of pictures any safety idea to any group regardless of its size. This method is well within the means of the smallest organization and requires no elaborate or expensive equipment.

First, let us consider the physical aspects of these slides. They are prepared from 35 mm. film, and are cut to size and mounted in cardboard holders approximately 2 inches by 2 inches. Some are prepared in black and white and some in color.

The first type is the simplest and most inexpensive. It is nothing more than a negative projected on the screen. In this case the image is reversed, the blacks are white and the whites are black. This type is considerably limited in scope and when projected to any size, its clarity is lost through the inherent grain of the film. However, in cases where persons are not included in the film it will suffice to illustrate the point that you desire to get across to your men.

This film can be purchased for approximately 90 cents for 36 exposures, development and mounting approximately 55 cents, making a net cost of approximately 4 cents per slide.

The second type of slide is a positive black and white slide. In this case the blacks and whites are not reversed but are in the correct relationship with one another.

This is somewhat better when there are persons in the scene. In many cases the people are recognizable and this always adds additional interest to the scene.

The cost of this slide is approximately 7 cents each. The same base material is used as in the case of the negative slide, plus a film amount of material required to convert the negative into a positive film.

From black and white positives slides, our next step is toward a more finished product. This finished product being slides in color. Colored slides have many advantages. Film grain is absent, there is inclined to be a stereoptical effect which enhances the perspective and gives an effect of solidity or relief.

In this case the persons are easily recognizable, the wires are clear and distinct, and also the absence of rubber protective equipment is clear.

Many are unfamiliar with poison ivy. In this case you can show them what it looks like without fear of becoming poisoned.

Or you may want to stress the value of retaining your eyesight. Use your goggles to protect your eyes so that you can still enjoy pictures such as these.

The cost of colored slides is considerably higher than for the previous type of slides. A roll of film containing 18 exposures will cost approximately $2.50, which price, however, includes all processing and mounting in slides. This makes each slide cost approximately 14 cents, which, considering the superior product, is well worth the cost.

Now let us consider the equipment that will be required.

The first piece of equipment needed will be a camera. Good cameras can be purchased for as little as $15 and up to as high as you desire to go, $200 or more if you wish to go that far. For example, the camera that I use cost $35. It has a reasonably "fast" lens and sufficient dials and knobs to cause me to stop and think just how to use it each time I attempt to take a picture. It's a well built camera, plain American throughout, but if it is used right it will give good results.

Along with your camera there are many accessories that are available: flash guns, range finders, tripods, light meters and other gadgets too numerous to mention. However, if you are just starting, leave the gadgets alone and stick to picture taking; gadgets can come later.

The next piece of equipment required is a projector. Projectors range in price from $2.50 to $65, and I presume you can go higher if you care to do so.

The next piece of equipment required will be a screen. Screens range in price from $6 to $20. Ten to twelve dollars will purchase a good beaded screen.

A screen is desirable, yet if necessary the pictures can be projected on the wall. However, the wall coloring will detract from colored slides and therefore, although the wall can be used, a screen is recommended.

Now we have briefly given you the idea of film slides and equipment required. Let us see what the total minimum cost will be for you to start illustrating your safety talks with pictures of *your* men, *your* working conditions, *your hazards* and your ideas of right and wrong ways of doing work.

First, a camera	$15.00
Second, a projector	12.50
Third, a screen	8.00
Total	$35.00

Now let us assume, for sake of argument, that you will have 24 safety meetings per year. Then the spread of your equipment cost over the year would be approximately $1.48 per meeting. Let us assume you will show ten slides per meeting. This would be $1.40 for slides, making a total cost of $2.48 per meeting. And I believe $2.48 is within the reach of every company.

Now do I hear murmurs going around the room to the effect that I have neglected to take into consideration the time involved?

That is true, I have not included the time involved because, as in my case, you will secure your pictures while around on your regular duties. You will see an unsafe condition here, a hazard there, and you will snap them. You will then have the slide prepared and ready for the next safety meeting, together with an exhortation on the evils of connecting the "hot line" to the bottom of a cutout; the unwise practice of not using rubber goods; and many others too numerous to mention. And what is more it will "get over" because you will be showing your men conditions that they will recognize as their own.

Home-Made Movies in Public Utility Work

By JOHN M. ORTS

Director of Safety Education, Public Service Corporation, Newark, N. J.

There are large numbers of men—and women—whose sales resistance to the accident prevention idea has yet to be broken down. Their reaction to the lecture, to the bulletin board, to the poster, to the pamphlet, and the classroom, is one of general indifference. They just don't care! And it is this group, who, in the main, are responsible for our accidents and to whom we have to devote particular attention and personal treatment.

1. It provides protection to the worker in case of accidental contact by isolating the worker from ground.

2. It offers additional insulation on poorly insulated or grounded structures.

3. It provides additional insulation where it is felt desirable on the higher voltages now being worked with rubber protective devices.

4. It offers the possibility of establishing at a higher voltage the dividing line between lines which can be worked with rubber protective equipment and those requiring wood insulated tools.

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TUESDAY AFTERNOON SESSION

October 7, 1941

Presiding:—GENERAL CHAIRMAN A. A. RALL, Safety Supervisor, Kansas City Power & Light Company, Kansas City, Mo.

Safe Use of Refrigerants

By H. H. SCHRENK

Chief Chemist, Health Division, Bureau of Mines, Pittsburgh, Pa.

The properties of refrigerants may be broadly classified into three main groups: (1) Those important for refrigeration; (2) those significant from the standpoint of confining the refrigerant; and (3) those that become important if the refrigerant escapes from the machine or container.

The first group of properties, such as latent heat of vaporization, specific heat of vapor, specific heat of liquid, etc., is not considered to be directly related to safety and is not discussed here.

The second group—those properties important in confining the refrigerants—has particular significance because it relates to "built-in" safety. This is emphasized because it is believed that the soundest procedure in designing equipment is to give due consideration to both the health and safety hazards likely to be associated with it. Furthermore, the toxicity, fire, and explosion hazards are controlled as long as the refrigerant is confined. Some properties of this group are (1) stability, (2) corrosiveness, (3) boiling point, (4) pressure developed in the system, (5) warning odor or irritation, and (6) [illegible] of detection.

The third group includes such properties as toxicity (of compound and decomposition products), irritating action, and explosibility.

Many substances have been suggested or tried as refrigerants, but the number used more or less extensively is limited. (Table 1 gives a list of refrigerants that are [illegible] in the American Standard Safety Code for Mechanical Refrigeration B9-1939.)

The compounds are listed in four [illegible] groups: (1) Miscellaneous, (2) hydrocarbons of the methane series, (3) chlorinated hydrocarbons, and (4) chlorofluorohydrocarbon compounds.

Table 1.—List of Common Refrigerants

Name	Formula	Mol. wt.
Ammonia	NH_3	17.03
Carbon dioxide	CO_2	44.01
Methyl formate	$HCOOCH_3$	60.05
Sulfur dioxide	SO_2	64.06
Ethane	C_2H_6	30.07
Propane	C_3H_8	44.08
Butane	C_4H_{10}	58.12
Isobutane	$(CH_3)_3CH$	58.12
Methyl chloride	CH_3Cl	50.49
Ethyl chloride	C_2H_5Cl	64.52
Dichloromethane (Carrene No. 1)	CH_2Cl_2	84.94
Dichloroethylene	$C_2H_2Cl_2$	96.92
Dichloromonofluoromethane (Freon-21)	$CHCl_2F$	102.93
Dichlorodifluoromethane (Freon-12)	CCl_2F_2	120.92
Trichloromonofluoromethane (Freon-11)	CCl_3F	137.38
Dichlorotetrafluoroethane (Freon-114)	$C_2Cl_2F_4$	170.93

Molecular weights are given because of their relationship to weight of gas per unit volume. The molecular weight of air calculated upon the basis of its composition is approximately 29. Any gas having a molecular weight less than this is lighter than air, and any gas with a higher molecular weight is heavier than air. Expressing it another way, the higher the molecular weight the less gas is formed per unit of weight; that is, 1 pound of ammonia will produce about 23 cubic feet of gas at 25° C. and 760 mm, while 1 pound of Freon-114 will produce 2.3 cubic feet of gas.

Table 2 gives some properties of refrigerants that are significant in connection with confining them in a mechanical system.

The refrigerants listed are arranged in accordance with decreasing boiling point, which, in general, tends to parallel the pressure developed in the system. Materials suitable to withstand such pressure must be chosen, as the greater the pressure the greater the possibility of leaks, as well as rupture of pipes and joints. Compounds having low boiling points operate at pressures exceeding atmospheric on both high-and low-pressure sides, and all leaks are outward. Those with high boiling points may operate on a negative pressure on both high and low side, or only on the low side. Should leaks occur, the escape of refrigerant would be much slower than for those compounds that have a low boiling point and are gases at ordinary room temperature and pressure. Prevention of leaks is necessary, not only because of hazard to health and safety but also to overcome operation difficulties.

Corrosiveness is one of the most important properties of refrigerants, not only from the standpoint of safety but also of operation. It is not surprising, therefore, that virtually all the common refrigerants are non-corrosive, particularly in the absence of moisture. Ammonia will attack copper and brass, but apparently even these metals will stand up in piston rings, rods, and bearings that are protected by an oil film. Aqua ammonia has virtually no effect on steel or iron pipe. Although noncorrosive when dry, sulfur dioxide is quite reactive in the presence of moisture.

The halogenated hydrocarbons containing either chlorine or fluorine, or both, in general have low corrosiveness even in the presence of moisture, the fluorine derivatives

keep in step. Particularly they should learn to respect the "point of application" of the cutting elements of the machine that is doing the work.

Typical machine accidents from our own experience with these machines confirm the statistics already quoted: namely, the percentage of permanent injuries is the greatest when accidents involve machines.

An analysis was made to determine the contributing causes of twelve typical accidents involving 462 days of lost time and, in addition, heavy penalties because of the loss of a hand and one and one-half fingers. Of these accidents

7—were in connection with the regular operation of the machine.

5—while adjusting or repairing it.

2—resulted from improper tool used.

3—from an improper method.

1—included a dangerous procedure.

2—the block of ice was broken.

3—the man slipped.

4—failure of the process.

8 out of 10 injuries could have been avoided if the man who was hurt had paid attention to what he was doing.

In 12 of them the machine was running.

In each case no accident would have occurred had the injured kept in mind the simplest of instructions and acted accordingly. In each case the machine and its saws or picks were still running which definitely increased the seriousness of the accident. Possibly the single cause would be heedlessness.

Even if the machine were not properly guarded and even if it had not stopped running, the workman might easily have avoided being hurt if he had paid attention to the conditions around him even if that meant a slight interval to permit a condition to develop in which he could work safely. These dangerous habits can be eliminated; the accidents resulting from the normal hazards of the work can be reduced to a minimum; and the men save themselves from painful and many times disabling injuries by keeping in mind and following these instructions:

1. Do not operate any power-driven ice processing machine unless you have been instructed in its use.

2. See that all safeguards are in place. Wear the proper protective clothing, and use all the protective equipment provided.

3. When handling ice into the machine, use the proper tools. It is dangerous to kick or shove ice blocks into a machine with your feet or hands.

4. Never put your hands into a saw-type cubing machine; never attempt to remove cubes with your hands while the saws are in motion.

5. Always stop any machine before removing refuse ice; then use a stick or an ice pick to clear away the ice.

6. Before oiling a power-driven machine, and before making adjustments or repairs, always lock the disconnecting switch in the electric circuit. When the work is completed, before removing the lock, see that all tools have been removed from the machine and that all safeguards are in place.

7. Keep the floor about the machine free of loose ice and stumbling hazards.

8. Before leaving a power-driven machine, always turn off the power and wait until it has stopped running.

These instructions are available on Safety Instruction Card No. 490 published by the Safety Council. Hand them to the men called upon to do this work when they are first assigned to the job.

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MONDAY AFTERNOON SESSION

October 6, 1941

Presiding:—General Chairman Oliver Hopkins, Supervisor of Safety, U. S. Rubber Company, Providence, R. I.

Lest We Forget

By M. A. CLARK

Manager, Industrial and Public Relations, U. S. Rubber Company, Detroit

As I look back a quarter of a century and review our attitude toward safety, I find there are four periods. The first was the very indefinite and small amount of interest and thought of safety developed only by those few brave souls who had the crusader spirit. The next period undoubtedly was that of the definite crusaders, and we went out with a lot of enthusiasm and hope and desire to save our fellow man from injury and death because we believed, or at least gave appearance of belief, that we were interested in him as a human being.

At that time, every speaker portrayed the husband and father leaving for work in the morning with the wife and children waiting on the doorstep, waving goodbye with the prayer that he come back to them in the same condition that night. He musn't come back with mangled limbs or be brought home on a stretcher. Of course, it was all exaggeration. No wife and children ever waved Dad off to work on a cold winter morning. Perhaps they were all glad he was gone, "the old crab." But the very exaggeration was intended to create emotion which would cause people to rise up and develop this great mission of accident prevention, and it was worthwhile.

Then came the next period, the rational one, when we began to preach accident prevention on the basis of the economic loss through lack of safety. We used figures and statistics to show the cost of insurance, the terrible loss in industry, to the wage earner, to the whole economic system, because of reduction and elimination of production through accidents, and because of compensation costs which might have been avoided. There, again, a sound contribution was made by those devoted people, who in spite of every setback, still worked for men. In approaching the situation today, I have used as the subject of my short address to you, "Lest We Forget," that in a new era of safety we are mindful of all types of preceding safety efforts.

Let us forget the value of the first and second, and not be unmindful of the results of the third. I am wondering, as I talk to you, if we haven't possibly, in the last phase of this situation, been devoting too much time to statistics and too little time to the real facts and doing something about it? I realize that there must be an accounting and I realize too that there must be some sort of proof to justify expenditures for safety work, but I wonder too, if we haven't erred a little in our statistics in side-stepping and being a little bit on the dishonest side.

I am well aware of the splendid records that have been made all over the country in the great reductions in lost time accidents, but I am wondering if we have not been altogether too prone to call the lost time accident only that accident which compels the individual to be absolutely away from his place of employment. We have not faced the fact that the lost time accident is the accident that prevents a man from carrying on his work in a normal way. The fact that we may take an individual, who has met with an accident on a particular machine, and have found a one-handed job for him, does not absolve us from the moral untruth which we are so willing to accept.

Have we not, in most cases, accepted statistics and figures as being the goal rather than merely a guide? I am inclined to think that from here on, whether we like it or not, we must be guided in our safety work, not merely by the thing that happened, but by all the conditions which caused the happening. We must recognize that when an individual cannot continue to work in a regular way at his regular job, it is as much a lost time accident as if we were paying compensation. Let us admit that, at least to ourselves.

Industry of itself has created an active Frankenstein, a monster which frequently gets out of control, and within that Frankenstein in our own particular industry, we have the juggernauts of production still getting out of control. Apparently we have not faced the fact that we created these conditions, and it is moral responsibility to see that these juggernauts are controlled and that we cannot escape our responsibility by attempting to prove that individuals suffer their accidents from their own carelessnesses.

Sometimes, I am inclined to believe that I personally, as an example, have been too prone to compare our statistical findings with those of others and have been satisfied that we have made progress in comparison, rather than taking the other point of view, never minding what the other fellow has, never minding how honest or dishonest the statistics might be. Let us find out what everyone has. Take the best and put it in operation.

24 Hours of Safety

Again, do we accept this safety job when we ring the card at 8:00 in the morning, and then relinquish the safety job when we leave at 5:00 at night? Possibly we all know, but emotionally I think we forget, that a safety program is operating 24 hours a day, 7 days a week, and when we accept an assigned responsibility as a safety supervisor, or in any branch of safety work, we must accept it on the basis that this is a crusade. This is not a clock watching job. This job is never finished. I can't possibly understand how we can do a safety job if we never get back to the plant at the odd times of night or Sundays when the equipment is not operating as well as when the thing is in full blast and everyone is tumbling over the other and it is hard to find out what is wrong.

Do a Better Job

I agree that human beings must have variety. Otherwise, the mental activities will atrophy. I agree that all work and no play certainly can make Jack a dull boy. So too, I can agree that this constant application of our minds to safety can become routine and monotonous. But if we can accept our safety responsibilities in the same light that we accept our Faith in our Maker, (and I am assuming that we are always conscious of Divine Presence) we can accept it in the spirit then that we are always conscious of safety.

We are conscious that we must do a better job than we are doing today and, "Lest We Forget", keep before our minds at all times the one golden rule, "Do for the other fellow about what you would expect him to do for you." Can we not always carry in our thoughts too, that our fellow worker is a man created in God's own image, and that you and I must recognize that our lack of acceptance of responsibility for him can be definitely a sin of omission, which may be great or greater than the sins of commission?

The time has long gone by when we can pass the buck and say, "I placed an order covering this job," or "I told the foreman to do it." We cannot evade the responsibility which carries the authority with it that we must get things done, although in the doing of them sound judgment, sound common sense, much cooperation and tact must be used.

I sincerely trust that in your deliberations throughout this entire safety conference, you and I and all others will be conscious of the fact that we have a definite responsibility to safeguard our fellow workers.

it is sometimes necessary to make substitutions for solvents formerly used. Also, entirely new processes or applications of solvents may require the attention of the safety engineer. If the plan of use comprises a number of units for either hand or machine application the construction of an experimental unit is recommended prior to the design of complete ventilation equipment. The experimental unit can be cheaply constructed, using such materials as wallboard, etc., to control the air currents. A damper or other control should be used for varying the amount of exhausted air. Using an instrument for measuring the vapor concentration, such a unit can be thoroughly tested under actual operating conditions. Variables such as air velocity, volume of air, location and dimensions of inlet slots or openings can be determined.

It is recommended that the ventilation of the experimental unit be such that the maximum vapor concentration breathed by the workmen does not exceed 50 per cent of the accepted maximum safe concentration. For example, the maximum safe concentration for Benzol adopted by the American Standard Association is 100 P.P.M. If the experimental unit is designed so that the vapor concentration breathed by the worker does not exceed 50 P.P.M. that leaves a safety factor to allow for unforseen variables.

Even with well designed local ventilation near the place of evaporation some of the vapor will probably leak past the exhaust inlet. Exhaust inlet openings at the floor level should be provided for removing this vapor. The speaker has found that 10 per cent of the total exhaust, including all local ventilation, should be at the floor level.

Safety in the use of solvents requires a knowledge of the vapor concentration in workroom air. You are probably familiar with the combustible gas indicator for testing manholes, tanks, etc., to determine if an explosive mixture is present and if it is safe for workmen to enter the tank. The indication on the dial of this instrument is a warning only concerning a possibility of acute poisoning which is a narcosis or asphyxiation. For chronic poisoning, the vapor concentrations are far too low to be indicated on the combustible gas indicator. A more sensitive form of this instrument is the M.S.A. Benzol indicator having a full scale reading of 1,000 P.P.M. and indicating 20 P.P.M. per division. When Benzol is used, this instrument is extremely valuable for determining the vapor concentration in workroom air. It has also been used with special calibration for vapors such as Toluol and Cyclohexane and can probably be used for any combustible vapor. The instrument is very useful in testing totally enclosed systems for incipient leaks around pipe flanges and pump gaskets.

In the prevention of chronic poisoning, it is extremely important that periodic tests be made of the workroom air especially during various stages of operation and when any changes are made in the ventilating equipment or method of application of the solvent.

ADJOURNMENT

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TUESDAY AFTERNOON SESSION

October 7, 1941

Presiding:—GENERAL CHAIRMAN J. R. TENNEY, Superintendent of Safety, Western Maryland Railway Company, Hagerstown, Md.

Grade Crossing Accidents

Presiding:—CHAS. E. HILL, General Safety Agent, New York Central System, New York City.

The Highway Grade Crossing Accident Situation as Viewed by the Railroad Claim Department

By WM. J. HOLDEN

District Claim Agent, New York Central System, Cleveland, O.

In 1940 over 1,800 people were killed and 4,500 injured in grade crossing accidents and for the first six months of 1941, 880 were killed and over 2,200 injured.

There are approximately 230,000 highway grade crossings in the United States, each a potential accident hazard. The cure, if there is one, and we believe there is, lies primarily in education and law enforcement and education must always begin with fundamentals. It is fatuous to believe that preaching alone will solve the problem. We may delude ourselves with statistics, slogans and platitudes and we may plead with the motorist to cross crossings cautiously, but it will avail us little unless we have a basic understanding of grade crossing accidents and face the problem with an open mind, willing to admit that the cure involves a dual obligation in which the railroad, as well as the highway traveler, must play its part.

The problem is to so regulate the conduct of the automobile driver and the operators of the railroad train that each may have the privilege and opportunity to occupy the crossing without contest from the other. It is a basic principle of law that where a railroad train and a person traveling on the highway each approach a crossing at the same time, it is not the duty of the operators of the train to stop the train, but in keeping with the custom of the country it is the duty of the traveler on the highway to stop and not attempt to pass in front of the train. The violation of this duty and the resultant contest for priority at the crossing is an underlying cause for grade crossing accidents. Motorists must be brought to the realization of their obligation and responsibility and the campaign of education must not be a flash-in-the-pan sporadic one. It must acquire its effectiveness from constant reiteration and follow-up. The rights and duties of the highway traveler and the railroad are reciprocal; each owes a duty to the other.

If every question of doubt at the railroad crossing were to be resolved on the side of safety and the chance-taker who contests the right of occupancy of the crossing with a railroad train could be made to appreciate the futility of his course, the railroad grade crossing problem would be one of theory rather than of fact. This statement would carry particular weight with those of us living in the middle western states when we realize that for the past few years the records of the Interstate Commerce Commission show that the four leading states in automobile grade crossing accidents are Illinois, Ohio, Indiana and Michigan. The chance-taker who is fortunate enough not to be struck when he contests the right of occupancy of the crossing with the train, is potentially as dangerous as his less fortunate brother.

Now what about the railroad? It, too, has certain duties and obligations. There must be a co-ordination of effort between the railroad and the highway traveler in order to obtain satisfactory results. First and foremost is the duty of the railroad to sound proper and effective engine bell and whistle signals for the highway crossing. Almost invariably in crossing accidents it is contended that this duty was not complied with. Experience shows that the occasion is comparatively rare when proper crossing signals are not sounded, and yet it is difficult to understand why we are met with so much testimony to the contrary in crossing accidents. The necessity is such that those charged with the responsibility should insist upon a strict adherence to the obligation and see that crossing signals are sounded so that the last blast of the whistle is drawn out until the crossing is reached. The continuous signal extending up to the crossing is a vast improvement over the old two long and two short blasts of the whistle which were usually finished a long distance before the engine had reached the crossing. A study is suggested with a view to improving the tone and penetration of the engine whistle and the possible use of sound directors and whistle shields.

In the same connection, the practice of locating engine headlights in the center of the engine boiler or even lower rather than on top of the boiler as is still the practice on some railroads, is recommended.

Then there is the duty to protect crossings by proper and adequate means consistent with the local situation and the nature and volume of the railroad and highway traffic. Opinions vary as to the preferred type of crossing protection. There are those, well versed in the crossing accident problem, who have a predilection for the manually operated crossing gates, operated from a tower located at the crossing. There is a definite favoritism for the mechanical type of protection. One pertinent observation is that there is too much variety in the type of mechanical crossing devices and a lack of standardization in locating the devices at the crossing. In the course of a hundred miles one may encounter a half dozen or more

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.

Amtzen, 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.

R. 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.

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.

Meiflex 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.

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

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

U. S. Bureau of Mines, Washington, D. C.

U. S. Department of Labor, Washington, D. C.

Univis Lens Co., Tulca Division, Dayton, Ohio.
Eye Protection.

Wagner Electric Corp., St. Louis, Mo.
Hydraulic Industrial Bridge Brake, Explosion-Proof Type Motors, Sangamo Tachograph.

Weaver Manufacturing Co., Springfield, Ill.
Vehicle Inspection Equipment.

West Disinfecting Co., Long Island City, N. Y.
Products for the Promotion of Sanitation.

F. H. Wheeler Manufacturing Co., Chicago, Ill.
Industrial Safety Clothing.

Wiesman Manufacturing Co., Dayton, Ohio.
Power Press Guards and Guide Pin Covers for Die Sets.

Willson Products, Inc., Reading, Pa.
Personal Protective Devices.

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TRANSACTIONS

30th
NATIONAL SAFETY CONGRESS

GENERAL SUBJECT AND
INDUSTRIAL SESSIONS

CHICAGO
OCTOBER 6-10, 1941

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

ployees to observe safety rules when off-the-job just as they do when at work. Try to influence a reduction in traffic accidents, the nation's number one killer and the probable cause of the loss of forty thousand American lives in 1941 long before we ring in the New Year less than three months from now!

We must intensify our efforts to get people to drive at reasonable speeds. We must bear in mind that a skilled employee is just as much dead and just as much a loss to America if he is killed on a Saturday night or a Sunday afternoon in a traffic accident as if he is killed in the shop. Actually he is two men lost—for in addition to our loss of production due to his accident, the Nazi egoists are relieved of the necessity of keeping some man over in tyranny-ridden Europe or at work to offset his production. Let's remember that.

The President's proclamation was a pl for cooperation. The National Safety Cou cil's acceptance of the task assigned to i and its call upon you to assist, also partoo of the same nature; it was a plea for a sistance. In the procedure that has bee set up, in the free cooperation that has bee asked and that will be forthcoming, we s an example of democracy working at its bes We see exemplified the principles of unit in dependence and independence in unit that made this nation the greatest and th freest civilization that ever evolved on th face of this earth—a civilization which, wit your help, will endure long after the blo of Naziism has been wiped forever fro the face of Europe and even the threat o any future dictatorship of a few mad mind over all the earth rendered an absolute an an eternal impossibility.

ADJOURNMENT

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 pre-

vent 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 affecttd 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 1.5 gallons per square foot of tank area per 10 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 significant 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 th installation is to serve the purpose of remov ing toxic materials or those which may b classified as nuisance contaminants. Bot are legitimate requirements but it should b clearly understood that one system is to pro tect health directly and the other to provid comfort. Proper consideration can then b given to the question of "how much" an "what kind" of ventilation is to be installe

A common sense program will include ex haust ventilation as one very important ai but only as related to other possible method of solving the problem involved. When sub stitution is feasible and economical, or re vision of process if possible, these may pro vide a cheaper, more satisfactory answer. A times, personal protection will best serve th purpose and in some instances a few simpl rules of operation and maintenance may be a that is needed. Ventilation often proves th only answer, but indiscriminate ventilation i the poorest and most costly answer that ca be devised. A system should be completel designed at one time with no additions with out a complete revision of all parts of th system. It is, of course, permissible to com pletely design a system in such a way tha units may be added from time to time b this should be a part of the original consid eration. Conversely systems well designe and installed to meet the condition encoun tered in the degree necessary are major aid in any health program.

Measuring Concentrations of Toxic Substances

By S. W. GURNEY

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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 industri hygiene and the number of chemists an medical school graduates who are goin back and taking these courses is a furth measure of the increasing importance of th general subject of industrial health.

Not many plants have experienced indus trial hygienists on their staffs; in fact i would be impossible for them to do so a there are not enough of them to go aroun I believe that there are very few in th meeting this morning who would call them selves industrial hygienists. With this as

sumption 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. Mo of the safety engineers have to depend up their own ingenuity to provide the answe By far the majority of our plant safety m have no industrial hygienist to lean upo neither have they been able to procu simply operated instruments which will gi them the answer they want for the particul air contaminant or exposure that exists their plant. Such safety engineers are entirely without recourse and there is qu a lot they can do to get some measure estimation of some of their plant exposu without outside help.

For example, take visual inspection, whi is simply the intelligent use of the sense sight. Dusts, which have given us mo cases, probably than all of the other contaminants combined, are usually perfect visible things. Considerable stress has be laid upon the point that it is necessary know the size distribution of such dust su pended in the air before we can tru measure the hazard that exists. In this has been my experience that wherever the have been big particles which can easily seen there are always plenty of small on which are deeply respirable which cannot seen. I have never yet made any dust studi in plants where it was obviously dusty sight that there were not many times mo fine particles well down in the so-call respirable range than there were big on Conversely you seldom find fine dust witho large ones along with it which can be se particularly near the source of the dust question. If your plant is a dusty one so evidence of dustiness is visible, even if y have to climb up on the rafter to look it as settled dust.

I can recall one safety engineer haulin me half way across the continent to ta dust counts at a brushing machine in radiator foundry. So much dust was thro off into the air by this operation that it w difficult to see from 25 feet away the t men who were operating it. It was obvio to anyone that so much dust could possibly be beneficial regardless of silica content and common sense should ha told him that here was a situation abo which something should be done promptly. As a matter of interest the d counts ran up into several billions per cub foot and the free silica content as quar

somewhere between 10 and 15 per cent. information may be helpful in getting improvements but it seems to me that anytaking the trouble to view this operation 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 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 pickle tanks may not be visible but the fumes 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 chunk with a knife and wrap it up and take 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 doubt 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 hydro-

carbons 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 ke down the concentration. It should be us with caution and understanding. Safety gineers often ask me whether or not coating process or a mixing process or ev such things as vapor degreasers should have something done about them. To su inquiries I frequently ask the safety gineer to go out and stand alongside of t operator of the process in question for much of the day as the operator does hi self. I further ask him to tell me just ho he feels at the end of this period. It remarkable how often after going throu this the safety engineer comes to the co clusion that further protection is necessar at least very desirable. Now you know th there are lots of smells, irritating gases a the like that workers finally get used to and they will probably affect you much mo violently than they do the experienc operator. On the other hand I wonder we are right in asking people to work disagreeable atmosphere where they ha to "get used to it" before they become re sonably reconciled to their job.

There is one other way we have of es mating exposure that is probably not good as the three I have mentioned b nevertheless it has its uses. I refer to co plaints on the part of the workers the selves. Safety engineers should be clo enough to workers in the departments whe toxic materials are used so they will g verbal reports of any complaints or o jective symptoms that arise.

I recall two fatalities this year alleged caused by high exposure to carbon tetr chloride vapor. There may have been oth cases but these two were such that I ha access to the reports of the investigation They were both rather simple jobs of clea ing metal objects with carbon tetrachlori and the whole operation was by hand. Bo operations had been performed occasional for a number of years, but as a result large defense orders the time spent at the operations had increased considerably. Bo men are on record as having complain considerably. They had been nauseated se eral times. They complained of feeling tir and restless for quite some time before th finally became really seriously sick. A alert safety man nosing about the pla 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

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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 importance in the selection of the air-purifying type. A particular absorbent may have a relatively high restraining capacity against one type or 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 com-

fort 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 r
pirator was giving inadequate protecti
against the high concentrations of vap
encountered in spray painting the inter
of buildings. The alternatives in supply
additional protecion were to increase t
quantity of absorbing material, or to use
air-supplied type. The relatively large v
ume of absorbent necessary to give compl
protection for an eight-hour exposure to
high concentration of vapors, required eith
an inconventiently larger container or f
quent refilling of a small one. A valid
jection to the standard air-line models w
that when it was necessary to move scaffo
ing or to perform other work in the ro
being sprayed, the painter must, to ret
his air source, carry the supply line where
he went, an inconvenient and even dangero
impediment to climbing on and off scaffo
ing and ladders. If he cut loose from t
airline ,he was exposed to the residual c
centrations of five to ten thousand parts p
million, an appreciable cumulative expos
during the course of a day.

An airline respirator was modified to i
clude a charcoal cartridge and automa
shutoff valves on both sides of the connecti
between the supply line and the respira
line. Thus when the airline connection
severed, the intake of air begins automati
ally thru the cartridge and continues un
the reconnection with the airline again aut
matically closes the small valve in the ba
of the cartridge. These modifications fr
quently require considerable experimentati
until a satisfactory result is obtained, b
the protection and safety afforded is adequ
compensation.

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

Temperature and humidity may influen
the selection in at least two ways since (1
they have a definite effect on the capacity
certain types of absorbents, and (2) th
affect the comfort of the wearer. The effe
of moisture on the life of activated charco
against gasoline vapors has been shown i
studies by the Bureau of Mines. The ca
pacity of the dry charcoal (0.35% moisture
was six to twelve times as great as th
containing 21 per cent moisture (in equili
brium with air at 25 degrees C and 85 pe
cent relative humidity, and showing no sen
sible moisture). The efficiency of hopcalite
absorbent (actually a catalytic agent for
anging carbon monoxide to carbon diox-
) is readily destroyed by moisture. It is
equently difficult to control the temperature
humidity of the air for air-supplied res-
rators. The lines carrying the compressed
for general plant purposes even though
latter may be pure for respirator use,
equently parallel steam lines or pass thru
areas, resulting in uncomfortably high
peratures at the terminals. Otherwise
tisfactory compressed air may have had the
isture removed because of certain opera-
requirements, and the relative humidity
es below 10 or even 15 per cent may
se discomfort and dryness in the respi-
ory tract.

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

Most of the respirators now available, if proper working condition, can be worn, for long periods of time, without appre-ble discomfort if the wearer has become chologically adjusted to the situation. It probable that the chief cause of failure of tection in exposures where respirators are vided is the mental and physical discom-t due to faulty operation or maintenance— clogging of filters, the unclean condition the face piece, the unsatisfactory fitting the contour of the face. Unless the work-n are exceptionally enlightened the un-fortable protection will seem worse than hazard of the exposure. In general men adapt to the wearing of respirators easily than men, and this relation in-eases with the size of the face piece or vering and the amount of equipment in-lved. Age and physical condition must be sidered, especially when devices such as self-contained oxygen breathing appara-is to be worn in emergency operations. The intelligence and cooperation of the work-n are obvious factors.

7. *Control of personnel exposed—educa-on, supervision.*

Too frequently the employee is merely nded the respirator with the order to "go ead and use it." Instruction as to the rea-n 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 he 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

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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 u ful conditions at home as well as on They receive a large return on the ment, not only through the reduction lost from the job through sickness b from the reduction in the cost of ind accidents and diseases.

Industrial Health

Although progressive employers reco the importance to them of healthy, sat employees, it is unfair and unjust to i upon them the legal liability for any illn or diseases among the employees that not actually caused by the employment. cupational disease laws should be care enacted and justly administered so that employer will not be expected to pro general health insurance for his employ The industrial environment is actually sponsible for only a small proportion o time lost from the job by employees.

Every employer should, of course, be re quired to provide his employees with a saf and healthful place in which to work. Suc an environment can be achieved only throu a study of every condition of industrial li followed by an adjustment of these condi tions to the health requirements of the indu trial worker.

Atmospheric Contaminants

Employees should not be subjected to th inhalation of atmospheric contaminants i sufficient concentrations to cause disease o poisoning, nor even in concentrations suf cient to cause any marked degree of di comfort. Polluted air is undesirable eve though the foreign material in the air is no present in harmful quantities. Workers wh are satisfied and contented with the workin environment are not only happier and mor efficient but healthier as well. Many ind viduals imagine all sorts of ill effects eve from trivial industrial exposures, and ma even worry themselves into an actual cas of illness which was not caused by the en vironment but from the mental attitude of th worker.

Atmospheric contaminants in industrial ants may consist of solid dispersoids, liquid spersoids or gases or vapors. Solid dispersoids may be divided into dusts, fumes nd smokes. Liquid dispersoids may be di-ided into mists and fogs.

Dusts

Industrial dusts are mechanically generated y many different processes and operations. ypical examples are drilling, blasting and rushing in mining and quarrying; polishng, buffing and grinding in metal finishing nd stonecutting, polishing and abrasive lasting in the granite and monument industry. The dust generated in every case is of he inorganic or mineral variety. Animal and egetable dusts are known as organic dusts nd are generated by such operations as the rocessing of cotton, the working of wood, r the polishing of skins.

From the health standpoint, industrial usts of above ten microns in size are of no mportance because they are too large to be nhaled into the lungs themselves. Dusts elow ten microns in size are not visible to he naked eye but can be seen with a microcope down to about two-tenths of a micron n size. Dusts containing sufficient percentges of free silica and asbestos may cause iseases known as *silicosis* and *asbestosis* if nhaled 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 n certain changes in the lungs which are vidently 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 on dust concentrations in workroom atmospheres. The American Standard Safety Code for the [illegible] of Heads, Eyes and Respiratory [illegible] recommends "that no employee be continuously subjected without a respirator to an atmosphere containing any [illegible] dust in quantity exceeding [illegible] per cubic foot of a size [illegible]." 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 th phase of substances which usually the form of liquids under ordina tions, gases exist only in the ga under ordinary conditions.

Vapors and gases are frequently b rectly termed "fumes." For exam trous fumes" instead of nitrogen oxi A liquid organic solvent such as tetrachloride will evaporate from a tank in a workroom and the vapors bon tetrachloride collect in the surro atmosphere. Thus the carbon tetra can exist under the ordinary condit the workroom either as a liquid or a On the other hand, the oxygen and c dioxide gases in the air of the work cannot exist under such normal conditio any other state.

There are a vast number of organic vents in use in industry and the numb increasing each year through the disc of new and better solvents in the indus chemical laboratories. The extent of d to the health of workers through the in tion of the vapors of many of these solv is not known.

American standards have been establi this year for benzol of 100 parts per mi parts of air, carbon disulfide 20 parts million, carbon monoxide 100 parts per lion and hydrogen sulfide 20 parts per lion. The American Standards Associat Committee on Allowable Concentrations at present engaged in the deve standards for acetone, carbon te diethyl ether, formaldehyde, hydrofl acid, methanol, nitrous gases, detrachl thane, tetrachlorethylene, toluol, trich ethylene and xylol. Tentative sugg standards for these as well as for abo additional gases and vapors are given i June, 1940, issue of the Journal of Indus Hygiene and Toxicology, as already m tioned.

Atmospheric Pollution

The only definite method of determi whether or not a concentration of at pheric contaminants exists in the worki that constitutes a health hazard is by m of collection and analysis of air sam

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 [illegible] times each minute during the entire day. On the other hand, he usually eats lunch only [illegible] day on the job. In addition he may [illegible] at other times during the day [illegible] lead which in itself could not cause [illegible].

Skin Contact

[illegible] organic liquids such as tetraethyl leaded gasoline and benzol poisoning by absorption through the skin 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 [illegible] broad geographical belts across [illegible] States in which heating of the [illegible] type is generally used during [illegible] months of the year. It does [illegible] rooms heated by radiant energy, [illegible] excessive glass area or those [illegible] insulated or cold walls. In dense [illegible] spaces somewhat lower tempera[illegible] be necessary. Satisfactory comf[illegible] tions for men at work have bee[illegible] vary from 40 to 70° E. T. depend[illegible] rate of work and the amount o[illegible] worn. In hot industries 80° E. T. [illegible] ered the upper limit compatible [illegible] ciency and whenever possible this [illegible] reduced to 70° E. T. or less.

In the summertime the averag[illegible] zone is from 66 to 75° E. T. with [illegible] as the popular average. This is 4 to [illegible] average than in the wintertime.

The temperature differential be[illegible] doors and outdoors which should [illegible] tained depends on a number of f[illegible] drop in temperature of 10° F. or [illegible] be extremely harmful if it occurred [illegible] especially when the skin and clo[illegible] wet with perspiration.

No standard has been establishe[illegible] proper amount of humidity. It m[illegible] from 30 to 70 per cent without dis[illegible] The air should be dry rather tha[illegible] The common belief that dry air in [illegible] erts a harmful effect on the skin and [illegible] membranes has never been proved [illegible] vincing evidence, although there h[illegible] numerous investigations on the subj[illegible] addition of moisture to the air of [illegible] rooms by any practical method has [illegible] shown to have any beneficial effe[illegible] health and comfort. Experiments hav[illegible] that the respiratory membranes of in[illegible] workers exposed to hot, *moist* air [illegible] tinctly more abnormal than those of [illegible] exposed to hot, *dry* air.

The maximum air movement shou[illegible] feet per minute with not less than [illegible] feet per minute per occupant of the [illegible] taken from an outdoor source. Mr. [illegible] states that "an air movement of no[illegible] 40 f.p.m. is permissible under present [illegible] neering practice, when the temperatur[illegible] the air current is 2° F. or less below [illegible] nary room temperature. Current velo[illegible] as high as 200 f.p.m. may prove desir[illegible]

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 90 decibels or a brief exposure to intense noises invariably impaired hearing. Other results are vestibular disturbances, mental fatigue, loss of efficiency, some nervousness which can become excessive noise. Some persons are more sensitive 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 illumi-

nation 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 improper posture among industrial The use of proper chairs eliminat and greatly improves efficiency.

The comfort and efficiency c workers are also affected by the colo of the environment, the length of th ing hours and the rest periods used nection with them, the general house conditions and cleanliness of the plant, washroom, sanitation and eating fac medical facilities, and by proper prov for recreation. Most of these, however, little or no important effect upon the health of the industrial worker.

ADJOURNMENT