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31st NATIONAL SAFETY CONGRESS

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**General Subject and
Industrial Sessions**

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Foreword

VOLUME I

THE Transactions of the 31st National Safety Congress and Exposition of the National Safety Council are published in two volumes. Volume I contains the General Subject and Industrial Section sessions. Volume II contains the Public Safety, Child Education, Home Safety and Farm Safety sessions.

Volume I is distributed to all members of the Council. Volume II is sent to those members who are believed to be interested chiefly in the sessions it contains, to other members on request.

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of material exhausted, or leakage losses caused by loose cleanout doors, broken joints, holes worn in duct (most frequent in elbows), poor connection to exhauster inlet.

Losses in suction can also be charged to additional exhaust points added to the system (sometimes systems are designed for future connections and more air than required is handled by present branches until future connections are made), change of setting of blast gates in branch lines (blast gates

adjust the air distribution between the various branches. Tampering with blast gates can seriously affect such distribution and therefore gates should be locked in place immediately after system has been installed and its effectiveness checked). Increased pressure loss through dust collector due to lack of maintenance, improper operation, wear, etc. vary with the collector design. Refer to operation and maintenance instructions furnished with the collector or consult the equipment manufacturer.

Testing Toxic Atmospheres

By N. R. BERNZ

Chief Industrial Hygienist, The Fidelity & Casualty Co. of N. Y., New York, New York

In manufacturing, many operations and processes of one industry are common to those of another, although the two industries may be engaged in the production of entirely different types of goods. For example, welding is used very extensively throughout the aviation, shipbuilding, automobile and steel industries; this applies also to spray painting, electroplating, buffing, grinding, and many other operations. Similarly with raw materials, various kinds of acids, organic solvents, etc., are found in almost any type of plant. For this reason there are certain industrial poisons which appear much more frequently than others and which may be found throughout the entire defense industry. Some of these are:

Dusts	Toluene
Carbon Monoxide	Xylene
Hydrogen Sulfide	Trichloroethylene
Hydrogen Cyanide	Carbontetrachloride
Sulfur Dioxide	Carbon Disulfide
Oxides of Nitrogen	Nitric Acid
Ammonia	Chromic Acid
Phosgen	Hydrofluoric Acid
Lead	Hydrochloric Acid
Cadmium	Sulfuric Acid
Benzene	

Others which are more directly associated with specific industries are:

Trinitrotoluene (dust and vapors)
Ammonium Picrate (dust)
Mercury (vapors)
Aniline
Radon
Thoron

As will be seen by examination of the above list, some of these substances are present as raw materials; others are final products, while a third group occurs as by-products generated in the various operations. Typical of the first group are the various acids, organic solvents, chlorinated hydrocarbons, ammonia, and carbon disulfide. In the second class we have TNT and ammonium picrate, while the remainder are commonly occurring dusts, fumes, gases and vapors of a toxic nature generated in various industrial processes. While the theoretic possibilities for exposure to toxic substance in the above industries are far too numerous for tabulation, this list represents those most commonly encountered.

Dusts

Silica-bearing inorganic dusts are profusely found in all of the above industries. For example, mining of the iron ore in the steel industry presents exposures to free silica dust in considerable quantities. Buffing, polishing, and grinding operations done ve-

tensively in a great many industries, generate inorganic dusts, which for the most part consist of aluminum oxide and silicon carbide, but also include free silica in amorphous and crystalline forms.

For the purpose of quantitative determination, dusts may be divided roughly into three classes, as follows:

1. The inorganic type such as free silica and asbestos, which is collected and the number of particles per unit volume of air determined microscopically.

2. Organic dusts of natural origin, the amount of which is usually determined by weight. Typical of these are tobacco and flour dusts.

3. Synthetically manufactured organic compounds which may occur in the form of dusts, such as TNT and ammonium picrate. These substances when present as air contaminants in low concentrations are generally valued quantitatively by chemical means.

Besides above types, there are also metallic dusts such as lead, zinc, cadmium, manganese, etc., some of which will be discussed under another heading.

Inorganic Dusts

The most common method for evaluation of this type of dust is to collect air samples in liquid solutions by means of an impinger

(1) and to make the quantitative determination microscopically. When calculating the dust concentration, usually expressed in number of particles per cubic foot of air, the microscopic calibration factor, the volume of the sampling liquid, and the size of the air sample are taken into consideration.

The sampling procedure, microscopic arrangement, and calculations are extremely simple, but the actual counting is a tedious job associated with severe eye strain and requires considerable experience before dust counts can be relied upon. In recent years the microprojection method (2) has been used for counting of impinger samples. With this method in which the microscopic field is projected on a translucent screen, the eye strain experienced in direct microscopic work, is eliminated.

Other methods for evaluation of this type

of dust are by means of electrostatic precipitators (3) and various types of "grab" samplers. With the electrostatic precipitator, the dust is collected in a dry state and either weighed as is, or suspended in water and counted in a manner similar to that employed with the impinger method. Several of the grab samplers have microscopes incorporated with the sampling device and these are calibrated in such a manner that the number of particles per cubic foot of air can readily be obtained by almost instantaneous readings (4).

Organic Dusts (Natural)

This group as a rule is not classified by medical authorities as fibrosis producing dusts, and hardly warrants any discussion in this paper. While claims do exist to the effect that some dusts in this class have produced respiratory irritation, bronchitis, asthma, etc., these dusts are generally looked upon as nuisances rather than occupational disease producers. No official physiological threshold limits have been established and sampling of this type of dust for the purpose of evaluating an occupational disease hazard has little or no meaning.

Most of these dusts, however, are explosive when dispersed in certain proportions in the air and require control from this point of view. Considerable work to establish explosive limits for this type of dust has been done by the United States Department of Agriculture.

Synthetic Dusts

In the manufacture of TNT and ammonium picrate, both of which represent basic war industries, we are confronted with toxic raw materials as well as hygienically injurious final products. In this industry great quantities of toluene, anhydrous ammonia, sulfuric and nitric acids are used, all of which are classified as industrial poisons. TNT and ammonium picrate are themselves systemic poisons as well as skin irritants known to have produced fatalities and severe cases of dermatitis.

A method for sampling and determination of TNT was described recently by Pinto and Fahy. (5) This procedure calls for the use of 10 c.c. of isopropyl alcohol in the midjet

impinger. The chemical determination is based on the reduction of TNT to triaminotoluene, and finally, a colorimetric comparison with known standards.

Ammonium picrate is highly soluble in water which therefore can be used as the collection medium in an impinger when sampling for this material in industrial atmospheres. The deep color which results upon solution of ammonium picrate in water is also evident in extremely low concentrations and for this reason a direct colorimetric comparison of the sample with known standards can be made. With this method there is a possibility of interference from dinitrophenol, the extent of which has not been determined (6).

Carbon Monoxide

This is a very toxic gas encountered in various industrial activities. The toxic limit for this gas is generally accepted as 100 p.p.m. for prolonged exposure. To the public in general its presence is most commonly associated with automobile exhaust and gas burning appliances utilizing manufactured gas with a high percentage of carbon monoxide. As a result of incomplete combustion it may also be present when burning natural gas or other fuels. In industrial operations involving baking ovens, drying kilns, coke ovens, blast furnaces, etc. carbon monoxide is frequently encountered. In industrial processes in general, and particularly where chemical reactions are involved, carbon monoxide may be generated as a dangerous by-product. In prism grinding, which is closely allied with the defense industry, a high quality iron oxide rouge is required. Occasionally this material is manufactured on the premises as an adjunct to the prism grinding work. This involves the use of oxalic acid for production of iron oxalate which is later decomposed by heat to yield iron oxide rouge. In this process carbon monoxide as well as other gases are generated.

Several methods have been developed for the quantitative determination of carbon monoxide, but only the two most expedient procedures employed in industrial hygiene work will be discussed here. One of these is the carbon monoxide indicator based on the catalytic reaction of hopcalite which oxidizes carbon monoxide to carbon dioxide.

The small electric current produced by heat of the reaction through a thermocouple is calibrated in terms of carbon monoxide concentration which is read directly on the dial of a milliammeter. The source of suction in this instrument is a small centrifugal blower, the motor of which is operated either from a built-in 6 volt battery or from a 110 volt lighting circuit through a transformer.

Another convenient method for estimation of carbon monoxide though less sensitive and not so accurate is the use of palladium chloride ampoules. In this reaction the palladium chloride is reduced to metallic palladium thereby producing a stain, the intensity of which is in direct proportion to the amount of carbon monoxide in the atmosphere under observation. The stain produced is compared to known color standards for evaluation of the carbon monoxide present. This method is not specific for carbon monoxide, however; three are other reducing gases which also will produce a stain in the presence of palladium chloride. Incidentally, the standard method for carbon monoxide evaluation, adopted by the British Department of Industrial Research (7) consists of a palladium chloride test paper through which the air to be sampled is drawn by means of a handpump. The stain thus produced is compared with a standard color chart.

Hydrogen Sulfide

Hydrogen sulfide is a very toxic gas with a disagreeable odor. It is found in many industrial operations where sulfur or sulfur compounds are used, but primarily it is encountered in the artificial silk, chemical and petroleum industries. Safe limits varying between 20 and 50 p.p.m. by volume have been suggested by various State authorities in this country.

The most rapid method for determination of hydrogen sulfide is undoubtedly the use of a hand operated instrument consisting essentially of an aspirator bulb and a detector tube through which the air sample is drawn. The detector tube contains a chemical substance which when in contact with hydrogen sulfide produces a discoloration the length of which is in proportion to the amount of hydrogen sulfide present and can be measured on an attached scale. It can also be determined iodometrically, either by bubbling

ough a sodium hydroxide solution and reacting with iodine, or by bubbling through potassium iodide starch solution and a measured amount of standard iodine in which region the disappearance of the color indicates the end point (8).

Hydrogen Cyanide

This gas for which the industrial hygiene bureaus of California, Connecticut and Massachusetts have established a safe limit of 20 p.p.m. by volume, is found in electroplating operations, heat treating, etc.

A portable instrument of the type designed in connection with hydrogen sulfide, has been developed for hydrogen cyanide also. I have been informed, however, that the hydrogen cyanide detector in its original form proved less satisfactory and that it has been withdrawn from the market temporarily pending further research.

Chemical tests are available for detection of hydrogen cyanide, such as the prussian blue and thiocyanate reactions, both of which are specific for this gas but allegedly not sensitive enough for concentrations encountered in industrial hygiene work. Other methods suitable for determination of this gas in small concentrations are the Congo red-silver nitrate and the benzidine-copper acetate test papers. These methods, which have been adopted as standard tests by the British Department of Industrial Research, are non-specific, however, so that the possible interference of other gases such as HCL, H₂N, SO₂ and H₂S should be taken into consideration.

In a method suggested by the Air Hygiene Foundation (A.H.F.) the air sample is bubbled through 0.5 per cent potassium hydroxide after which the determination is made by titrating with silver nitrate (9).

Sulfur Dioxide

Exposures to sulfur dioxide gas are common in the petroleum industry, rubber works, and sulfuric acid manufacturing. Sulfur dioxide is also encountered in bone and glue works, magnesium foundries, and other industries where sulfur compounds are used. It is an extremely irritating gas for which a threshold limit of 10 p.p.m. has been suggested.

For the testing of sulfur dioxide, the American Public Health Association (A.P.H.A.) (10) refers to an iodometric method (11) by means of which the air sample is passed through a gas wash bottle containing a measured amount of standard iodine in potassium iodide-starch solution. The disappearance of the color indicates the end of the test, after which the amount of sulfur dioxide present can be calculated.

The British Department of Industrial Research employs a starch-potassium iodate test paper through which the air sample is drawn by means of a handpump. The sulfur dioxide reduces the iodate to iodine with the production of a stain the degree of which is compared to known color standards.

Oxides of Nitrogen

This is a group of gases, some of which are extremely toxic. They are produced when nitric acid comes in contact with organic materials and certain metals; during chemical nitration processes and burning of nitrated materials; they are also present in small quantities during electrical discharges in the air. Above gases may, therefore, be found in such industries and operations as ammunition works, photographic film manufacturing, nitric acid plants, electroplating (bright dipping), detonation of explosives, electric welding, etc.

During the chemical reactions that accompany above operations, a mixture of oxides are formed. The hazardous nature of this group, also called "nitrous fumes" is due primarily to the nitrogen dioxide, a reddish brown gas which reacts with water and upon respiration forms nitric acid in the lungs. The result is often pulmonary edema which frequently proves fatal. The fact that the respiration of these gases does not produce any immediate discomfort in spite of their toxicity, makes them doubly dangerous. A person may be exposed to these fumes and experience only a slight respiratory irritation immediately following the exposure, while the case may develop into a fatal condition by next day.

For example, I know of a case in a nitric acid plant where a man was engaged in filling nitric acid into carboys in a department with a wooden floor. One of the carboys accidentally broke causing the acid to

flow over the wooden floor producing the brown nitrogen dioxide gas in great volumes. The operator not being familiar with the toxicity of this gas and experiencing no immediate physiological warning, remained on the job attempting to clean the floor by mopping up the acid, instead of leaving the work place for fresh air. As a result a considerable portion of this gas was probably inhaled. He became seriously ill a few hours later and died within 48 hours. Cases of men becoming sick while doing electric welding inside tanks or in other confined spaces are often referred to in the literature. Many of these cases are undoubtedly due to oxides of nitrogen generated in the electric arc.

While there are several methods known for the quantitative determination of oxides of nitrogen, testing for these air contaminants is not so simple as that for some of the others discussed in this paper. Incidentally, in view of the cumbersome procedures involved in testing for these gases, the amount of ventilation required for their control after blasting in mining and tunnel work is sometimes based on the amount of carbon monoxide present, which can readily be determined. With explosives designed for a low oxygen balance resulting in a relatively high carbon monoxide concentration and correspondingly low volumes of oxides of nitrogen, this is a safe and expedient procedure.

For actual detection of nitrogen dioxide, the method employing starch-potassium iodide test paper is probably the best known. This paper when damp is colored blue in the presence of nitrogen dioxide. The method is non-specific, however. Other, specific methods for evaluation of nitrogen dioxide, and sensitive at low concentrations are the Griess-Ilosvay and the Bismarck Brown tests. With both methods, the air sample is bubbled through chemical solutions after which the quantitative determinations are made in the laboratory by colorimetric analysis. Although physiological safe limits up to 40 p.p.m. have been proposed for these gases, atmospheres which by odor or color indicate the presence of nitrous fumes should always be viewed with suspicion.

Ammonia

As stated elsewhere, ammonia is an important raw material throughout the chem-

ical industry. It is a strong respiratory irritant for which safe limits ranging between 50 and 85 p.p.m. have been recommended (Russian investigators 13-39 p.p.m.; State of Massachusetts 50 p.p.m.; Flury and Zernik 85 p.p.m.).

Ammonia vapors can be evaluated directly in the field by bubbling the air sample through a measured volume of 0.1 N hydrochloric acid in water solution using phenolphthalein as an indicator; the appearance of a pink color indicates the end point. From the amount of acid used and the size of the air sample, the concentration of ammonia vapors can be calculated (8).

Sulfuric acid can also be used with above method. In another method, recommended by the A.P.H.A., the air sample is collected in sulfuric acid, but the final evaluation is made in the laboratory by standard analytical means.

Lead

Exposure to this metal occurs very extensively in nearly all types of manufacturing. The most frequently encountered forms of lead are fumes, dust and dispersed pigments. These occur around lead melting operations, soldering, welding of metals covered with lead-bearing paints, and in spray painting work.

Sampling of lead-contaminated atmospheres is usually done either by means of the impinger or by the electrostatic precipitator. When the impinger is used, as is frequently the case when investigating spray painting and many other types of work involving lead dispersion, the sampling liquid may be either distilled water or dilute nitric acid.

Regardless of the collection method used, the final evaluation of the amount of lead present is done in the laboratory by various analytical methods, the description of which is beyond the scope of this paper. It probably should be emphasized, however, that although some of these methods are highly sensitive and the experienced analysts usually well-trained to handle minute quantities of lead in their work, it is preferable to take large air samples wherever possible to facilitate the laboratory work. With the large impinger and the electro-static precipitator

with sampling rates of 1 and 3 cubic feet of air per minute respectively, this is not a problem. With the midget impinger, on the other hand, with a sampling rate of only 0.1 cubic foot per minute, this becomes a tiresome task, especially if the handcranked instrument is used. Let us take, for example, a case in which the atmospheric lead dispersion is just about on the border line of the safe limit, i. e. 1.5 mg. per 10 cubic meters of air. For a 30 minute sample with the midget impinger, only 3 cubic feet of air have been sampled. This represents only 0.013 mg. of lead in the air sample, which evidently requires a fairly sensitive analytical method and careful handling for a successful completion of the test.

Cadmium

The United States Public Health Service (U.S.P.H.S.) (16) suggests as a safe limit with respect to toxicity of cadmium fumes a concentration of 1 mg. per 10 cubic meters of air.

The metal is used extensively as a coating of iron and steel for rust prevention, as well as in structural steel to impart certain properties. Exposures to cadmium and cadmium fumes may, therefore, be encountered in such operations as electroplating, welding of cadmium-bearing iron and steel as well as many other processes where work involves cadmium-plated articles. Some of you are probably familiar with the cases of cadmium intoxication in a plant in Ontario, Canada, a few years ago, when 14 persons were poisoned—two fatally—during annealing of cadmium plated rivets (17).

As in the case of lead, sampling for cadmium fumes or dust may be done either with the impinger (with water as collection medium—A.P.H.A.) or by the electrostatic precipitator and the samples evaluated in the laboratory by gravimetric or colorimetric analytical methods.

At this point it probably should be brought out that for sampling of metal fumes, the impinger has a lower collecting efficiency than the electrostatic precipitator, which should be taken into consideration when comparing results obtained on samples collected by the two instruments (18).

Mercury

The present emergency has greatly accelerated the use of mercury, not only in our ammunition works, but also in many other plants directly or indirectly connected with the defense industry. In some cases entirely new uses have been introduced for this metal. For example, a recent development is an anti-fouling paint containing mercury, now used in our shipyards. Application of this mercury-bearing paint by means of spraying naturally introduces a serious exposure to mercury poisoning and calls for careful control; this applies also to the manufacture of the paint. Due to the great demand for mercury and the shutting off of foreign supplies, many old mercury mines are now being reopened so that refining of this metal with accompanying occupational disease hazards has expanded considerably during the past year.

The toxic properties of mercury as a respiratory hazard when present in the form of vapors or in a finely divided metallic state are probably fairly well-known to most men concerned with industrial health. A safe limit, toxicologically, of about 2 mg. per 10 cubic meters of air appears to be generally accepted for inhalation exposures. Although the metal has a relatively low vapor pressure at ordinary temperatures, investigations have shown that sufficient vapors are emitted to produce a mercury hazard in rooms where this material is used in metallic form.

A number of methods are available for the evaluation of mercury vapors in air. One of the most expedient procedures is probably by means of the Nordlander apparatus utilizing a selenium sulfide test paper, the color of which darkens in the presence of mercury. The amount of mercury present is estimated by comparing the degree of darkening with a standard color chart.

Another more recently developed method involves an optical instrument based on the opacity of mercury vapors to ultra violet light of a certain wave length. In this instrument, therefore, when ultra violet light of a specific wave-length is directed towards a phototube, interfering mercury vapor will reduce the light received by the phototube and consequently also its current flow, which in turn is calibrated in terms of mercury concentration. This instrument is not specific as it is

subject to other light intercepting media such as smoke and fog.

There are also other methods for determinations of mercury, entailing condensation of the vapors and subsequent electrolytic deposition of the metal, chemical reaction methods, etc. The first two mentioned above, however, are the most expedient and yield immediate results during the field investigations.

Benzene (Benzol), Toluene and Xylene

These three aromatic hydrocarbons are widely used as industrial solvents and ingredients in a number of chemical reactions. Toluene, for example, is an important raw material in our ammunition manufacturing, especially in the production of trinitrotoluene. With the increased demand for toluene and the corresponding scarcity of this material, benzene is rapidly taking its place as a solvent in many industries. Xylene, which besides being an important solvent, also does enter as a raw material in certain chemical processes, at present associated with the defense industry and therefore used in great quantities. For instance, in a plant I visited recently xylene is used in the production of a certain type of resin, which in turn is employed in an article manufactured for the United States Army.

All these three materials are classified as industrial poisons, although there appears to be some confusion as to the relative toxicity of each. Benzene is generally considered as the worst offender, although this may not be due to a greater toxicity of the material *per se* but to the fact that it has a higher vapor pressure than the other two so that for a given temperature more of it will be found in the air. However that may be, the toxic effect of all of them, once dispersed in the air, is generally recognized and therefore indicates the need for strict control wherever they are used.

For the evaluation of these materials some chemical as well as physical methods are available. Most of these, however, are complicated and cumbersome, involving such operations as nitration by bubbling the air through nitric acid with subsequent colorimetric determination, or condensation of the vapors followed up by laboratory analytical procedures for the final evaluation. While methods of this type may be satisfactory for scientific purposes, for routine sampling in control work in industrial plants, a combus-

tible gas indicator is far more expedient. Most of these devices, used primarily for prevention work, are designed to read within 1% of the lower explosive limit of gas or vapor under test. For above substances with lower explosive limits around 1% by volume, this means that concentrations down to 100 p.p.m. can be detected, which is approximately the accepted toxic limit for these solvents. For benzene with a safe limit of 75 p.p.m. (19) a modified combustible indicator has been placed on the market, which measures concentrations ranging between 0 and 1000 p.p.m. A spectroscopic method for determination of benzene and toluene in air has been described by Cole (20).

Chlorinated Hydrocarbons

Of these, trichloroethylene and carbon tetrachloride are probably most frequently found. They are used extensively as metal cleaning agents; the former in regular degreasing machines on a production basis and the latter for work of a more occasional nature. These materials with their grease dissolving properties are regarded by medical authorities as very injurious to the fatty tissues of the human body.

As in the case of other substances referred to above, there are chemical methods for quantitative determination of vapors from these materials, but they are mostly too cumbersome for routine sampling. Optical instruments are available, however, for rapid evaluation of such vapors dispersed in the air. The best known of these is probably the portable interferometer in which the difference between the refraction of air (the comparison substance) and that of the gas mixture to be examined is measured. This difference is calibrated in terms of concentration of the gas or gases under observation. Naturally the same readings will be obtained for all gas mixtures resulting in the same refractive index, so the instrument is therefore not specific. With information, however, as to the type of air contaminant concerned in a particular problem it is an exceedingly useful instrument applicable to the investigation of a great variety of gases and vapors.

Carbon Disulfide

This substance which at ordinary temperatures occurs as a liquid with a high vapor pressure, generates toxic vapors for which

very low safe limits have been suggested by various authorities. Russian investigators recommended a threshold limit of only 10 p.p.m. for prolonged exposures, while the Department of Scientific and Industrial Research has suggested a value of 10 p.p.m. and our own State of Massachusetts, 10 p.p.m. While there is a wide divergence in these values, they all tend to indicate potential dangers connected with exposure to vapors of carbon disulfide.

Though this solvent may be encountered in many industrial operations, it is primarily in the viscose—and rubber industries where it constitutes an important material.

In the evaluation of these vapors, the Air Hygiene Foundation recommends drawing through an alcoholic potassium hydroxide solution to form potassium ethyl xanthate which is determined iodometrically. The Department of Scientific and Industrial Research uses a colorimetric method of bubbling the air through diene and copper acetate forming a compound the intensity of which is compared with standards. In view of the inflammability of these vapors, a rapid method of evaluation in high concentrations would mean of a combustible gas indicator. Unfortunately, however, the sensitivities of instruments as built at present, are not high enough to get within the physiological range of this material.

Acids

This group probably nitric, chromic, sulfuric, hydrochloric and sulfuric acids are most commonly encountered. Of these acids, nitric acid has been discussed under anhydrides. Exposures to chromic acid in chrome ulcers and the perforated ulcers are frequently found around plating tanks. A safe limit of 1 cubic meters of air has been established for chromic acid which in electroplating is used as a mist over the plating baths. Nitric and hydrochloric acids also exist in the form of hydrogen fluoride and hydrogen chloride respectively. A safe limit has been suggested for the former, and has been set at 10 p.p.m. for the latter.

For nitric, chromic, and sulfuric acids, the method of detection is done by bubbling through a sodium hydroxide solution; hydrofluoric acid

through potassium hydroxide; and hydrochloric acid through glycerol-potassium carbonate-water solution. For the final laboratory evaluation I refer to standard methods of the A.P.H.A.

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Selection, Use and Maintenance of Respiratory Protective Devices*

By H. H. SCHRENK

Chief Chemist, Health Division, Bureau of Mines

and

S. J. PEARCE

Associate Chemist, Gas and Dust Section, Central Experiment Station, Bureau of Mines, Pittsburgh, Pa.

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H. H. Schrenk, chief chemist, Health Division, Bureau of Mines and

S. J. Pearce, associate chemist, Gas and Dust Section, Central Experiment Station, Bureau of Mines, Pittsburgh, Pa.

There are several well-recognized procedures for controlling exposure to hazardous atmospheres in industry. They include (a) substitution of less toxic material, (b) enclosure of processes, (c) wet methods, (d) local exhaust, (e) general ventilation, and (f) use of respiratory protective devices. In addition to their employment as a control measure in occupational exposures, respiratory protective devices also are essential in emergencies that may arise from fail-

ure or improper use of other control equipment.

Respiratory protective devices usually are employed to supplement other methods of control, as a temporary expedient, or when other methods are not readily applicable or practicable. It seems reasonable to assume, however, that where respirators are used, consideration has been given to the factors involved, and that the devices can provide satisfactory protection if used properly. Their use should not be arrived at simply by a process of elimination of other methods that are more difficult to apply.

Atmospheric contaminants include gas vapors, dusts, fumes, mists, and fogs. Respiratory protection against these contaminants may be required for concentrations that are immediately dangerous to health or life.

ness will eliminate these hazards. Passageways, ladders, openings, ditches, etc., should all be kept clear and free as possible of these items. Cables installed in ducts or suspended overhead will eliminate this hazard.

A welder or a worker, on whatever job he may be doing, must be conscious not only of his own safety but of the safety of others working near at hand. By his own safety efforts, his own work not only is

made easier and safer, but his fellow workers' opportunity for doing their jobs faster and safer is furthered.

These many factors—proper clothing, protective equipment, ventilation, goggles, fire prevention, elimination of tripping hazards, and the regard for others helps all of us individually and collectively to conserve our efforts so that each of our jobs can be done faster and better.

Health Aspects of Welding

By A. G. CRANCH, M. D.

Union Carbide Company, New York City

and

B. L. VOSBURGH, M. D.

General Electric Co., Schenectady, N. Y.

The purpose of this paper is to offer some practical points for the better protection of the health of welding operators. It is not intended as an exhaustive research document. The health hazards of welding may be classed as "real and unreal". The former should not be ignored, nor should the latter be allowed to cause undue alarm. The real hazards are not mysterious; they should be easily understood by any reasonably well trained operator and means for protection are available and effective when used.

A welding operator is usually exposed to all the general accident hazards common to the industrial field in which he is working. Structural iron workers, ship builders and the like are exposed to increased accident hazards. As a large proportion of welding operations are in connection with such work, this may be one reason for the common assertion that welding is a dangerous and unhealthy occupation.

Another possible source for the charge that welding is a health hazard is the circumstance that the formulas of most rod coatings are "trade secrets" so that there is a tendency to indulge in all sorts of speculation as to the danger to health from ingredients in these coatings. These coatings would appear to

have introduced any important health hazards. As for the "mystery," most of these coatings have been patented. Not long ago the Bureau of Mines issued an Information Circular (1) giving much detailed information on the composition of welding rod coatings and fluxes. This was based on patent information, purposes served by the various ingredients and analyses of many typical coatings. This and other reports remove the "mystery."

A third and perhaps the most important reason for the assumption that welding is a health hazard, are the dramatic deaths which have been reported in a relatively few instances following massive exposures to welding fumes in strictly confined spaces without suitable protection for the operators. That such incidents do not reflect a general hazard is well shown by the fact that in the past three years the number of welding operators has increased some 400% and in the past ten years consumption of welding rods has increased some 2800% with scarcely any increase in such fatalities.

Until quite recently the health problems of welding have been approached from a speculative rather than scientific view point. Unfortunately in a number of instances even medical men, apparently with little attempt to

check exposures or weigh evidence available, have attributed an amazing variety of ills to welding exposures. These include digestive disorders and malnutrition, liver diseases, respiratory affections even including cancer of the lung, circulatory, blood and glandular changes including thyroid disease and Hodgkin's disease, various skin diseases, neurological changes, sterility, and various other complaints. A careful analysis of these reports generally shows little or no evidence of any connection with welding exposures. The agents usually blamed for these various ailments would ordinarily be present in entirely negligible concentrations, if at all.

Such substances as silica, asbestos, manganese, chromium, nickel, cobalt, various other metals and even iron have been given as "potential hazards" in welding fumes. These have been charged with directly causing ill health or serving to activate other conditions such as pneumonia, tuberculosis, etc. With the exceptions shortly to be mentioned, there seems to be no evidence to indicate that they are present in a form or an amount which would constitute a health hazard. Some have stated that welding operators "are dying every day, and others suffering permanent health impairment as the result of their work," and charge that no studies have been made to identify or control the hazards. Anyone at all familiar with the research which has been done and is still going on in this field will realize that such charges must be due to ignorance or prejudice. The very thorough study conducted by Britton and Walsh (2) and the experimental work and observations in this field by many other investigators (3) (4) (5) (6) fail to show any excess of ill health among welding operators, or any outstanding type of illness among them.

The Real Welding Hazards

The real hazards peculiar to welding are essentially from: (1) radiation and (2) air contamination by gases and fumes.

Radiation presents the hazard of intense light, glare and of ultraviolet exposures. Probably all workers even casually acquainted with welding operations are familiar with the need for eye protection in this work. In the case of gas welding there is little, if any, exposure to ultraviolet rays,

but only glare from too intense light. Eyes must be protected by suitable lenses. In electric arc welding there is not only the glare but enough ultraviolet radiation to call for a deeper shade of protective lens for the eyes, and also a face shield and protective clothing to cover all skin areas which might be exposed. At present no attempt will be made to go into details as to this form of protection, as these are easily available from a number of sources, especially the American Standard Safety Code for the Protection of Heads, Eyes, and Respiratory Organs (7) (9).

Hazards from radiation are not confined to the welding operator alone, but also involve his helpers and others working in the immediate neighborhood, usually considered to be within seventy-five to one hundred feet in the case of arc welding. Any workman within this area should be protected either with suitable goggles or by the use of screens. If screens are used they should be so designed as to "interfere as little as possible with ventilation. Some types of operation can be done in ventilated booths which may serve to reduce the hazard to others. Not only must direct rays be kept from the unprotected eye, but reflected rays must be considered. This invariably calls for the use of dull non-reflective paint on areas which may otherwise serve as reflectors.

Excessive exposure of the eye to ultraviolet radiation damages chiefly the outer structures of the eye, setting up conjunctivitis of varying degree. The damage is analogous to a blistering sun burn of the skin and if the exposure is severe very painful reactions will occur, with some temporary visual disturbances. Ultraviolet rays do not penetrate the lens or injure the deeper structures of the eye. Experimental cataracts have been produced in rabbits by prolonged exposure to ultraviolet rays, but in actual welding experience lens changes do not occur and optic nerve injury is impossible from a physical standpoint.

Before leaving the subject of radiation it should be mentioned that in welding there is no exposure to short waves like the x-ray. This has been demonstrated repeatedly by having welding operators carry dental x-ray films in their pockets. No systemic effects have been demonstrated as due to the radiation.

tion in welding, least of all sterility. This is mentioned because this charge has recently been revived in some quarters. It was originally made during the last World War and several investigations proved it to be unfounded. There is no valid evidence to support such a theory.

Gas Hazards

Among the much discussed hazards of welding are those due to gases. These gases may be essential to the type of welding as the oxygen and acetylene in oxyacetylene welding or they may be produced through the reactions occurring in the welding process as oxides of nitrogen, ozone, or in some cases of imperfect combustion carbon monoxide. It is hardly necessary to state that oxygen in welding does not produce a health hazard. Misused, for instance, as a substitute for compressed air in ventilating small spaces, it may increase the hazard from burns, as any material will burn more actively in the presence of an excess of oxygen. Ozone, a "peroxygen," may be formed in the welding arc and in concentrations of over 1 p.p.m. may act as a pulmonary irritant. On leaving the arc, ozone rapidly ceases to exist as such and many investigators have demonstrated that even in confined spaces a dangerous concentration is not found in the air breathed by an operator. It is extremely doubtful that ozone is anything but a theoretical hazard in welding.

While speaking of oxygen, mention may be made of the hazard said to be due to "oxygen deficiency" from welding. This could occur only in very confined spaces, as in tanks or of the small compartments in ship's hulls, and the like. There may have been accidents due to oxygen deficiency in such locations but in all probability investigation would show that this condition already present in the area before welding operations were attempted. In the case of oxyacetylene welding where a certain proportion of the gas is drawn from the atmosphere the flame will usually become entirely colorless for its purpose and the deficiency recognized before the oxygen reaches a level enough to be dangerous to the welder. Also the heat generated by the reaction under normal atmospheric conditions would usually be unbearable in a space before dangerous oxygen

depletion occurred. "Oxygen deficiency," then can be put into the category of unreal hazard.

One not infrequently sees references to the toxic effects of unburned acetylene or the "impurities" present in acetylene gas. Acetylene is a simple asphyxiant gas not in itself a poison. It has had fairly wide use as an anesthetic. A hazard would exist only when the gas is present in such concentration as to reduce the oxygen in the air breathed so that not enough remained properly to supply the body. As the lower explosive limit of acetylene in air is about 2½ - 3% it is evident that in the presence of a flame an explosion would result long before the concentration would appreciably reduce the available oxygen in the air. As for the alleged hazard from impurities—arsine, phosphine, hydrogen sulphide or ammonia—this purely theoretical hazard is based chiefly on early analyses of acetylene made from materials of foreign origin. No significant amounts are present in acetylene produced today from raw materials from North American sources. Recently tests were made for arsine in dissolved acetylene from four commercial producers and not even a trace was detected. The minute amounts of impurities sometimes found in acetylene are, of course, destroyed in the flame. The health hazards from acetylene and its "impurities" belong in the "unreal" class.

Gases formed in the flame or arc are the oxides of nitrogen, sometimes called "nitrous fumes." They are *not* nitrous oxide, but are nitric oxide and other higher oxides of nitrogen. In the concentration present in connection with welding they are so diluted as to be colorless. Under other conditions of exposure these fumes may present other hazards but in welding the real hazard is as a pulmonary irritant. Except in small rooms or in very confined spaces as in tanks, etc., no dangerous concentration would be likely to occur. Just what is a dangerous concentration has been undergoing considerable discussion in the last two or three years. The classic figure of 39 p.p.m. by volume in air, admittedly was based on very limited observations but has proved a fairly satisfactory working standard. Just as much more extensive experiments were beginning to indicate that 70 p.p.m. or even up to 100 p.p.m. might be a safe limit for a day's work;

others on what basis is not clear, are advocating a "safe concentration" of only 10 p.p.m. Certainly a study of available evidence indicates that in welding operations concentrations of 50 p.p.m. or less have not produced symptoms, and that probably under many conditions this amount may be exceeded without harm. Protection will be discussed under fume protection.

Carbon Dioxide and Carbon Monoxide

Carbon dioxide is produced by the oxy-acetylene flame and by the electric arc but never in concentrations of physiological importance. Carbon monoxide may be produced through imperfect combustion as when starting welding or cutting of cold material or through the combustion of organic matter which may be present on the surface to be welded, or in the coatings of rods used. There is considerable divergence of opinion on the degree of hazard from carbon monoxide in welding. A careful comparison of the various reports seems to indicate that the danger of a significant concentration is very slight under all ordinary conditions of welding. If standards of ventilation indicated by other features of the work are followed the hazard from carbon monoxide should be non-existent.

Probably the most discussed health hazards of welding are those due to fumes. These are chiefly metallic, from the material being welded or used as a coating on that material or in the welding rod or its coating. The composition of welding fumes is so varied that this furnishes a wonderful field for the discovery of hypothetical and unreal hazards. These fumes also are the source of some very real hazards. If proper precautions are taken to avoid the real and recognizable hazards the same precautions should eliminate the theoretical hazards. Welding is now in such general use and the number of metals and their combinations involved is so great that there are probably but few metals which may not be handled by a welding operator.

The most common complaint due to fume exposure is metal fume fever. This often called "zinc chills," "brass founder's ague" and the like, is really a non-specific reaction which might come from any of a number of metal fumes. The most common source is

zinc fume, from welding on galvanized material, or brass, or from using rods with a high zinc content. Zinc should not be considered "highly toxic," however, as this condition is an acute, self-limiting reaction of short duration and without known after-effects or complications. In a large number of those affected a considerable degree of immunity is established so that subsequent attacks are very mild or lacking altogether. The permissible limit for zinc fume in the air has been suggested as 15 milligrams of zinc per cubic meter of air. If this concentration is not exceeded it is unlikely that any cases of metal fume fever will occur. (6)

The most serious condition likely to result from metal fume exposure is probably lead poisoning. This is not a hazard common to all welding operations, but only in the relatively few cases where welding or cutting is done on material previously covered with lead paint, coated with metallic lead, or where lead has been introduced as an alloy as in certain steels. In such cases very definite protective measures will be required.

Next to lead ranks cadmium as a potential hazard. Lately cadmium has come into more general use as a rust-proof coating for steel in place of zinc. It enters into some alloys. The fume may produce a pulmonary irritation and edema resembling in many ways the effects from inhaling oxides of nitrogen.

A wide variety of other metals have been mentioned as injurious. Manganese, chromium, cobalt, copper, tin, antimony, magnesium, aluminum, tellurium, vanadium, titanium and many others. As encountered in welding fumes the amounts are usually definitely less than those known to have toxic effects, and it is doubtful if any reports alleging injury from these metals in welding can be substantiated. Manganese has been most frequently suspected, but a study of the reports of alleged effects fail to show any conclusive evidence and the amounts involved are below those known to have produced effects. The charge that even small amounts of manganese predispose to pneumonia is not borne out by the known experience of welding operators.

Other materials than gases or metals may create fume hazards through air contamination. These may be encountered especially in repair work on various tanks, vats, etc.

air presence calls for special ventilation.

There is one other source of real hazard which may be present in many operations involving aluminum or some of the "stainless" steels and alloy metals. This is from the presence of fluorides in many of the fluxes or coatings used for this work. Hydrofluoric acid may be formed and the fume if inhaled in appreciable concentrations or for long periods may cause considerable irritation to the nose and throat or even pulmonary edema.

Prevention

To sum up: The real hazards of welding are not many, are generally easily identified and protective measures are available and effective when used. These real hazards could not be minimized or passed by. Briefly they are due to:

1. Radiant energy—ultraviolet and visible light.
2. Oxides of nitrogen.
3. Metal fumes—lead, cadmium and zinc.
4. Fumes from organic residues or wastes.
5. Fumes from fluoride-containing fluxes and rod coatings.

Protection from radiant energy has already been outlined. Protection from the rest is most wholly a question of ventilation. Various means of approach have been tried to establish standards for ventilation. Standards in terms of concentration of contaminant expressed in parts per million by volume for the gases or milligrams per cubic meter for metallic and other fumes have been suggested. Some have standards expressed in number of air changes per time unit. Both methods have value and studies made along these lines have done much to solve some of the difficult points in ventilation requirements. Unfortunately, it is very difficult to obtain quickly and easily a determination of fume concentration on a given operation. Local conditions may also change the efficiency of measures based on rate of air change. Notwithstanding some of the practical difficulties in applying such standards in specific cases, several general rules on ventilation have been evolved which have proved to be of considerable help.

Various studies of present day practice have been made which indicate that welding out of doors or in large shops seldom results in any serious air contamination except in the case of lead. In spaces of less than 1000 cu. ft. and especially inside tanks, ship holds, etc., special ventilation is necessary. Usually the exhaust of contaminated air is much more effective than an attempt to force fresh air into the space. In stationary locations this can generally be done with properly located exhaust fans or by the use of hoods and ducts to withdraw fumes as near as possible to their source. Portable exhaust systems have been designed which are adapted to field needs.

In the case of gases such as oxides of nitrogen, or the rare instances of carbon monoxide, if sufficient ventilation is maintained from the beginning of the operation and sufficient to insure good visibility and to insure a comfortable temperature there should be no gas hazard even in confined spaces.

If lead or cadmium fumes are present the only complete protection is by the use of air supplied masks. These are of three types—air supplied by special blower, air supplied from compressed air system, and masks with larger hose without use of forced air supply. If compressed air is used from a general supply, special filters and pressure regulators are required. In the last named type with no forced air supply the length of hose can seldom be over 50 feet. In confined spaces one of the above devices should be used. Out of doors or in large well ventilated shops and for moderately short exposures one of the filter type respirators approved by the Bureau of Mines for lead fumes may be satisfactory. In any confined space at least local exhaust ventilation is required when there is exposure to zinc or fluoride fumes, or to fumes from heavy deposits of organic wastes and sludge. Air supplied respirators offer, of course, the most positive protection.

Briefly, a minimum standard of ventilation is one that will be sufficient to insure good visibility at the point of operation, and insure a temperature within a reasonably comfortable limit. In confined spaces this would call for exhaust ventilation. In case of lead or cadmium exposures air supplied masks are required. No serious hazard is apt to be present except in confined spaces or when lead is involved. Special standards for venti-

lation in welding of leaded steel have been given by Halley (8) General requirements for ventilation are given in more detail in the reports of Tebbens and Drinker, (6) and in Special Bulletin No. 5 of the U. S. Department of Labor, "Control of Welding Hazards in Defense Industries, (9) and by Hemeon. (10)

Summary and Conclusions

1. Health hazards in welding may be divided into "real" and "unreal."
2. Real hazards should not be ignored or minimized. They are usually easy to recognize and effective preventive measures are available.
3. Unreal and hypothetical hazards are often alleged. If indicated precautions are taken to guard against the real hazards, the unreal will disappear entirely.
4. Hazards from radiation in welding are limited to eyes and skin. No systemic effects have been demonstrated. Means of prevention are well known and available.
5. Hazards from air contamination can usually be controlled by ventilation and in some instances, by respiratory protective equipment. Hazard from gas is essentially limited to oxides of nitrogen. Ozone and carbon monoxide hazards are of minor importance. Oxygen deficiency, if present, is usually not due to the welding operation but to other causes. Fume hazards for practical purposes are limited to fumes from lead, cadmium, zinc or fluorine, and rarely from organic wastes or sludges. Fumes from other materials, when present, are usually in non-toxic amounts, or would be removed by protective measures indicated for the well recognized hazards just mentioned.
6. No reliable evidence has been presented to show that welding operators have any poorer health and accident records than other tradesmen working in the same environment, or that they show any characteristic type of illness which could be associated with their work.

7. That the health hazards due to welding exposures are not great and can be well controlled is evident from the enormous increase in welding and its applications without a corresponding increase in illness.

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Safety Engineering Exchange

THURSDAY MORNING SESSION

October 29, 1942

Presiding:—K. A. COLAHAN, Engineering Mgr., Atlantic Div., American Mutual Liability Insurance Company, Philadelphia

CHAIRMAN COLAHAN: It would be somewhat superfluous to say much about the importance of the present industrial activity from the safety standpoint. Those who have attended meetings of the other sessions have undoubtedly felt a great deal the need for stepping up our accident prevention work because of war production activity. There has been not only a very sharp increase in the tempo of manufacturing, but there has been a very material turnover or change in the personnel of industrial plants, meaning by that, of course, that to a large extent women are coming into industry to a much greater degree in many of the plants. Many plants have encountered in the past problems that required solving at the time.

In many other instances, those problems are now occurring for the first time in other plants.

So the purpose of this session is to draw upon the knowledge and experience of those plants or people who have, in the past, worked out the answer to many of the questions that are now arising in other places for the first time.

I should like to tell you who makes up this panel by introducing the various members. Beginning on the left, Mr. E. S. Beaumont, Director of Safety, The Peoples Gas Light & Coke Company, Chicago.

Next is Mr. Louis Boraks, Supervisor, Machine Guarding, Liberty Mutual Insurance Company, Boston. Mr. Boraks, I might say, for a period of fifteen years or more has put all his energy and has concentrated on the solving of intricate guarding problems at points of operation.

To my left is Mr. Julius A. Draper, Safety Director, Consolidated Paper Corporation, Ltd., Grand Mere, Quebec, Canada.

On this side is Mr. H. F. Gilbert, Safety Director, American Cyanamid Company, New York City.

Next is Mr. Johan Norvig, General Superintendent, Pennsylvania-Dixie Cement Corp., Nazareth, Pennsylvania.

Last, Mr. J. L. Ridinger, Safety Director, Inland Steel Company, East Chicago, Indiana.

The first question:

"New York State passed a law about a year or two ago limiting the amount of dust which might be permitted in the air in a rock crushing plant. Is this law being enforced today? If it is, how does it affect the industry?" Mr. Norvig!

MR. NORVIG: As far as I know, New York State has had a dust prohibition law in effect since 1910 or 1912. It was a law that didn't have any real teeth in it, and it wasn't very rigidly enforced. I don't know the wording, but the sense of it was that in an industry—this refers to a rock crushing plant, but in any industry where there is an amount of dust in the atmosphere of such a concentration that it could be considered injurious to the health of the employees, that condition had to be rectified.

In our particular industry, cement and rock crushing, there wasn't much said about it. Around in '34 or '35 there was quite a furor, which started in New York City in connection with tunnel work.

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WEDNESDAY LUNCHEON AND MORNING SESSIONS October 27, 28, 29, 1942

The American Society of Safety Engineers, sponsors of all subject sessions programmed for the Congress, held their Wednesday luncheon and afternoon meeting on October 28 at the Terrace Casino of the Morrison Hotel, H. J. Griffith, Mgr. Safety & Welfare Dept., Jones & Laughlin Steel Corp., Pittsburgh, Pa., presiding.

Following the annual report of the General Chairman and election of officers, the Society was entertained by a stage demonstration of

magic by Mr. Clyde R. Powell, personnel director, Endicott Johnson Corporation, Endicott, N. Y.

A special session was arranged on each morning of the Congress, each devoted to the discussion of a National Safety Council safe practices pamphlet in the process of revision. The three pamphlets discussed were: Pamphlet No. 11, "Floors and Flooring"; Pamphlet No. 12, "Wood Scaffolds"; Pamphlet No. 95, "Compressed Gases."

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†As elected by the delegates in Congress session**TUESDAY MORNING SESSION**

October 27, 1942

Presiding:—PAUL S. STRECKER, Personnel Dir., Flying Boat Div., Nash-Kelvinator Corp., New Orleans

Safety's Contribution to Our War Efforts

By B. W. KNAPP

President, Warren Gear Mfg. Co., Warren, Pa.

When a publisher sends a book out into the cold, hard world, he attempts to prepare the way by including a preface or introduction which, in turn, attempts to prepare the minds of the reading public for the subject matter to follow. I am one of the vast army of readers to whom the preface is an important and extremely interesting part of any printed matter.

The preface to many volumes, even including the most technical tomes, is often written by an outsider, a person to whom the field covered may be intensely interesting but who brings an unbiased view because the subject matter falls outside his usual line of endeavor. I find myself in that position today. As the head of a manufacturing plant, I am naturally concerned with the matter which you are to discuss here and, not being a professional in the field, I hope I may bring you a glimpse of the work you are doing which may reach you in your close contact.

The compiler or publisher must first of all consider the reading public which will be attracted by the volume placed on sale. In the present case your National Safety Council

and in particular the program committee, has been presented with a hand-picked public since your presence at this conference indicates your keen interest in the subjects to be discussed.

Why should this group, already under terrific pressure because of war production, take time to study additional precautions and safeguards? Your own National Safety Council in its statistical year book reports that time lost through accidents in 1941 deprived 200,000 American troops of the equipment which they must have to guarantee victory. The army itself has gone on record as believing in protection. I quote General Somervell, Chief of the Army Service of Supply:

"The Army has ordered an unrelenting campaign against accidents, accident hazards, and unsafe practices. Accident-prevention activities will be consolidated under the Provost Marshal General who is already responsible for plant protection and internal security. This is planned to result in nation-wide safety policies and a uniform system of inspection to discover, eliminate or control hazards. Impressive safety records already

somebody told me that they allow us five days before demurrage set in. I do not know about that particular part of it.

MR. NORVIG: I would like to have just one point cleared up. In your description of this work that was done a day or two in advance, did that consist of putting the Primas into the stick of dynamite with the fuse attached? I would think that you gentlemen here would just jump up and condemn definitely a practice like that, because it is against the fire laws in the handling of explosives.

MR. GOODMAN: First of all, as I have

always understood, in the handling of explosives, Primas should be made up as they are used. We recommend that they be made at the shooting face before being inserted into the hole. This refers to Primas. It is a practice to be condemned, I agree with you.

CHAIRMAN POWELL: Anybody else? If not, we do not want to delay you unnecessarily, so if we have no more questions, on behalf of our section I wish to express my appreciation to you all for coming out, and on behalf of our program committee and Mr. Warner, I want to express my sincere appreciation to those who have taken part in the program this afternoon.

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TUESDAY MORNING SESSION

October 27, 1942

Presiding:—J. J. DUGGAN, Carbide & Carbon Chemicals Corp., South Charleston, W. Va.

The Use of Conductive Flooring and Materials

By E. J. MEYERS

Assistant Manager, Safety & Fire Protection Div., E. I. du Pont de Nemours & Co., Wilmington, Del.

Conductive flooring and materials have become increasingly important in helping to prevent accumulations of static electricity in manufacturing equipment and operations in industry where flammable vapors, dusts, or materials may be ignited by an electrical arc or spark. By conductive we mean, basically, that the aggregate conductivity should be such that with a low voltage the charges will be conducted away as they are generated to prevent any dangerous accumulations of static electricity on these materials.

Various types of conductive flooring which are now being marketed by manufacturers which may be of special interest are namely: spark proof mastic, magnesium oxychloride type of flooring, conductive linoleum, conductive asphalt tile, and conductive rubber. We will discuss types of floors based upon available experience, and it should be understood that the following remarks merely indicate some factors which should be kept in mind. The statements may or may not apply to all of the similar types of flooring available on the market today.

Spark proof mastic has an asphaltic base which we are advised should not exceed 25 per cent. Common practice is usually to use a mixture of this material with metallurgical coke dust, graphite, and in some cases silica dust with a setting or emulsifying agent. The metallurgical coke dust or graphite are added to make the floor conductive. This flooring material can be applied on existing concrete, wood, or steel bases. The minimum practical thickness for this floor is $\frac{3}{8}$ of an inch; the average used is $\frac{1}{2}$ of an inch to one inch. The grounding wires are embedded in the

material. This material will withstand excessive moisture and can be placed on a ground floor slab; however, it will not stand up under high temperatures, is not resistant to oils and hot liquids or concentrated loads, and may be injured by heavy moving loads. The color of this flooring is usually black.

Magnesium oxychloride is the base for magnesium oxychloride type of conductive floor. It has mixed with it generally some of the following materials: Dolomite, wood flour, and silica dust. Copper mesh, copper dust, graphite, or metallurgical coke dust are generally added for conductivity. This material can also be applied on wood, concrete, or steel as a base. When placed on a base which is in immediate contact with soil, some means should be taken to prevent absorption of moisture. When installed on wood floors, light metal lath is used to bond the finish to the base. A special bonding mixture is used when the material is laid on steel or concrete. A minimum practical thickness for this type flooring is $\frac{1}{2}$ inch. Manufacturers usually prefer a $\frac{3}{4}$ inch layer. The average is probably $\frac{5}{8}$ of an inch. The grounding wires in this case are imbedded in the material. This type flooring is limited to areas which are fairly dry or well drained where occasional wetting occurs. One of its outstanding properties is its hardness and smoothness of wearing surface. This material may be obtained in neutral gray, red or green colors which are most commonly used.

Linoleum

Conductive linoleum is usually supplied in thicknesses of $\frac{1}{8}$ " or $\frac{3}{8}$ ". It can be laid on

Co., Inc., Edge Moor Plant.	0
1. E. I. du Pont de Nemours & Co., Inc., Baltimore Plant	0
1. E. I. du Pont de Nemours & Co., Inc., Newport Plant....	0

Small Group

Average Rate12.26

1. E. I. du Pont de Nemours & Co., Inc., Toledo (F & F) Plant	0
1. E. I. du Pont de Nemours & Co., Inc., Chicago Plant....	0
1. E. I. du Pont de Nemours & Co., Fort Madison Plant....	0
1. E. I. du Pont de Nemours & Co., Inc., Everett Plant....	0
1. Canadian Industries Ltd., Paint & Varnish Div., Montreal, Quebec	0
1. Canadian Industries Ltd., Chatham Works	0

Division III

Average Rate7.30

Large Group

Average Rate6.37

1. National Carbon Co., Inc., Factory "A"	.59
2. The Geo. T. Stagg Co., Inc., Frankfort, Ky.	1.07
3. Michigan Alkali Co., Wyandotte, Michigan, North Works	1.23

Small Group

Average Rate15.03

1. The J. B. Ford Co., Wyandotte, Michigan	0
1. E. I. du Pont de Nemours & Co., Inc., Experimental Station, Henry Clay	0
1. Canadian Industries Ltd., Toronto Chemical Group...	0
1. Hercules Powder Co., Inc., Kalamazoo, Michigan	0
1. E. I. du Pont de Nemours & Co., Inc., Alcohol Plant, Deepwater, N. J.	0
1. American Cyanamid & Chemical Corp., Valdosta, Ga.,	0

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TUESDAY AFTERNOON SESSION

October 27, 1942

Presiding:—W. A. HAZARD, Eng. of Erection, Bethlehem Steel Co., Bethlehem, Pa.

Pre-employment Examination of Construction Workers

DR. RAYMOND L. BALDWIN

Iowa Ordnance Plant, Burlington, Ia.

Recently there has been a gradual change in the feeling of the employer and employee toward physical examinations. In each state the employer has been made legally responsible, to a greater or lesser extent, for the disease or injury of his employees arising out of and in the course of their employment. This has resulted in the awakening of industry to the value of pre-employment examinations. Not only does the examination establish the applicant's physical fitness to do the job for which he is hired and prevent him from injuring himself or others because of some physical defect, but it reduces costly labor turn-over and creates a more efficient working force.

The employer and employee are also benefited in case of compensation hearings before a commissioner or board in establishing or proving the presence or absence of a pre-existing physical defect. The employee is benefited by his knowledge of existing defects which often can be remedied producing greater comfort or greater earning power or even prolonging his life by several years.

When the employer has decided that he will adopt physical examinations as a prerequisite to employment, his next step should be to employ a physician to help organize his department. If he is to hire a full time physician on the project to care for his ill and injured employees, he should work with him in arranging the details of the examination, the personnel required, the space for examination and other pertinent details.

In construction work the examination procedure will, in most events, be different from that in other forms of industry where the term of hire is for considerably longer periods. Of course there are construction jobs where the term of hire may be for several years, in which instances much more detailed examinations may be provided and a majority of cases where the job will be completed in from six to eighteen months, there need not be an extensive layout for pre-employment physical examinations.

Where possible, the pre-employment

examinations should be done as close to the employment office as possible. On large jobs this office is frequently some distance from the site of operations and from the first-aid station or hospital. Frequently the employment office will be in town. In this case, it is usually possible to select two or three rooms in the same building and fit them up as a physical examiner's office. Sometimes a private practitioner in the vicinity will contract to do the examining, but this, in my experience, is not as advisable as having a separate suite of offices expressly for the use of the contractor's physical examinations. However, where the size of the project will not permit the use of a separate office, this method is preferable to no pre-employment examinations whatever.

Frequently it will be advisable or even imperative that the contractor erect a physical examination building or combine a hospital or first-aid room in the same building or even construct a service building to house the employment office and the medical unit.

In my experience, it is not advisable to mix men reporting for pre-employment examinations with patients coming in for treatment. If both types of work, first-aid and pre-employment examinations, are to be done in the same building they should be definitely separated.

In selecting the type of building or physical examination rooms, therefore, the size of the project, the availability of space and the type of construction work being done will be major factors, though there are certain minimum requirements which remain the same in all instances.

Medical Rooms Layout

Let us consider briefly these general requirements as a foundation on which to build the more detailed structure to fit the particular job. The employee is usually first seen in the interviewer's office of the employment department where, after due consideration of his experience and record, he is then subject to the completion of the physical examination.

Reception Room:

When then comes to the physical examiner's office and is received in a reception room. This should be very definitely separated from

the examining room and space should be provided for him to hang his outer garments and also space provided for him to be seated until called for physical examination.

Usually the admitting clerk can be entrusted to take the medical history of the patient and do a superficial visual acuity test and to test him for color blindness. Space in the waiting room, therefore, would have to be sufficient to obtain the required distance for the eye chart reading.

Dressing Room:

Adjacent to the waiting room should be a room where the employee may disrobe preparatory to his examination. In construction work we do not have the difficulty often encountered in production of having to examine both men and women and consequently needing separate facilities for each sex. What few women are required in the contractor's clerical force can be examined in the same rooms at times not in use by men. If large numbers of women are to be examined it is necessary to provide cubicles in the dressing room for them to disrobe as they object to disrobing in the presence of one another, while men do not.

Examination Rooms:

The medical examiner or examiners should be in a room or rooms of their own adjoining the dressing room where they and the patient being examined will not be annoyed by the presence of others in the room. Where indicated by physical examination, the examiner may feel that he wishes to go more thoroughly into the medical history which has been sent to him by the admitting clerk on the form provided; and if he is in private he will often times secure a more accurate answer to his questions. The only other person who should be permitted in the physical examiner's room is a clerk who must be very accurate, cooperative and have the ability to keep to himself any information which he gets.

Toilets:

Toilet facilities should be provided adjacent to the examiner's office, either opening from the office or from a hall just off the office where the employee may be sent to produce a sample of urine to be examined. It is preferable that this be in such a place

In the small plant it is recommended that every accident be thoroughly investigated. This includes not only so-called reportable cases but also every first aid case. The information maintained on first aid cases may be modified depending upon the circumstances under which the accident occurred.

If the first aid case occurred in a manner that you can rightfully assume would probably result in a serious injury in event of a recurrence then it should be treated as respects recording and corrective action in the same manner as an actual serious case. For example, an employee irritated his eye slightly while preparing a washing solution for cleaning the floor. Only first aid was necessary to relieve the trouble as far as the injury was concerned. However, his failure to use the protective goggles and gloves provided for this operation was the cause of the accident and this fact should not be forgotten. The next occurrence could easily be a serious caustic burn and probable impairment to sight.

As a part of the corrective action procedure, the manager should take the opportunity to talk personally with each individual. He

should endeavor to establish the fact that the employee understands the company attitude on safety and agrees that the instructions issued are practical and that it is reasonable to expect that he will make an honest effort to abide by them.

Personal talks of this kind take the place of group meetings in larger organizations but they have the advantage of creating a better understanding between management and employee.

If an accident should occur from one of the causes already included in the list which has been given to the employees, a personal talk will determine whether or not disciplinary action is required, or whether the accident occurred because of a lack of understanding of instructions, or a failure to appreciate the extent of the hazard involved.

If a manager will follow this procedure and then take every advantage he can through contact with members of the local safety council to maintain his own interest and enthusiasm in the work of accident prevention, I believe he can meet his safety problem.

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†As elected by delegates in Congress Session

TUESDAY AFTERNOON SESSION

October 27, 1942

Presiding—CARL F. HOLMES, Mgr., Marine Claims Dept., Marsh & McLennan, Inc., New York City

The Correlation of Inspections With Accident Analysis

By CAPTAIN R. F. ALEXANDER

Assistant Chief, Safety Section, Corps of Engineers, U. S. A.

At present the Corps of Engineers is one of the operating divisions of the recently formed Services of Supply which also includes the Ordnance Department, Quartermaster Corps, Chemical Warfare Service, and others. Stating it simply, the Corps of Engineers is the Engineering agency for the entire United States Army and is generally divided into two divisions, namely, (1) that which has to do with the training of combat engineering troops with very obvious functions and (2) the Construction Division which does all the military construction, maintenance and repair of barracks and buildings and operation of utilities, river and harbor construction and maintenance work, flood control, and other civil works.

The accident prevention program of the Corps of Engineers covers all operations of the Construction Division which has just reached a peak employment of 1,200,000 employees. The scope of this program is to maintain a comprehensive and continuous accident prevention program for the purpose of preventing death, injury, occupational sickness and disease, and destruction of and damage to materials and equipment for all operations of the Corps of Engineers with the exception of that dealing specifically with troops. The program is carried out through the command echelons of the Corps of Engineers, namely, the Office of the Chief of Engineers to the Divisions, which are subdivided into districts, which in turn are composed of individual projects.

The safety organization of the Corps of Engineers follows exactly the same command echelons with a central staff in the Office of the Chief of Engineers and safety sections in

the divisions and districts, and a resident safety engineer on the projects. The Safety Section, Office of the Chief of Engineers deals mainly with specific technical problems, the development of standards, uniform regulations and procedures, the compilation of accident records and statistics and analysis of same. The total field personnel of the safety organization is approximately 900 safety engineers and safety inspectors.

Incidentally, your attention is called to the fact that our personnel in the Safety Section, Office of the Chief of Engineers, totals less than three per cent of our field safety organization, which is quite unusual in government service.

The Corps of Engineers has a navy which consists of 2,711 pieces of floating plant, varying in size from 22 foot launches to 500 foot seagoing dredges and similar craft. This equipment is used in connection with river and harbor construction and maintenance work and flood control operations.

The frequency rate for our floating plant operations for the first 6 months of 1942 was 10.04 and in ship building and repair, 9.33. Although we have won some trophies, we are certainly not satisfied with these rates and consider them entirely too high. This naturally brings up the point, "How are these rates to be reduced?" and this leads us to the subject of this talk, namely, "The Correlation of Inspections with Accident Analysis."

Small Units

A single unit of floating plant is a comparatively small scale operation and acci-

MR. FALKNER: Either beef or sheep.

MR. GAVEY: Any improvement?

MR. FALKNER: No. Is there any guard that has been developed that has proven practical?

MR. GAVEY: No, sir, not that I know of. Does anybody else know of a guard that has been developed that is practical for that operation? I would like to know it, if there is one.

MR. FALKNER: Well, there are one or two companies that have used a form of a hand grip, but that has slowed up the operation somewhat.

MR. GAVEY: I have heard of it, but I have never seen it in operation.

CHAIRMAN McCLELLAN: That is one machine I think we have to change the design of to get around the guarding.

MR. SCHAFFNER: I feel that the packing industry, as well as other industries, today has a definite problem in helping to curtail these off-the-job accidents. I don't know what your experiences are in some of the vicinities and cities in which your plants are located, but in the new type of labor that we are having in the smaller plants we have people who are not accustomed to packing-house operations, and to keep our older employees from being injured, we try to keep

accident prevention before them as much as possible.

How we are going to do it is a question. Most of us don't have enough time to have safety meetings. When we do have them, it is very unusual nowadays to have everybody able to attend, because they are working on various shifts. So we have to encourage the worker somewhat in making each department responsible for accident prevention off the job. Whether a man is injured off the job or on the job, he is no good for the next day's work, and if a member of his family is injured, likewise, the man's thoughts are not on his job, but with the family, and he is prone to accidents.

So I think we have to use a good deal of good horse sense in trying to educate all of our employees, and have them in turn try to educate their own families in accident prevention work.

I mentioned a few moments ago first aid training. One of the primary objects of first aid training is accident prevention, and I think that this is an excellent opportunity for all of us to encourage first aid training, not from the point of view of first aid work, then from the point of view of accident prevention work. We are going to be speeded up as production increases, and we must along those lines speed up our accident prevention work as well, and do it in a good, logical manner.

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October 27, 1942

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As elected by delegates in Congress Session

TUESDAY AFTERNOON SESSION

October 27, 1942

Presiding—F. R. McLEAN, Mgr., Safety and Insurance Dept., White Star-Ohio Div., Socony-Vacuum Oil Co., Inc., Detroit

War-Time Security of the Petroleum Industry

By L. S. WESCOAT

Vice-Pres., The Pure Oil Co., Chicago

In the petroleum industry we did not wait for war actually to descend upon us before taking specific action in the field of war-time protection of petroleum facilities. Just two years ago this month the American Petroleum Institute, at the request of Secretary of the Navy Knox, took the first steps. A committee known as the National Committee for the Protection of Oil Storage was organized, and under its direction five regional committees were organized, based primarily on the geographical lines of what were then known as Army Corps areas and now termed Service Commands.

In the fall of 1941, the Office of Petroleum Coordinator for National Defense was created by Presidential decree, and Secretary of War Ickes was appointed Coordinator. Shortly after the organization of this office, Coordinator Ickes organized the Petroleum War Council and in-

vited seventy-five of the outstanding oil and oil trade association men of the country to compose its membership. By coincidence, the first executive meeting was held in Washington on December 8, 1941. This council was organized for the purpose of advising the Coordinator with respect to problems in the petroleum industry and to assist in putting into effect such recommendations as his office may direct from time to time.

In view of the importance of the oil industry to the war effort, it was deemed advisable that the National Committee for the Protection of Oil Storage and its regional committees, which had been set up by the American Petroleum Institute, be incorporated as a part of the Petroleum Industry War Council. In so doing, it was felt that the industry's efforts in connection with the protection of petroleum properties against war connected risks could be made more ef-

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TUESDAY MORNING SESSION

October 27, 1942

Presiding:—RALPH S. FARNUM, Safety Supvr., U. S. Rubber Co., Detroit

All Out for Safety

By PAUL VAN CLEEF

Van Cleef Bros., Chicago, Ill.

Safety is something which cannot be purchased like an ordinary commodity, nor can it be captured like material from an enemy. It can only be secured in the largest measure by education and enlightenment. Everyone must be made aware of its importance. Every effort must be made to secure it.

Not until the beginning of this century did any group of people band together to study the problems of accident prevention from the social standpoint. Practically no thought had previously been given to the effect of accidents occurring in the home, in public places and in industry. But as a result of the organized safety movement we are constantly gaining ground.

As we look back over the years it seems strange indeed that so little attention has been paid to accident prevention. No doubt, the first man to use a lever to pry rocks loose had his accidents. The charioteers of ancient Pompeii driving on its narrow streets created a serious traffic problem. Coming through the ages down to the present we still have so-called accidents in appalling numbers. There has certainly been enough time to learn how to prevent them. Are we doing our utmost to do so? The responsibility is not only the householder's, a worker's, a foreman's or management's. It is all com-

bined. The state too, must bear its share. Safety should be placed above every other consideration. We should stress the needlessness of accidents, the elimination of the maimed, the improvement of morale, the prevention of economic distress, the betterment of society. Although we measure our success in terms of severity and frequency ratings, why not let the whole problem be approached more from the humanitarian standpoint?

It ought not to be too great a problem to solve if we go at the matter in a fundamental way. Until recently the world has not seen the relationship between the care of the individual and society as a whole. Now we are trying to remedy this by improving the individual's education, his comfort, his health and his safety. When these are perfected, we will have a strong and happy people.

The Rubber Section has steadily improved its conditions, because the personal welfare of the workers was its first thought. It has regarded severity and frequency rates merely as a barometer indicating how well it has succeeded. When other divisions of the Council take the same attitude as the rubber group there will be improvement everywhere. If we try earnestly to train our workers more thor-

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Officers 1941-1942

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31st National Safety Congress and Exposition

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- Werte Manufacturing Co., Chicago, Ill.**
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Non-Slip Treads of Greenstone.
- Disinfecting Co., Long Island City, N. Y.**
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