FILE NAME: National Safety Council (NSC)

DATE: 1942 Oct

DOC#: NSC245

DOCUMENT DESCRIPTION: Excerpt from Transactions of the NSC - 31st National Safety Congress

TRANSACTIONS

31st NATIONAL SAFETY CONGRESS

General Subject and
Industrial Sections

CHICAGO

October 24-28, 1944

National Safety Council, Inc.
[illegible]
[illegible]

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.

The Transactions are a record of the proceedings of the Congress, condensed and edited for reference purposes. They are therefore an abridged version of the papers and discussions. The original manuscripts, some of which have drawings and charts too expensive to reproduce here, 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 views expressed, either in the discussions of the Congress itself or in this record of them.

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 are 75 cents each.

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

National Safety Council, Inc.

Honorary Members

ASSOCIATION OF IRON AND STEEL ENGINEERS
W. H. CAMERON
ROBERT W. CAMPBELL
LEW R. PALMER

Officers (1942-1943)

COL. JOHN STILWELL, President
I. W. MILLARD, Vice-President for Finance and Treasurer
G. T. HELLMUTH, Asst. Vice-President for Finance and Asst. Treasurer
B. B. MCCULLOCH, Assistant Treasurer
WALTER S. PAINE, Vice-President for Industrial Safety
LEW R. PALMER, Vice-President for Transportation
A. V. ROHWEDER, Vice-President for Home and Farm Safety
JUDGE LEE E. SKEEL, Vice-President for Community Councils
R. T. SOLENSTEN, Vice-President for Membership
LESLIE J. SORENSON, Vice-President for Public Safety
DR. LEWIS A. WILSON, Vice-President for Education
NED H. DEARBORN, Executive Vice-President, Managing Director and Secretary
R. L. FORNEY, Assistant Secretary

Executive Committee (1942-1943)

J. I. BANASH, Past President
WALLACE N. BARKER, Pullman-Standard Car Manufacturing Company
C. W. BERGQUIST, Past President
ROBERT W. CAMPBELL, Past President
D. B. CHANT, Ontario Pulp & Paper Makers' Safety Association
R. G. CREVISTON, Crane Company
A. J. R. CURTIS, Portland Cement Association
NED H. DEARBORN, National Safety Council, Inc.
LEWIS A. DEBLOIS, Past President
R. E. DONOVAN, Standard Oil Company of California
MARCUS A. DOW, Past President
G. W. ELSTE, JR., Baltimore & Ohio Railroad Company
HAROLD F. ENLOWS, The American National Red Cross
D. D. FENNELL, Past President
R. H. FERGUSON, Metals Section
ROBERT F. GILMOUR, Utica Safety Council
E. E. GROVER, Columbus & Southern Ohio Electrical Company
JULIEN H. HARVEY, Greater New York Safety Council
W. A. HAZARD, Construction Section
DR. T. LYLE HAZLETT, Westinghouse Electric & Manufacturing Company
G. T. HELLMUTH, Chicago Rapid Transit Company
G. A. HEUSER, Louisville Safety Council
CARL E. HOLMES, Marine Section
W. A. JARVIS, Chase Brass & Copper Company, Inc.
W. DEAN KEEFER, Lumbermen's Mutual Casualty Company
WALTER G. KING, Past President
JOHN E. LONG, Past President
J. WILLARD LORD, Atlantic Refining Company
THOS. H. MACDONALD, U. S. Public Roads Administration

Officers (contd.)

WILLS MACLACHAN, ASSE-Engineering Section
HON. CARROLL E. MEALEY, New York State Tax Commission
I. W. MILLARD, Industrial Gloves Company
HAROLD L. MINER, E. I. du Pont de Nemours & Company
PHILIP M. MORGAN, Massachusetts Safety Council; Worcester Safety Council
CLARENCE J. MUTH, Safety Division, Milwaukee Ass'n of Commerce
ELIOT NESS, U. S. Office of Defense Health & Welfare Services
WALTER S. PAINE, Aetna Life and Affiliated Companies
LEW R. PALMER, Past President
C. E. PETTIBONE, Past President
R. J. RESCHLUTH, New Haven Trap Rock Company
COL. HENRY A. RENNIGER, U. S. Office of Civilian Defense, 3rd Region
A. V. ROHWEDER, Duluth, Missabe & Iron Range Railway Company
CARL J. RUTLAND, Street & Highway Traffic Section
HENRY G. SCHAFFNER, Erie Safety Council
JUDGE LEE E. SKEEL, Appellate Court, Cleveland
CARL L. SMITH, Greater Cleveland Safety Council
THEODORE F. SMITH, Oliver Iron & Steel Corporation
R. T. SOLBERSTEN, Elliott Service Company
LESLIE J. SORENSON, City Traffic Engineer, Chicago
COL. JOHN STILWELL, Consolidated Edison Company of New York, Inc.
MAJOR R. C. STRATTON, G.W.S., Chemical Section
C. P. TOLMAN, Past President
DR. C. H. WATSON, Past President
DR. LEWIS A. WILSON, The University of State of New York
C. E. WOOLLEVER, Automotive & Machine Shop Section
ARTHUR H. YOUNG, Past President
V. A. ZIMMER, U. S. Department of Labor

Board of Trustees (1942-1943)

WINTHROP W. ALDRICH, Chairman Board of Directors, The Chase National Bank, New York City
SEWELL L. AVERY, President, Montgomery Ward & Company, Inc., Chicago, Ill.
MORGAN B. BRAINARD, President, Aetna Life Insurance Company, Hartford, Conn.
HOWARD COONLEY, Chairman of the Board of Directors, Walworth Company, New York City
BENJAMIN F. FAIRLESS, President, United States Steel Corporation, Pittsburgh, Penn.
* W. S. FARISH, President, Standard Oil Company of New Jersey, New York City
WALTER GIFFORD, President, American Telephone and Telegraph Company, New York City
E. R. HARRIMAN, Director, Union Pacific Railroad Company, New York City
WILLIAM A. IRVIN, Member Executive Committee, United States Steel Corporation, New York City
THOMAS I. PARKINSON, President, The Equitable Life Assurance Society of the U. S., New York City

* Deceased

ROBERT C. STANLEY, President, International Nickel Company of Canada, Ltd., New York City
COL. JOHN STILWELL, Vice-President, Consolidated Edison Company of New York, New York City
THOMAS JOHN WATSON, President, International Business Machines Corporation, New York City
CHARLES E. WILSON, President, General Electric Company, New York City

Directors (1942-1943)

H. J. ALDRICH, Spencer Kellogg & Sons, Inc.
T. O. ARMSTRONG, Springfield Safety Council; Hampden County Safety Council
W. C. BAKER, Power Press Section
J. I. BANASH, Past President
WALLACE N. BARKER, Pullman-Standard Car Manufacturing Company
ERNEST W. BECK, United States Rubber Company
C. W. BERGQUIST, Past President
MISS FRANCES BETHUNE, R.N., Textile Section
W. F. BIGGS, Peoria Safety Council
H. R. BIXLER, Mutual Life Insurance Company of New York
H. W. BOGGESS, Sinclair Prairie Oil Company
F. A. BOGUE, Steam Railroad Section
E. G. BORSERINE, Kansas City Safety Council
C. B. BOULET, Wisconsin Public Service Corporation
EMERSON A. BRANDT, Refrigeration Section
EDWARD H. BRINK, Grand Rapids Safety Council
JOSEPH A. BROPHY, Elizabeth Safety Council
W. F. BROWN, Commercial Vehicle Section
SAM W. BURCHIEL, Automobile Club of Rhode Island, Safety Department
W. H. CAMERON, Evanston, Ill.
ROBERT W. CAMPBELL, Past President
RAYMOND A. CAREY, Evanston Safety Council
RAY CARR, Portland Traffic Safety Commission
D. B. CHANT, Ontario Pulp & Paper Makers' Safety Association
CHARLES A. CHAPPELL, Safety Division, Syracuse Chamber of Commerce
LAMMOT DUPONT COPELAND, Delaware Safety Council
C. S. CRAIGMILE, Greater Chicago Safety Council
R. G. CREVISTON, Crane Company
W. H. CRISMAN, Seattle Traffic & Safety Council
J. E. CULLINEY, Bethlehem Steel Company
A. J. R. CURTIS, Portland Cement Association
JOHN D'AMBROSA, SR., Railway Safety Council
NED H. DEARBORN, National Safety Council, Inc.
W. N. DEATHERAGE, Long Beach Traffic Safety Council
LEWIS A. DEBLOIS, Past President
C. W. DEMPSEY, The Liquid Carbonic Corporation
S. T. DIBSDALE, Wood Products Section
MILTON W. DOBRZENSKY, East Bay Safety Council
R. E. DONOVAN, Standard Oil Company of California
JAMES B. DOUGLAS, The Philadelphia Gas Works Company
MARCUS A. DOW, Past President
D. C. DUNCAN, Public Utilities Section

Officers (contd.)

G. W. Elste, Jr., Baltimore & Ohio Railroad Company
Harold F. Enlows, The American National Red Cross
D. D. Fennell, Past President
R. H. Ferguson, Metals Section
Dr. Hart E. Fisher, Chicago Rapid Transit Company
Victor B. Fitzpatrick, Richmond Safety Council
Howard B. Fonda, Burroughs Wellcome & Co. (U. S. A.) Inc.
Ray Gillett, Meat Packing, Tanning & Leather Industries Section
Robert F. Gilmour, Utica Safety Council
John L. Griber, Rubber Section
W. A. Griffin, American Telephone & Telegraph Company
H. J. Griffith, Jones & Laughlin Steel Corporation
E. E. Grover, Columbus Safety Council
Harry Guilbert, The Pullman Company
A. J. Hager, Lansing Safety Council
D. T. Harrington, U. S. Bureau of Mines
Frank H. Harrison, International Harvester Company
Julien H. Harvey, Greater New York Safety Council
W. A. Hazard, Construction Section
Dr. T. Lyle Hazlett, Westinghouse Electric & Manufacturing Company
G. T. Hellmuth, Chicago Rapid Transit Company
G. A. Heuser, Louisville Safety Council
H. W. Hirsheimer, Chattanooga Safety Council
Carl E. Holmes, Marine Section
Dr. Ralph H. Houghton, Kenosha Safety Council
Stephen J. Hurley, Rochester Safety Council
Wm F. James, Philadelphia Safety Council
E. A. Jarvis, Chase Brass & Copper Company, Inc.
Thomas P. Kearns, Industrial Commission of Ohio
W. Dean Keefer, Lumbermen's Mutual Casualty Company
Walter G. King, Past President
C. L. LaFountaine, Great Northern Railway Company
George LaMair, Des Moines Safety Council
Roy Lee, Contra Costa County Safety Council
Wallace O. Lee, Safety Division, Indianapolis Chamber of Commerce
John E. Long, Past President
C. H. Longman, Chicago & North Western Railway Company
J. Willard Lord, Atlantic Refining Company
R. A. McArthur, Public Service Coordinated Transport
B. B. McCulloch, Bureau of Safety, Inc.
Thos. H. MacDonald, U. S. Public Roads Administration
Wills MacLachlan, ASSE-Engineering Section
Alfred E. Maffly, Berkeley Traffic Safety Commission
H. T. Marker, Petroleum Section
Hon. Carroll E. Mealey, New York State Tax Commission
I. W. Millard, Industrial Gloves Company
Harold L. Miner, E. I. du Pont de Nemours & Company
H. H. Mohler, St. Joseph Safety Council
Philip M. Morgan, Massachusetts Safety Council
R. B. Morley, Industrial Accident Prevention Associations
C. L. Murray, Mason City-Cerro Gordo County Safety Council
Clarence J. Muth, Safety Division, Milwaukee Association of Commerce
Elmo Nunn, U. S. Office of Defense Health & Welfare Services

Officers (contd.)

FRANK S. NEWELL, Toledo Safety Council
F. EDWARD O'NEIL, The Safety Council of Greater St. Louis
GEORGE C. A. OPP, The Detroit Edison Company
WALTER S. PAINE, Aetna Life and Affiliated Companies
LEW R. PALMER, Past President
DAVID A. PATTON, Newark Safety Council
R. E. PERKEY, South Bend Safety Council
C. E. PETTIBONE, Past President
G. H. PFEIF, General Electric Company
D. W. PONTIUS, Greater Los Angeles Safety Council
W. M. POWELL, Cement and Quarry Section
ALBERT S. REGULA, General Time Instruments Corporation
R. J. REIGELUTH, New Haven Trap Rock Company
COL. HENRY A. RENINGER, U. S. Office of Civilian Defense, 3rd Region
J. W. REYNOLDS, United Pacific Insurance Company
ROLAND W. RICHARDSON, Paper & Pulp Section
CLIFFORD T. RIPLEY, Superior & Douglas County Safety Council
MISS SADIE ROGERS, Employees' Publication Section
A. V. ROHWEDER, Duluth, Missabe & Iron Range Railway Company
CARL J. RUTLAND, Street & Highway Traffic Section
HENRY G. SCHAFFNER, Erie Safety Council
FRANK T. SHEETS, Portland Cement Association
JOHN R. SHERWOOD, Baltimore Safety Council
DR. L. A. SHOUDY, Bethlehem Steel Company
JUDGE LEE E. SKEEL, Appellate Court, Cleveland
CARL L. SMITH, Greater Cleveland Safety Council
THEODORE F. SMITH, Oliver Iron & Steel Corporation
R. T. SOLENSTEN, Elliott Service Company
LESLIE J. SORENSON, City Traffic Engineer, Chicago
JOHN L. SPENCER, Blackstone Valley Safety Council
E. C. SPRING, Philadelphia, Pa.
E. B. STAHLMAN, Safety Dept., Nashville Chamber of Commerce
COL. JOHN STILWELL, Consolidated Edison Company of New York, Inc.
MAJOR R. C. STRATTON, C.W.S., Chemical Section
H. B. TAYLOR, Food Section
C. P. TOLMAN, Past President
JOHN TREWEEK, Mining Section
R. A. TUCKER, Western Pennsylvania Safety Council
J. A. VINCENT, Madison County Safety Council
DR. C. H. WATSON, Past President
M. F. M. WERTH, Lehigh Valley Safety Council
H. W. WHITCOMB, Transit Section
T. ANGLIN WHITE, Safety Div., Birmingham Chamber of Commerce
A. W. WHITNEY, National Conservation Bureau
C. E. WILSON, Detroit Industrial Safety Council
DR. LEWIS A. WILSON, The University of State of New York
C. E. WOOLIEVER, Automotive and Machine Shop Section
ROY V. WRIGHT, Simmons-Boardman Publishing Corporation
MISS MARY MAY WYMAN, Child Education Section
ARTHUR H. YOUNG, Past President
M. W. YOUNG, Sacramento Safety Council
WALTER S. YOUNG, Worcester Safety Council
E. J. ZAUPT, Safety Bureau, Duluth Chamber of Commerce
IRVING R. ZEHAN, Omaha Safety Council
V. A. ZIEHEN, U. S. Department of Labor

Each edition of
library of safety
men and women—
portation, insura
agencies—give the
and background to
vention at the Am

This knowledge
ing year after yea
gressive industrial

Plan o

Safety ideas, to
as personalities in
ty, can be found
Table of Content
at the end of the

The *Table of*
Sessions. (b) Su
problems commo
Industrial Sectio

Subject Sessio
are arranged alp
the book the seve
trial Section are
the daily time s
gram.

The detailed
easy to find spe
hundreds of iten
jects discussed, i
shoes, third shi
in the case of fo
are printed in
tions, i. e., Ch
Marine, etc. U.
are listed the s
gram.

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

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 theoretical possibilities for exposure to toxic substances in the above industries are far too numerous for tabulation, this list represents those most commonly encountered.

Dusts

Silica-bearing inorganic dusts are probably 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 very

extensively 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 crystaline 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 evaluated 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 midget

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 the 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

through a solu
titrating with iodine
potassium iodide sta
ured amount of standa
action the disappearanc
cates the end point (8).

Hydrogen

This gas for which th
bureaus of California, C
achusetts have establishe
p.p.m. by volume, is fo
operations, heat treating

A portable instrume
cussed in connection wi
has been developed fo
also. I have been inform
hydrogen cyanide dete
form proved less satisfa
been withdrawn from th
pending further researc

Chemical tests are a
of hydrogen cyanide,
blue and thiocyanate re
are specific for this g
sensitive enough for c
tered in industrial h
methods suitable for
gas in small concentra
red-silver nitrate and
acetate test papers. T
have been adopted as
British Department of
are non-specific, howev
interference of other
H_3N, SO_2 and H_2S
consideration.

In a method suggest
Foundation (A.H.F.)
bubbled through 0.5
hydroxide after which
made by titrating wit

Sulfur

Exposures to sulfur
mon in the petroleum i
and sulfuric acid
dioxide is also encoun
works, magnesium fo
dustries where sulfur
It is an extremely ir
a threshold limit of 1
gested.

...current produced by the ...action through a thermo... ...ted in terms of carbon mon... ...on which is read directly ...a milliammeter. The source ...instrument is a small centri... ...motor of which is operated ...ilt-in 6 volt battery or from ...ing circuit through a trans...

...nient method for estimation ...ide though less sensitive and ... is the use of palladium ...s. In this reaction the palla... ...s reduced to metallic pal... ...producing a stain, the in... ...is in direct proportion to ...rbon monoxide in the atmos... ...ervation. The stain produced ...known color standards for ...e carbon monoxide present. ...not specific for carbon mon...; three are other reducing ...will produce a stain in the ...adium chloride. Incidentally, ...ethod for carbon monoxide ...ed by the British Depart... ...al Research (7) consists of a ...de test paper through which ...ampled is drawn by means ... The stain thus produced is ...standard color chart.

...drogen Sulfide

...ide is a very toxic gas with ...dor. It is found in many in... ...ns where sulfur or sulfur ...ed, but primarily it is en... ...artificial silk, chemical and ...ries. Safe limits varying be... ...p.p.m. by volume have been ...ious State authorities in this

...ed method for determination ...ide is undoubtedly the use ...ated instrument consisting ...aspirator bulb and a detector ...ich the air sample is drawn. ...he contains a chemical sub... ...ion in contact with hydrogen ... a discoloration the length ...proportion to the amount of ... present and can be measured ...ached scale. It can also be ...metrically, either by bubbling through a sodium hydroxide solution and titrating with iodine, or by bubbling through potassium iodide starch solution and a measured amount of standard iodine in which reaction 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 discussed 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, H_3N, SO_2 and H_2S 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 it dustry, rubber works, and sulfuric acid manufacturing. Sulfur dioxide is also encountered in bone and glue works, magnesium fownderies, and other industries where sulfur compounds are used. It is an extremely irritating gas for which a threshold limit of 5 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 spit 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 chemical 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 handled. 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 with 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. Althouh 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 combustible gas indicator is far more expedient. Most of these devices, used primarily for fire prevention work, are designed to read to within 1% of the lower explosive limit of the 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 gas 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

relatively low safe limits have been suggested by various authorities. Russian investigators have recommended a threshold limit of only 5 p.p.m. for prolonged exposures, while the British Department of Scientific and Industrial Research has suggested a value of 10 p.p.m. and our own State of Massachusetts, 20 p.p.m. While there is a wide divergence between these values, they all tend to indicate the potential dangers connected with exposures to vapors of carbon disulfide.

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

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

Acids

In this group probably nitric, chromic, hydrofluoric, hydrochloric and sulfuric acids are those most commonly encountered. Of these, nitric acid has been discussed under another heading. Exposures to chromic acid resulting in chrome ulcers and the perforated nasal septum are frequently found around chromium plating tanks. A safe limit of 1 mg. per 10 cubic meters of air has been established for chromic acid which in electroplating work occurs as a mist over the plating baths. Hydrofluoric and hydrochloric acids also exist in gaseous form as hydrogen fluoride and hydrogen chloride respectively. A safe limit of 3 p.p.m. has been suggested for the former, while it has been set at 10 p.p.m. for the latter.

Sampling for mist, chromic and sulfuric acids is usually done by bubbling through a sodium hydroxide solution, while 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.

Bibliography

1. Greenburg, L. and Smith, G. W. A New Instrument for Sampling Aerial Dust. R. I. 2392, U. S. Bureau of Mines, 1922.

2. Brown, Carlton E.; Baum, Lester A. H.; Yant, William P., and Schrenk, Helmuth H. Microprojection Method for Counting Impinger Dust Samples. R.I. 3373, U. S. Bureau of Mines, January, 1938.

3. Barnes, E. C. and Penney, G. W. An Electrostatic Dust Weight Sampler. Jc. Industrial Hygiene & Toxicology, *20*, 3, p. 259 March, 1938.

4. Berns, N. R. Dust Counts and Their Significance. Heating, Piping and Air Conditioning, March, June and October, 1942.

5. Pinto, S. Sherman and Fahy, John P. A New Colorimetric Method for the Determination of T.N.T. (2, 4, 6 Trinitrotoluene) in Air. Jo. Industrial Hygiene & Toxicology, *24*, 2, p. 24 February, 1942.

6. Sands, Frederick W., 189 Claremont Avenue, New York, N. Y. Unpublished data obtained through personal communication, August, 1942.

7. Department of Scientific and Industrial Research, London, England Methods for Detection of Toxic Gases in Industry.

   Leaflet No. 1—Hydrogen Sulfide
   Leaflet No. 2—Hydrogen Cyanide
   Leaflet No. 3—Sulfur Dioxide
   Leaflet No. 4—Benzene
   Leaflet No. 5—Nitrous Fumes
   Leaflet No. 6—Carbon Disulfide
   Leaflet No. 7—Carbon Monoxide
   Leaflet No. 8—Phosgen
   Leaflet No. 9—Arsine
   Leaflet No. 10—Chlorine
   Leaflet No. 11—Aniline
   Leaflet No. 12—Organic Compounds

8. Method employed at the Harvard School of Public Health.

9. Air Hygiene Foundation of America, Inc. Prevention Engineering Series, Bulletin No. 2, Part 8.

10. Cook, Warren A. Report on Methods for Determination of Poisonous Atmospheric

Contaminants. pp. 80-85, 1935-1936 Year Book, American Public Health Association.

11. Fieldner et al. Jo. Industrial & Engineering Chemistry 11:519, 1919.

12. Evans, R. D. Apparatus for the Determination of Minute Quantities of Radium, Radon and Thoron in Solids, Liquids and Gases. Review of Scientific Instruments. 4:99—112 (1935).

13. Brown, S. C.; Elliott, L. G.; and Evans, R. D. Detection of Radon by Means of A Proportional Counter. Review of Scientific Instruments *13*: 147—151 (1942).

14. Evans, R. D. and Goodman, C. Determination of The Thoron Content of Air and Its Bearing on Lung-Cancer Hazards in Industry. Jo. of Industrial Hygiene & Toxicology, *22*, 3, pp. 89-99 March, 1940.

15. Evans, R. D.; Nilson, S. J.; Goodman, C.; and Bernz, N. R. Industrial Application of a Method for Determining the Thoron Content of Air. Proceedings of the VIII International Congress on Occupational Diseases and Preventive Medicine, held at Frankfurt a. M. Germany, September 26-30, 1938.

16. United States Public Health Service. Division of Industrial Hygiene, National Institute of Health, Washington, D. C. Cadmium Poisoning. Public Health Reports *57*, 17 April 24, 1942.

17. Bulmer, F. M. R.; Rothwell, H. E.; and Frankish, E. R. Industrial Cadmium Poisoning. A report of fifteen cases, including two deaths. Canadian Public Health Jo. 1938, V.29, 19-26.

18. Littlefield, J. B.; Feicht, Florence, L. and Schrenk, H. H. Efficiency of Impingers for Collecting Lead Dusts and Fumes. R.I. 3401, U. S. Bureau of Mines, May, 1938.

19. American Standard Association. Benzene, allowable concentration. Z 37.4, 1941.

20. Cole, Peter A. Determination of the Concentration of Benzene and Toluene in Air by a Spectroscopic Method. Jo. Optical Soc. Am. *32*, 304-306, May, 1942.

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.

*Published by permission of the Director, Bureau of Mines, U. S. Department of the Interior, Washington, D. C.

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

Officers 1942-1943†

General Chairman—F. A. Bogue, Chicago, Rock Island & Pacific Railway Co., Chicago, Ill.

Vice-Chairman—H. A. Daake, Erie Railroad Co., Cleveland, Ohio.

Secretary—M. T. Fulton, Kansas City Southern Railway Co., Kansas City, Mo.

News Letter Editors—M. T. Fulton, Kansas City Southern Railway Co., Kansas City, Mo.
H. G. Townsend, Kansas City Southern Railway Co., Kansas City, Mo.

Program Committee—J. R. Tenney (*Chairman*), Western Maryland Railway Co., Hagerstown, Md.
P. F. Buckle, Chicago, Burlington & Quincy Railroad Co., Chicago, Ill.
H. A. Daake, Erie Railroad Co., Cleveland, Ohio.

Membership Committee—G. W. Elste, Jr. (*Chairman*), Baltimore & Ohio Railroad Co., Baltimore, Md.
J. E. Long, The Delaware & Hudson Railroad Corp., Albany, N. Y.

Statistics Committee—T. H. Carrow (*Chairman*), The Pennsylvania Railroad, Philadelphia, Pa.
F. R. Bradford, Boston & Maine Railroad, Boston, Mass.
D. G. Phillips, Wabash Railway Co., St. Louis, Mo.

Contest Committee—C. L. LaFountaine (*Chairman*), Great Northern Railway Co., St. Paul, Minn.
O. F. Gnadinger, Elgin, Joliet & Eastern Railway Co., Joliet, Ill.
L. R. Palmer (*Secretary*), Equitable Life Assurance Society of the U. S., New York, N. Y.

Poster Committee—E. L. Henry (*Chairman*), Chicago & North Western Railway Co., Chicago, Ill.
G. M. Dempsey, Chicago, Milwaukee St. Paul & Pacific Railroad Co., Chicago, Ill.
J. J. Snavely, New York, New Haven & Hartford Railway Co., New Haven, Conn.

Safe Practices Pamphlet Committee—W. J. Flannigan (*Chairman*), Northern Pacific Railway Co., St. Paul, Minn.
S. C. Flagler, Atchison, Topeka & Santa Fe Railway Co., Topeka, Kansas.
H. C. Helwig, The Delaware & Hudson Railroad Corp., Oneonta, N. Y.

Nominations and Elections Committee—W. R. Lofgren (*Chairman*), Chicago & North Western Railway Co., St. Paul, Minn.
C. M. Kimball, Southern Railway System, Washington, D. C.
L. B. Harper, Illinois Central System, Chicago, Ill.

Health Committee—Dr. I. S. Cutter (*Chairman*), Chicago & North Western Railway Co., Chicago, Ill.
Dr. Harvey Bartle, The Pennsylvania Railroad, Philadelphia, Pa.

†As elected by delegates in Congress session.