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30th
NATIONAL SAFETY CONGRESS

GENERAL SUBJECT AND
INDUSTRIAL SESSIONS

CHICAGO
OCTOBER 6-10, 1941

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

Ventilation - [illegible]
measuring contaminants

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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Contents

Council Officers .....
Make Profitable Use o
Council Purposes and
Annual Meeting of M
Congress Banquet ...

Subject Sessions—

Dusts, Fumes, Ga
Electric Welding
Elevators ....
Fire Control and
Fundamental Cau
Governmental Saf
Human Engineeri
Industrial Health .
Industrial Nursing
Maintaining Safety
Sabotage Preventi
Safety Engineering
Safety Organizatio
Safety Training ..

Industrial Section Sess
Aeronautical Secti
ASSE—Engineerin
Automotive and M
Cement and Quarr
Chemical Section .
Construction Secti
Food Section .....
Marine Section ...
Meat Packing, Ta
Industries Sec
Metals Section ...
Mining Section ...
Paper and Pulp Sec
Petroleum Section
Power Press Secti
Public Utilities Sec
Refrigeration Secti
Rubber Section ..
Steam Railroad Sec
Textile Section ...
Wood Products Sec

Exposition Exhibitors .
Index ....

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:esident's proclamation was a plea
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;tance of the task assigned to it,
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In the procedure that has been
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Dusts, Fumes, Gases and Vapors

THURSDAY MORNING SESSION

October 9, 1941

Methods of Combating Industrial Health Hazards

A Symposium

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

Ventilation and Exhaust Equipment

By GORDON C. HARROLD, Ph. D.

Industrial Hygiene Laboratories, Medical Department, Chrysler Corporation, Detroit

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

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

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

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

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

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

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

It was pointed out that with flanged slots, decreasing the depth of the liquid below the slot reduced the air required by about 15 to 20 percent. This is probably due to decreased turbulence as an unflanged hood is not 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 particles but the maintenance costs are Electrical precipitation is also very ef but is often too expensive to instal maintain.

The velocity of air in the pipes shou sufficient to prevent deposition. This ve may be as high as 4500 linear feet in th of lead dust. Since too great a veloc wasteful and results in excessive pipe the system should be so designed as to inate the need for excessive velocity. distances to collectors, coupled with st sections of pipe with no sharp bends, ar in this endeavor. When sections of l pipe are joined to a main pipe the jo angle should be 30 degrees or less.

A corollary of Dalla Valles work i the exhaust hood should be as close as sible to the source of dust formation. ideal would lead to a total enclosure t duce openings to a minimum and thus the resultant face velocities to be higher.

Often gases and fumes are collecte gether and usually the limit of air re ments is set by the velocity needed to the pipes from plugging up. In some as in foundry operation, back draft exha resorted to in order to collect the air dust. Then a separate downdraft s keeps dust from getting into the air.

Welding of various kinds produces fume, fumes from the flux and gases su nitrogen dioxide and ozone. The iron apparently is only a nuisance dust bu manganese, fluorides, etc. resulting fro welding flux are harmful. The gases are harmful when in sufficient concentr

Work performed in the Chrysler La tories indicated that this situation wou be harmful in open spaces unless h coated rods were used. In tanks and spaces, dangerous concentrations of gases and fumes could be predicted. Va types of exhaust systems have been de The most common one depends on a attached to flexible metal pipe so tha face of the hood may be placed in near imity to the work. Other types range floor grills to hood canopies, each type adapted to the kind and size of the to be welded.

In closed tanks, the "Airbooster" as

should not be allowed to become half wet but should be thoroughly flooded at all times. The parts of the system where work is done should be of non-sparking material. It is not safe to collect this material in filter screen or cyclone collectors, nor should sparking type metals be allowed to get into the ventilation system.

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

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

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

Measuring Concentrations of Toxic Substances

By S. W. GURNEY

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

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

Not many plants have experienced industrial hygienists on their staffs; in fact it would be impossible for them to do so as there are not enough of them to go around. I believe that there are very few in this meeting this morning who would call themselves industrial hygienists. With this assumption in mind I have tried to pl[…] paper for the ordinary safety engine[…] the safety committee man who does[…] member his chemistry too well—bu[…] does feel that he should know more […] the possible health hazards in his plan[…] may also be somewhat worried about […] for alleged health damage that have […] submitted and may wonder if there i[…] thing he can do about it himself. It cer[…] would be fine if every plant large e[…] to have even one man wholly interes[…] safety could arrange to have one trai[…] well as interested in the fundamental […] lems of industrial hygiene. However […] would take a long time to accomplish a[…] the present we shall have to get along […] what we have.

I should like this morning to try t[…] plant safety men what they can do alon[…] line without the benefit of specially tr[…] industrial hygienists. I am assuming th[…] know the names of, and are familiar in […] way with the materials used in conn[…] with the operations in the plants wher[…] are. This includes the dusts, fumes, v[…] and gases, the solvents and other chen[…] that are used, produced as necessary […] products of, or enter at all into the n[…] facturing processes in any way. If yo[…] not you certainly should find them out—perhaps this is the first thing you can […]

We are safe in saying that wherev[…] toxic substance is used an exposure e[…] For example, if you have in your pla[…] process using benzol you undoubtedly […] a benzol exposure. If somewhere in […] plant you are melting lead or a lead […] for any purpose, an exposure to lead e[…] in that part of the process. This does […] mean necessarily that a health hazar[…] benzol or to lead exists, but we can say […] we do have the exposure.

Now over the years by means of an[…] experimentation, and by the results of h[…] experience, it has been shown that […] dosages of these toxic materials which […] as air contaminants are pretty well t[…] care of by the healthy human organi[…] High dosages in the time factor as we[…] the concentration are not well handled […] damage to various organs and tissues […] result from continued exposure.

Further, these same studies, both an[…]

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 Such information may be helpful in g improvements but it seems to me that one taking the trouble to view this oper would have immediately recognized health hazard.

I have often been asked to define o scribe by appearance what constitutes much dust. I'm afraid I have no pr answer to that question. I have often re to such questions that if you actually see clouds of any dust produced or diss nated into the air of a working area any process it is a good idea to enclose ventilate it, or at least to try to control dust source in some way.

It has been my experience that most dustrial commissions and accident bo are not particularly impressed with counts and analyses and discussions threshold dosages as such. If testim shows that a plant is dusty, and anyone see that it is so, the plant is pretty li to have to accept any claims for respirat system damage as an industrial case.

The acid vapor which arises from hot pickle tanks may not be visible but steam that accompanies it usually is. can see where it is coming from and get idea where it is going. The etched or rus appearance of metal work in the room w these pickle tanks is also visible evide that acid vapors have escaped into the roo

The fumes from arc welding are perfec visible—and the 25 mgs. per cubic me suggested as a limiting dosage in Massach setts is a very dense cloud. One investigat describes it as so thick you could cut out hunk with a knife and wrap it up and ta it home.

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

The human nose is probably not a pa ticularly precise measuring device and doubt different people's noses differ wide in their ability to detect and estimate a contaminants by this means. However, ma of our industrial vapors and gases do ha distinct and characteristic odors and muc can be done by a safety engineer by th intelligent use of the good old nose.

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 this up and recognized it as a meas excessive exposure. Both cases tern fatally and in the medical picture at a showed about what one would expect acute case of carbon tetrachloride pois It is interesting to know that after air samples were taken in a number of tions around the operation and conc tions well over 100 ppm., the sug threshold dosage, were found.

I think if we investigate our plants oughly we will find that there are a n of processes and operations involving materials or at least materials with degree of toxicity that have for years carried on safely without complai symptoms or any other evidence of damage. The reason for this was t frequency of the operation or the quantity used or the short time of exp With increase in production a numb these processes have speeded up so gradually the weekly degree of ex to the dust, fume, vapor or gas has increased. As a result of defense processes that used to take place other Thursday are now being carrie

Personal Respira

By DI

Director, Laboratory of Industrial

The need for personal respiratory p tion in many types of industrial oper is now well recognized, but the probl determining in a specific instance wh a respirator is required, and what ty best indicated, is sometimes not a simpl

Every type of respirator places son striction on the wearer, and although it be only a slight inconvenience and nificant compared with the protection it vides, it must be recognized as a con mise. Ideally, all operations would be ducted so as not to contaminate th which must be breathed, or the degr contamination, would be kept at safe by ventilating devices. Only after the mary effort to achieve this ideal has p to be impossible or impractical shoul use of personal respiratory protective