1946

NATIONAL SAFETY COUNCIL OFFICERS

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VOLUME I
Part 1

General Subject and
Industrial Sessions

VOLUME I, Part 2, concludes the Industrial Sessions

VOLUME II contains the Traffic, Commercial Vehicle, Transit, School and College, Home, Farm and Women's Activities Sessions.

National Safety Council, Inc.
20 North Wacker Drive, Chicago 6

Foreword

VOLUME I

THE Transactions of the 34th National Safety Congress and Exposition of the National Safety Council are published in two volumes. Volume I is published in two parts, of which this is Part 1, and contains the Annual Council Meeting, the Banquet, the general subject sessions, and the Industrial Section sessions. In Volume II will be found the Traffic, Commercial Vehicle, Transit, School and College, Home, Farm and Women's Activities sessions.

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 (including Parts 1 and 2, which cannot be sold separately) may be obtained by Council members at $2.50 each. The price to non-members is $5.00 each. Extra copies of Volume II are $1.25 each.

THE NATIONAL SAFETY COUNCIL, INC.
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Each edition of these Transactions is a library of safety experience. Hundreds of men and women—leaders in industry, transportation, insurance, and governmental agencies—give the best of their knowledge and background to the cause of accident prevention at the Annual Safety Congress.

This knowledge and experience, accumulating year after year, is of great value to progressive industrialists and businessmen.

Plan of Arrangement

Safety ideas, topics, and problems, as well as personalities important in the field of safety, can be found by reference either to the *Table of Contents* or to the *Index* at the end of Part 2 of the volume.

The *Table of Contents* lists (a) General Sessions, (b) Subject Sessions dealing with problems common to many industries, (c) Industrial Section meetings.

Subject Sessions and Industrial Sections are arranged alphabetically. In the body of the book the several meetings of each Industrial Section are printed as they appeared in the daily time schedule of the original program.

The detailed alphabetical *Index* makes it easy to find specific safety material. It lists hundreds of items in three ways; (a) subjects discussed, i.e., absenteeism, dusts, safety shoes, welding; (b) speakers in the case of formal papers. Speakers' names are printed in italics; (c) Industrial Sections, i.e., Chemical, Construction, Food, Marine, etc. Under each Industrial Section are listed the subjects of its complete program.

Use the Transactions . . .

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. . . To obtain speech-making materials for the safety director or business executive who plans to speak on accident prevention. In addition to facts and authoritative opinions, this book contains many splendid examples of safety talks which can be used as guides or models. In addition, much of the material can be used in local publicity, plant publications and bulletin board announcements.

. . . To learn the points of view held by the leaders of the safety movement. These leaders, as officers or members of the Council's Industrial Sections, or as publice officials, contribupte ideas which can be used in the organizing of safety programs.

. . . To gain a better understanding of the National Safety Council's services and the national safety program. A survey of the material contained in the Transactions will supply the reader with increased knowledge of the growing power of the safety movement and of the means by which this power is expressed.

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TUESDAY EVENING SESSION

October 8, 1946

Presiding: W. DEAN KEEFER, Second Vice-Pres., Lubermens Mutual Casualty Co.

(Summary of Proceedings)

W. DEAN KEEFER:

The activities of the Standing Committees and of the Chapters are contained in a printed report, copy of which was distributed to those in attendance at Sunday's Executive Committee meeting. Additional copies will be mailed to all Chapter Chairmen and Representatives.

These reports are comprehensive, and cover the principal activities of the Society. I would only supplement these by saying that the ASSE has continued to grow, eight new Chapters having been added during the business year now closing, bringing the total of Chapters to 30. I am informed that several more are in prospect.

I would like to take this opportunity to commend the Secretary, whose untiring efforts have been responsible in no small measure for these increases. In the discharge of secretarial duties, he has visited with each of the chapters and many of the prospective chapters. This has necessitated considerable traveling in addition to office duties.

I also want to take this opportunity to express my sincere and grateful appreciation to the chairmen and members of the Standing Committees. They have served throughout a two-year period, and have each done a splendid job. I especially want to commend the Committee on Revision of the Constitution and By-Laws. They worked diligently on a most difficult assignment. We will discuss their findings a little later in the program.

It was voted that the nominations be ordered closed, and the Secretary instructed to cast a unanimous ballot electing the slate of officers presented by the Nominating Committee to serve the Society in the respective offices for the 1946-1947 season.

ROY M. GODWIN (Chairman-elect and Safety Dir., Philadelphia Electric Co.): Mr. Chairman, fellow-members of ASSE, and guests. First, I want to thank the Nominating Committee for selecting me to head this organization, and also to thank ea of you for your confidence in honoring n with the office of General Chairman, ar placing me in a position to serve you.

I am not going to make a speech. Hov ever, I do want you to know that aft many years of activity in ASSE, I belie I am conversant with many of the prol lems, the aims, and objectives of this o ganization, and the one promise I make that I will do my utmost to carry on t affairs of this Society in accordance wi the trust you have placed in me.

It will be my aim to help bring safe engineering closer to professional reco nition by the other engineering societies. I order to accomplish this, we must have you wholehearted support in maintaining th standards of our Society on a high plane.

I now have a very pleasant duty to pe form. Dean, will you please stand up. I is a pleasure, on behalf of the membershi for me to present you with this engrosse certificate in token of our appreciation fo your leadership during the past two year With it goes the hope that you will co tinue to serve for many years helping us t continue to build ASSE.

A. D. CADDELL (Secretary, ASSE) In addressing the members on the importar question of the Revision of the Articles o Government of this Society, I believe it t be only proper to point to the magnitud and many difficulties of this task, whic confronted the Committee. Because of war time travel restrictions, it was not alway possible for Committee members to atten meetings. Although numerous meeting were held, it was necessary to carry on large amount of correspondence, all o which was given consideration in reachin the consensus presented to the membershi in the August, 1946, issue of the Society' News Letter, as provided in Section I o Article VIII of the Constitution, on amend ments.

production and in some cases, it is rather difficult to impress them with the fact they are not going to get out production, efficiently and economically, at least, without getting it out safely.

And then there is the worker! Did you ever go around a shop and try to get just one employee to admit that perhaps he will be in the hospital at the end of the day as the result of an accident due to a cause attributable to himself? If you haven't, try it sometimes and you will really have your eyes opened. Most workers feel that accidents will happen—but not to him. It is always "the other guy" who is going to get hurt and yet, look at the accident statistics—mounting steadily day by day, month by month and year by year.

Why is this apathy displayed by the salient groups which go to make up a successful safety organization? It is because safety is a necessary and dry evil.

Safety is like anything else. To be successfully sold, it must be advertised. I am not going into the ways and means of accomplishing this selling job, I merely point out the necessity of it. Safety must be glamorized and dramatized. We know that most of our work in safety must deal with the human mind—that at least 85 per cent of all accidents involve the human element. It is, therefore, only logical that we must go to the advertising and publicity fields to get our subject across to those whom we wish to participate in the safety effort.

I do not mean to propose that we make a "Barnum and Bailey" sort of a thing out of safety, forgetting the old fundamentals and the actual engineering phases of the business. But I do say we must reach the three units of our safety structure in such a manner that they will take readily to our teachings. I'm of the school that believes "any means to reach an end," so long as that end is the reduction and elimination, if possible, of accidents. Sometimes such an attitude can get us in trouble—like that time I plastered a large, gruesome picture of four severed fingers over the front page of our plant safety paper. But, do you know, we didn't have a single lost time accident for three months after that picture appeared? For a long time there was considerable talk about safety in that plant.

I do not advocate such a thing as a steady diet, but it serves to illustrate the point. Perhaps this talk has not given you too much for digestion on the subject "Use of the Safety Organization." I do hope, however, that it has stimulated a little thought and if it serves no other purpose than to get you to go back to your plant and get something under way for safety's sake, then I feel my job has been well done.

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1946-1947

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have no medical setup there, but we do. I said they should call the Henry Street nurse, and they will do that. He said they can't do that because the union would get mad. If we spent two hours there in the day shift, the twilight shift and the midnight shift would want two hours, too. What's the answer to that?

MISS HARMON: That's a real problem. We are constantly being faced with it. It goes back to management's fear that what is given to one group of workers, if it is not given to all groups, will cause more disruption in labor relations.

We have gone on the premise that whenever possible, and when the individual nurse is willing to work at odd hours, we will supply as much nursing service on the other shifts as we do on the daytime shift. That is only possible when your nurse is willing to do it We have had nurses go out at five o'clock in the morning, for instance. Right now we have one who works from six-thirty in the morning until eight, although our regular working hours are from eight-thirty until five. We have one nurse who has gone out at eleven o'clock in the evening to cover the change of shifts.

I don't think that is a solution for the problem at all. It is merely an attempt on our part to give as much service for each group of workers as the group during the day is getting. But I am afraid that it will become increasingly difficult for us to do that, as time goes on, and certainly, where you have only a small group of workers on any one shift, it isn't possible to employ a full-time nurse for each shift. The solution to the problem depends upon how willing your nurse is to sacrifice her working hours, and probably very few of them would be.

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1946-1947

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TUESDAY AFTERNOON SESSION

October 8, 1946

Ship Construction and Repair

Presiding: H. GERRISH SMITH, Pres., Shipbuilders Council of America.

Report of General Chairman

By W. C. GARBUTT

General Chairman, Marine Section, and Mgr., Industrial Relations, Pittsburgh Steamship Co.

Two years ago when we last met, I expressed the fear that the Marine Industry might expect rising frequency and severity accident rates because of the new and unusual conditions to which both construction and transportation were being subjected.

There was a war to be won and the order of the day was "speed" and "Haste makes waste." Ships and more ships were to be built. In many instances workers were hastily trained and equipped. The vessels were eventually loaded by other inexperienced workers and manned by green crews. That accidents and injuries were more numerous is not surprising, but we are gradually returning to normal and the lessons we have learned will undoubtedly reflect themselves in future statistics. There is even now reason for congratulation and commendation to the marine safety engineer that both frequency and severity rates through the war years were in line with the decreasing trend begun in 1936. Our efforts are pledged to bring our safety record to comparison with that of less hazardous industries. The return of our experienced men to teach and direct those who will follow them makes for assurance that this will be done.

Those of us who, of necessity, remained behind have endeavored to carry on the work of the Marine Section, despite transportation and hotel accommodation problems. Most of our contacts were through correspondence, although those residing in the New York area met several times and to them is the deserved credit for this excellent meeting. Special thanks of the entire Section should go to Past Chairman Carl Holmes whose unstinted service and wholehearted cooperation has largely contributed to the success of our program.

The Council suffered a serious loss on the West Coast when Past-Chairman Byron Pickard passed on. "Pick" was one of those fellows to whom you take an instant liking and never changed your opinion. You could work with him or play with him. He was always your friend, ready with help and advice at all times. His experience was extensive, but he never suggested superiority. His mantle has fallen upon Joe Travers whom we welcome into our circle and wish for him the success that was "Pick's."

Our activities on the West Coast are still being carried on by Andy Schmitz, Frank Blackstone, Ed. Lange and others. To them, our sincere thanks for their continued cooperation.

The Gulf Coast operations are being ably handled by Slim Schroder and his helpers. Many of them were not able to devote much time to the Section affairs because of their war duties, but as they return to normal occupations, we can expect increased activity in the South.

The East Coast has always been the hub of the Marine Section. The number of members in the New York area permits closer personal contact. The thanks of your retiring Chairman is especially due to John Hunter, Frank Cogan, Ed Herges, Harold Segrave and Harold Wick, who have never been too busy with their personal affairs to prevent them lending assistance and counsel to Carl Holmes. Your new Chairman will find that the return of Ed. Holden will add further energy to the New York group.

We are also indebted to Arthur Tode, who has generously included the Marine Section in the activities of the Propellor Club.

Our thanks are also due to the Regional

Metals Section

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1946-1947

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MONDAY AFTERNOON SESSION

October 7, 1946

Presiding: EARL H. FYLER, Supt., Industrial Relations, Carnegie-Illinois Steel Corp.

The Safety Problems of a Small Plant

By CHARLES S. CRAIGMILE
Executive Vice President, Belden Manufacturing Company

What has the size of the plant to do with the handling of safety? Usually it is just this—in a large plant you find more full time positions and fewer "jack of all trades" jobs so characteristic of the small plant. You will probably find a full time safety director in the large plant, with a department of considerable size under him. In the small plant safety may be directed by anyone from the president down, and almost surely will be only one of several responsibilities assigned to him.

Right there the difference ends as far as I am concerned, and I believe that generally we make too much of the difference. I hear large-plant safety men say that if they could only have the close contact with employees which the small plant executive has, their safety problem would be a cinch. Just as vehemently the small plant man says that if only he could have a safety director, a full time doctor, a nurse and a safety staff, of course he could make a fine showing.

Experience proves that they can both be wrong. Size is not and never will be a measure of safety efficiency. What *is* essential is that the spark of safety consciousness be alive in someone's breast whether he be the president, the vice-president or the janitor, and then the means of translating that spark into safety power.

Specifically then, what should top management do about safety? To start with, the chief executive officer or the executive designated by him to be responsible for safety, should either organize and conduct a carefully integrated safety program, or definitely assign that responsibility to one of his subordinates, preferably, of course, not too far down the line. Whether he assigns the function or not, he must keep in touch with it and give it his full cooperation, and I mean by that he must attend plant safety meetings on invitation, watch the plant safety record, and show clearly that he considers it a major responsibility and not just a side line of minor consequence. Employees take their cue from management and if top management is indifferent to safety they should not be surprised if the whole organization follows suit.

In the second place, the "brass" should see to it that their company joins the local safety council if there is one, for specific help in carrying on their safety work, and also joins the National Safety Council to assist in the broad job of safety education and coordination. To keep any movement alive and efficient you must have organized effort.

Third, our plant manager should give some of his time to safety council work. All such organizations are plagued by individuals who are perfectly willing to agree to serve on boards of directors but who actually contribute nothing. Many of these individuals claim they are too busy, but I often wonder just what they are so busy doing. Personally, I am afraid in many cases a diary of their activities might indicate a lack of proper evaluation rather than time.

Let us turn now to the job of the safety director, whoever he is, and see if we can point out some of the important steps he will find necessary to success.

1. *Organize a Safety Committee.* Safety direction is not a one-man job. The safety supervisor needs the support of the whole organization, and one of the ways of getting it is to appoint a representative safety committee. The members should be rotated and nomination can be used to recognize out-

sensitivity, but generally there is this maximum allowable amount, so you approach the problem in this way: If possible, don't get it on the skin at all, but if it does get on the skin, get it off as soon as possible.

MODERATOR RIDINGER: We have time for one more question: "Should a safety engineer remove or have removed a hazard over the objections of a foreman? In either event, how would you do it?" Bob Ferguson.

MR. FERGUSON: I think it would be a mistake for a safety engineer to go into a foreman's department and try to do something over his objections. The men in our organization have definite instructions, when they see a hazardous job to just shut down, but to be sure they are right.

The thing to do in a case like that is to get the department head immediately and decide then and there whether it is right or wrong. I don't think anyone should try to usurp the foreman's authority in a given department.

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MONDAY AFTERNOON SESSION

October 7, 1946

Presiding: C. M. FELLMAN, Safety Eng., The Montreal Mining Co.

Safety Equipment and Methods Used by the Climax Molybdenum Company

By EDWIN J. EISENACH
Safety Director, Climax Molybdenum Company

Throughout the history of the Climax operation, the company officials have shown an active interest in maintaining high employee morale. They have provided modern homes, schools (both grade school and high school), modern hospital facilities, and recreational facilities.

A continuous study of modern methods and equipment is carried on, and installations adaptable to the mining and milling of the molybdenum ore are made. Careful consideration is given to every suggestion for improving conditions of safety and production made by employees. A small award is given for any suggestion that is used. Occasionally a suggestion appears to be of little value but leads to a study of the objectionable condition, and major installations or alterations are made.

Stationary spot lights suggested for use in slusher drifts were first rejected. However, later experiments revealed that a properly mounted 200 watt spot light greatly increased the safety and efficiency of slusher operations. These lights are mounted so that they may be easily removed during heavy blasting.

To illustrate how suggestions may grow, I wish to describe our car-cleaner. Damp muck frequently freezes in the bottoms of the 10-ton Granby cars and will not dump. The cars were side-tracked and a crew of men loosened the muck with picks and shovels. This method was slow and somewhat hazardous, and moils operated by jack-hammers were used to loosen the muck, but this method was not successful. Then spaced holes were drilled and loaded with dynamite and the muck blasted. This added hazards to both men and equipment. Other experiments were tried, including: a swinging steel plate hinged to the top of the side opposite the door, drag-chains, blasting holes in back of the car, and rubber mats on the car bottoms. A device operating on the principle of a steam-shovel was proposed, and the idea of fingers operated by a compressed air piston with suitable guides was developed. This solved the problem. It is possible to clean and dump a train of 20 cars in approximately four minutes.

The method of mining at Climax is block caving. Both the grizzly and slusher system are used in handling the ore. A paper describing the details of these two methods was written by Mr. Robert Henderson, the mine superintendent, and is available upon request. The slushing system is safer and more efficient than the grizzly and chute method. The accident frequencies are about the same, but the loss of time for chutes is over twice as high. Injuries due to falls and blasting are more numerous in the chute system because of the need for working over an open grizzly and blasting in two places instead of one.

The ore drawn from either the slusher drifts or chutes is hauled to the crusher bins in 10-ton Granby cars. A train consists of 20 cars, drawn by a 19-ton Atlas Trolley Locomotive on a 36 inch gauge track with 60 or 90 pound rails. The first six cars are equipped with air brakes. All cars are equipped with automatic couplings and safety chains; the safety chains are a protection in case the coupling fails or become unhooked.

All trains approaching and entering the tunnel are controlled by an interlocking switch-board installed in the underground dispatcher's shack. Haulage accidents are numerous in most mines and are our second largest problem. Some serious wrecks were caused by two trains trying to occupy the same place at the same time. The out-going trains come from two sections of the mine workers. Some of these may be listed as follows:

1. Eye examinations. Comprehensive tests can be performed to screen out those individuals with a variety of serious visual defects. It is hardly necessary to stress the value resulting from the correction of visual defects found by routine eye examinations.

2. Dental Hygiene. Dental examinations disclose unhealthy conditions in the mouth. We know that neglected dental conditions can affect the general health of an individual. The extent of neglect found in the examination of large numbers of workers is surprising.

3. Mass Chest X-ray Programs. Tuberculosis is still one of our worst killers. We cannot hope to bring this disease under control unless we find the active cases and prevent the spread of the disease to non-infected individuals.

4. Venereal Disease Control Programs. Infectious cases must be found and properly treated to prevent the spread of the disease.

Venereal diseases should not be a bar to employment unless in an infectious stage. The employer who thus unnecessarily discriminates against workers with non-infectious venereal diseases is not only interfering with the control of those diseases but is also creating bad labor relations which may never be erased.

5. Immunization Programs. Unfortunately comparatively few industries have inaugurated programs for immunizing against some of the contagious diseases—such as small pox, diphtheria and typhoid. When adults develop these so-called childhood diseases, they may be extremely serious and become epidemic in nature.

First-Aid, Nursing and Medical Services

Every industry, down to the smallest should have adequate first-aid facilities administered by someone trained for that purpose. Industries from 250 or more employees should have an adequately equipped first-aid dispensary preferably under the supervision of a graduate registered nurse —in a full-time or part-time capacity, depending upon the size of the plant and the hazards of the jobs.

Part-time nursing can be obtained either through the local visiting nursing association, if your city has one, or by 3 or 4 smaller plants hiring one nurse to spend certain hours each day in each plant, depending on the needs and the number of workers to be served. The cost of this part-time nursing service is proportioned by the participating plants, according to the hours spent in each one.

The larger the plant, the greater is the need for one or more full-time nurses. The industrial nurse is no longer just a finger wrapper—she is the key person in an industrial health program. Show me the plant where top management is not only sold on the nursing service but also takes a personal interest in the nursing program and I will show you a plant with good labor relations, less turnover and less absenteeism. The effect of those conditions on production costs is obvious.

A plant dispensary with one or more nurses on the staff can perform the most efficient health service when a physician is in direct charge of that department. The trained medical personnel are becoming available—many of our larger medical colleges are teaching industrial medicine to the students or providing post-graduate courses for those wishing to enter this type of practice. There is every indication that this trend in providing medical services for industrial establishments will increase in scope to include more plants, particularly the smaller ones on a part-time basis.

Programs to Reduce Non-Industrial Disabilities

Employers now realize that non-industrial illnesses and accidents are their concern, that personal hygiene, living habits and social problems affecting the physical and mental fitness of an individual are definitely reflected in his ability to stay on the job and to perform his duties satisfactorily.

Unless these factors are taken into account in developing an industrial health program, the benefits to employer and employee will fall short of the mark. There are two principal activities through which industry can approach these problems—absentee studies and health education.

1. Absenteeism. Industries are urged to keep absentee records and to make a careful appraisal of the findings. These statistics form the basis for a health educational program and for any reduction program. It is necessary to determine where, why, who and to what extent absences from work are occurring. If an occupational cause for absences is indicated, it should receive close attention. We know that ordinary illnesses account for several times more absences from work than do industrial and non-industrial accidents combined.

Absentee studies were conducted by our Industrial Hygiene Unit in several Wisconsin plants for a period of 5 years. In addition to the well known data, it was found that only 9 per cent of the employees accounted for half the cases of *legitimate* absences and half the work days lost, another 25 per cent accounted for the other half of the absences and the work days lost. In other words, 66 per cent of all employees had no absences and no days lost from work by reasons of illnesses or accidents. Certainly, in view of these findings, any attempt at a reduction program should first consider a very careful medical investigation of that small percentage of workers to determine why they were ill and absent more than the large majority of the plant employees.

2. Health Education. Health education has not experienced the same period of trial as has safety education. Only during the past few years have any serious efforts been directed toward making the public health conscious. As with safety education, health campaigns will prevent illnesses—but we have a right to expect an improvement in the health status and a longer production life span as a reward for a continued and intensified health education program. If we were to devote as much energy and co-ordinated effort to a health campaign as we have to our safety campaign in the past, we should reap the same benefits.

Health educational programs for industrial workers are growing in scope and effectiveness. Educational material of various kinds is available in increasing quantities. Many agencies and organizations are developing pamphlets, posters, leaflets, films and radio programs. Industry should take advantage of this service and plan health educational programs along the same lines as their in-plant safety campaigns. The plant physicians and nurses are key personnel in such planning and administration.

The various phases of such an industrial health program may sound too big and too complex for the average establishment. The points discussed are merely high lights of adequate health coverage and in bare outline form at that. To those of you who may feel that this is something belonging only in the budget of the large corporation, let me say that more and more small industries are adopting the very services described and are doing a good job of it. An industrial health program can be just as comprehensive and as effective as you want to make it. *Top* management must be sold first. If you have qualified personnel plus the ambition to do the job, it will produce the same results for you that others have experienced.

New Challenges for the Industrial Hygienist

By EDWARD E. DART, M.D.

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This report is a summary of the progress that has been made in industrial hygiene during the last few years. In it is recounted knowledge which has made it possible to meet the ever-present and always-new challenges of making the factory a desirable place in which to spend a large portion of one's life.

There are two concepts which should preface any remarks on new industrial health challenges. The first is that a substance may appear as a new health problem and so much may be written as to fill all the journals, and yet the basic toxicological studies on the nature of this so-called new substance may have been carried out a half century before. Paradoxically, then, what is in reality old may often be thought of as new, either because it has come into wide spread usage or because it has become associated with processes wherein it had never previously been employed. Well known substances with new industrial application constitute a major pro-portion of that which is new in industrial hygiene.

The second concept necessary for an understanding of what is new in industrial hygiene is that operations must be considered as a whole. We are all prone to think of specific entities, for instance the problems associated with the handling of lead. The unwary person may not realize that in a given operation the oxides of nitrogen may require more consideration than would fumes from burning lead or that associated arsenic may demand major control measures exceeding those used for the lead. In developing a philosophy of safety, it is necessary to think of the industry or process as a whole with multitudinous exposures. As an example aluminum is about as nearly non-toxic as any substance can be, but in aluminum foundries controls have been employed to prevent exposure to chlorine gas, aldehydes and silica. Salt tablest are provided to prevent untoward effects of high temperatures in aluminum casting operations; and the medical and safety departments are ever active in preventing dermatitis from coolants used in aluminum machining operations. In this manner, safety engineers, industrial hygienists and physicians view industry as a whole and meet the wide scope of industrial health challenges by awareness of many different situations.

I. HEALTH CHALLENGES IN THE METALLURGY AND FABRICATION OF METALS

There are few newly discovered metals, although recently certain metals have been used on an appreciable scale in industry for the first time. Some of these metals that have come into prominence within the last few years will be discussed:

A. Beryllium

Beryllium is used to form alloys, especially with copper, aluminum and nickel. A small amount of beryllium imparts to the metal a considerable amount of fatigue resistance. This is especially true of the copper alloy. Injury from beryllium was reported in 1933 by Weber and Englehardt[1] who considered that the pathological conditions observed resulted from the presence of fluorides in the dust. In 1943, Hyslop[2] and his associates described experiments indicating that beryllium is relatively non-toxic and that fatalities in animal experiments resulted from exposure to the acid radicals such as fluorides and sulfates rather than to beryllium per se. A predisposition to pneumonitis, one of the important findings in human experience, was however noted in animals exposed to only beryllium oxides. Although excellent data were presented in this paper, there was nothing to prove that this predisposition to pneumonitis was not a specific reaction rather than such as might occur from the inhalation of any dust. In 1945, Van Ordstrand and his associates[3] reported the occurrence of dermatitis with chronic ulceration of the skin, inflammatory changes in the respiratory tract and pneumonitis in a group of 17 workers exposed to beryllium compounds who were observed over a three year period. These inflammatory changes probably result from the extreme hygroscopicity of these compounds which enables them to extract water from tissue. It was the opinion of these investigators that severe damage mighe be caused by factors other than acid salts. They did not however describe instances of disease in which the possibility of exposure to acid radicals was well ruled out. Gardner[4] found that beryllium granuloma of the lung developed in animals from exposure to beryllium silicate.

Clinical and experimental investigations indicate that exposure to the acid salts of beryllium will produce serious consequences more readily than exposure to the less soluble non-acid compounds. Beryllium itself apparently predisposes to pulmonary inflammation and granulomatous lesions. At any rate most exposures include those to the acid salts such as fluorides, oxyfluorides or sulfates, and control aimed at limiting the concentration of acid radicals, coupled with ordinary precautions to prevent undue inhalation of beryllium dust, should provide ample safeguard for the health of workers.

B. Cadmium

Cadmium has been used extensively in recent years in electroplating, as a coating metal, and in alloys. It is used in bearing metals, electrical conductors, pigments, ceramics, engraving processes, cadmium vapor lamps, and as a rustproof coating in place of zinc. Toxic reactions from cadmium have developed as a result of drinking lemonade mixed in cadmium-lined containers,[5] and safety must be considered when cadmium may be used as a lining for food containers. As an industrial problem cadmium must be thought of whenever the metal is heated sufficiently to give off fumes, as in welding.

By 1944, 59 cases of cadmium intoxication from inhalation had been reported since 1858.[6] Cadmium fume is noteworthy because it is not immediately irritating or unpleasant, and a workman may easily inhale sufficient fume or dust to produce severe pulmonary injury without realizing that he is being harmed. The symptoms, which develop several hours after exposure, are irritation of the throat, headache, cough, and in some instances nausea with a constricted feeling in the chest and shortness of breath as the condition progresses. The most serious consequence of exposure to cadmium fume is a severe pulmonary edema and pneumonitis. Safeguards to completely protect those near the operation should be provided whenever it is necessary to weld or burn cadmium.

C. Indium

Indium is one of the rare metals, but its use is becoming more generalized. It is used particularly for electroplating on cadmium for airplane motor bearings or for bearings in other high speed internal combustion engines. In 1942, indium was investigated by McCord, Meek, Harrold and Heussner,[7] who found the metal and its salts to have cutaneous irritant properties but demonstrated some toxicity with subcutaneous or intravenous injection. No injury from indium was found among indium platers in an airplane motor plant over a three year period.

D. Magnesium

Magnesium is a metal of importance to anyone responsible for safety because of its flammability. However, the necessary safeguards in respect to fire protection are well known. In 1942, McCord[8] described the development of gas tumors resulting from the implantation of magnesium particles in the tissues of animals. Accordingly at the beginning of the war, physicians in plants in which magnesium was machined were alert for evidence of gas in the tissue of operators. One such case was reported.[9] I have seen a similar patient in whom gas developed in the tissues of the hand and forearm, unaccompanied by febrile symptoms or other evidence of infection. The presence of gas was demonstrated both by crepitus on palpation and by distention of the fascial spaces as shown on roentgenographic examinations. The patient was a drill press operator who worked on magnesium castings. No injury more extensive than minor scratches on the hands was noted. He was removed from work on magnesium, and the gas disappeared only to return the day after he returned to his work with magnesium castings. The accumulation of gas in the tissue did not reoccur when he was removed permanently from the work with magnesium. Magnesium was never isolated from the tissue, so definite proof of liberation of gas in tissues from occupationally implanted magnesium is lacking but the possibility of such cannot be denied. This property of magnesium is of no great consequence; but rather it is interesting to medical people as a rarity. Magnesium is perhaps the classic example of a substance which is in itself practically harmless but which may have associated with it in numerous operations other materials requiring control measures for the protection of health. Of importance are several potential exposures connected with magnesium foundry operations. Either molds and cores are sprayed with a fluoride or a substance such as fluo-borate is incorporated with the sand in the core or mold. Therefore precaution in the form of ventilation and enforced personal cleanliness may be necessary. Of even more interest is the presence of sulfur gases in the work room. Sulfur dioxide is used for flushing core and for maintaining a reducing atmosphere in heat-treat ovens. In addition, hydrogen sulfide and/or other sulfides are found in the core gas at shakeout operations resulting from the sulfur used as a flux for the molten metal. In general it may be said that procedures adequate to safeguard against a silica hazard and sufficient to maintain comfort with respect to sulfur dioxide and other sulfur gases will protect the workers from any dangerous exposure to hydrogen sulfide.

E. Osmium

Osmium is one of the rare metals and occurs naturally in combination with iridium. Because of its extreme hardness osmiridium is desirable as a compound f fountain pen tips. Use for osmium compounds is found in the manufacture of electrical contacts and explosimeters. Osmium is also used as a catalyst. Metallic osmium is innocuous, but osmium tetroxide is formed on exposure of the metal to the air. As early as 1814, Berzelius[16] noted the irritant properties of osmium oxide. The toxicological properties of osmium tetroxide were reported by Brunot in 1933.[17] By exposing himself to some of the vapor he noticed after ten minutes a metallic taste in the mouth, followed at 30 minutes by a smarting sensation in the eyes, and lacrimation. Later he felt a constriction in the chest and difficulty in breathing, and objects then appeared to be surrounded by halos. These findings were confirmed in cases of industrial exposure reported by McLaughlin.[18] These authors ascribed the halo observed around objects as possibly due to osmium crystals on the cornea.

F. Selenium

Selenium occurs as a contaminant in certain ores, especially copper. Until recently it was considered an unusable product. It now has become important because of its excellent property for rectifying alternating current. It is also used in the glass industry, in paints, and plastics and as an alloy metal for steel and copper. Selenium contamination of the soil causes "Blind Staggers" in cattle, a disease in which hoofs, horns and hair drop off. Absorption of selenium in human beings produces garlic-like odor in the breath and sweat. Lemley and Merryman [19] found skin disorders of a non-specific type, marked disability, depression and inability to concentrate in patients suffering from chronic selenium poisoning. Armor and Pringle[20] noted that when operators were exposed to fine dust anosmia, catarrah and bleeding from the nose occurred. These authors stated that exposures should be kept at such a point that selenium would not be excreted in the urine. Hydrogen selenide requires careful control in industrial operations as a concentration of 0.005 mgm. per liter produces nasal and occular irritation.[14]

G. Vanadium

Vanadium is rarely encountered in the pure state, but the different oxides (Hypovanadous oxide—VO or V_2O_2, vanadium trioxide—V_2O_3, hypovanadic oxide—VO_2 or V_2O_4 and vanadium pentoxide—V_2O_5) are used to increase the hardness and malleability of steel and to increase resistance to corrosion. The pentoxide is used in some chemical oxidation processes as a catalyst in place of platinum, especially in the oxidation of naphthalene to phthalic anhydride. Here again is a health problem that can be solved by the use of proper safeguards to prevent dust or fume exposure before any harm has been done. Vanadium has no cumulative action in the body, and the acute and chronic symptoms are similar.[21] These consist of increased blood pressure with constriction of the blood vessels (by direct action on arterial muscle or the vasometer endings) and constriction of the muscles of the bronchial system.[16] A worthwhile discussion of industrial vanadium poisoning was presented by Symanski.[22] The clinical signs are pallor of the skin, greenish black discoloration of the tongue, paroxysmal cough (rarely with hemoptosis), dyspnea, pain in the chest, palpitation with exertion, tremor of the fingers and arms, emphysematous type of chest, profuse bronchitis, bronchospasm, raised blood pressure with accentuated P2 sound, and reticulation on X-ray film of the lungs.

The health hazards associated with exposure to inorganic materials have been reviewed with a fairly extensive bibliography by Fairhall.[18]

II. HEALTH CHALLENGES IN THE PRODUCTION OF NUCLEAR ENERGY

Nuclear fission has presented one of the greatest challenges for industrial health protection of all time, and this challenge has been met so successfully that almost no permanent injury has resuted. Uranium was known to the toxicologist even before the days of the atom bomb and chain reactions. In 1854, LeConte[19] found that the absorption of small amounts of uranium over a long period produced hepatitis. MacNider,[20] in experiments with dogs, found liver injury and DeLaet [21] reported four cases of poisoning in workers handling uranium salts.

Of more importance are the hazards associated with the production of atomic power.[22] In the process of nuclear fission radioactive gasses and dust are given off producing alpha, beta and gamma ray emissions. These radiations are well known and have been previously associated with X-ray and radium. The new feature of exposure in relation to nuclear fission is the production of slow neutrons. Little has been published on the biological effects of slow neutrons, but apparently their action is similar to that of the beta and gamma radiations with injury to the blood-forming organs as one of the early reactions. Protection of health in such exposures requires the study of the employees, the use of instruments for detection of exposures, the employment of mechanical handling and processing and of barriers of distance and concrete to prevent exposures.

III. HEALTH CHALLENGES IN THE PLASTICS INDUSTRY

The development of plastics is one of the most rapid that has occurred; constantly new materials are introduced.

A. Resins

Fortunately most of the resins employed have little potency as systemic toxins. As skin sensitizers, the phenol-formaldehyde resins, the phenol-furfurals and the urea-formaldehyde and melamine-formaldehyde resins are of considerable importance.

B. Antioxidants

Many of the antioxidants and stabilizers are organo-metallic compounds which act as primary irritants to the skin. Some of the hydroquinone derivatives are of interest because of their interference with normal skin pigmentation and the consequent whitening of the skin.

C. Plasticizers

Plasticizers are added to increase the flexibility or decrease the brittleness of the material. A number of the plasticizers are skin sensitizers; still others may be important both as a cause of dermatitis and of systemic reaction. Perhaps the most important of the potential systemic reactors are the chlorinated diphenyls.

D. Solvents

However by far the greatest problem in the plastics industry is exposure to numerous solvents. These are for the most part alcohols, amides and amines, esters, ethers, furans, glycols and their derivatives, halogenated hydrocarbons, aliphatic and aromatic hydrocarbons, ketones, nitriles, nitrocarbons and sulfur derivatives. Of these the chlorinated hydrocarbons, the aromatic hydrocarbons, carbon disulfide and to a lesser extent the nitrocarbons are all well known systemic toxins, and the usual precautions should be taken to prevent excessive exposure. It is of interest that the chances of exposure are sometimes less inherent in the manufacture of these products than in the use of plastics in later fabricating processes, due to the enclosure and mechanization of operations in the manufacture of the basic materials. In other instances, in which such safeguards cannot be provided, greater opportunity for exposure is attendant on the manufacture of the crude product. A highlight review of this subject may be found in the paper by Cranch.[23]

IV. HEALTH CHALLENGES IN THE RUBBER INDUSTRY

The replacements of natural rubber by synthetic rubber has also created some new and challenging problems which have been fairly well worked out during the war but which may be new enough to many to warrant inclusion here. The most widely used synthetic rubber is Buna S, a copolymer of butadiene and styrene. Because of its resistance to petroleum products, there is also considerable demand for Buna N, a copolymer of butadiene and acrylonitrile.

Butadiene has little or no cumulative effect from repeated inhalation if the concentration is well below the explosive limit of 2.2%,[24] and it is only mildly narcotic in these concentrations. Styrene acts principally as an irritant of the lungs, mucous membranes and skin. Liver and kidney damage has been reported for excessive exposure. A maximum safe concentration of 200 p.p.m. has been advocated by Carpenter.[25] Acrylonitrile (vinyl cyanide) is an extremely toxic material—comparable to a molecular equivalent of cyanide[26] and in the new synthetic rubber plants great pains have been taken to prevent any harmful exposure to this substance.

The synthetic rubber industry has also presented new possibilities for exposure to solvents. Whereas gasoline and petroleum naphthas can be used to replace the more toxic solvents for use in the manufacture of natural rubber products, benzol and its homologues and chlorinated hydrocarbons are necessary to dissolve most of the synthetic rubber. Ethylene dichloride is perhaps the only satisfactory solvent for the thiocol type of rubber. Neoprene, Buna N, and butyl rubber require cyclic or chlorinated hydrocarbons for solution. Buna S latex, like natural rubber latex, can be dissolved in petroleum naphthas. Safeguards consist of the usual enclosure of processes, ventilation and personal protective devices.

V. HEALTH CHALLENGES TO THE INSECTICIDE INDUSTRY

Until recently the armamentarium of the insecticide industry has consisted mostly of calcium and lead arsenates, nicotine, rotenone, pyrethrum, dinitro products, fluosilicates, sulfur and copper compounds, and lime-sulfur mixtures. More recently has been added DDT (1-trichloro-2, 2-bis (p-chlorophenyl ethane), its close relative DDD or TDE (1, 1-dichloro-2, 2-bis (p-chlorophenyl ethane), the chlorinated benzenes, and hexaethyl tetraphosphate. Extensive usage of DDT by the Army [27] has shown that DDT is relatively non-toxic to humans and that absorption of the dry powder through the skin is negligible. On the basis of animal experiments and observations of human subjects, Cameron and Burgess[28] concluded that there was a wide margin of safety in the use of DDT as an insectcide. They stated that only gross carelessness would cause exposures great enough to produce toxic effects when spray concentrations were not maintained in excess of 0.5%. These investigators found that although absorption through the skin may result from exposure to preparations of DDT in fat solvents, absorption of the dry powder does not occur. Illness has however been reported both in this country and in England, and precautions should be taken to prevent excessive exposure, especially to preparations of DDT in solvent. Symptoms consist of pains in the extremities, irritability, fatigue, paresthesia, uneasiness. Indicanuria is an important laboratory finding.[29] (One death has been reported.)

Hexaethyl tetraphosphate is effective against a number of insects, red spiders, citrus mites, aphids and flies at dilutions of from 0.25% to less than .025%. Approximately 0.2 ml. per kg. is lethal to rats when applied to the skin and 0.005 ml. per kg. when administered orally, according to data provided by the manufacturer. This chemical is said to be readily hydrolyzed in water thus minimizing the likelihood of toxic reactions from eating fruit or vegetables co[illegible] ered with residual from spraying.

VI. HEALTH CHALLENGES IN WOR[K] REQUIRING HAND POLISHING O[F] METAL

In the airplane industry, where the ligh[t] metals are used extensively, a new problem developed which challenged doctors, engi[-] neers and safety personnel. Hand burring and polishing of castings with high spee[d] rotary tools was carried out on a larg[e] scale. Investigations in this country[30] have indicated that a somewhat different conditio[n] results from exposure to vibration pro[-] duced by these tools when the rates wer[e] in excess of 10,000 per minute as compare[d] to most of the previous industrial expo[-] sures in which the rates of vibration were below 4,000 per minute.

The solution of the problem was found i[n] the rather general applicability of wet san[d] tumbling, thus making at least partial elim[-] ination of the process possible. Investiga[-] tion of insulating materials to determin[e] those most effective in eliminating vibra[-] tion are under investigation so that when such tools are necessary they can be used safely. Other measures used in meeting thi[s] challenge were elimination of exposure to cold, pre-employment examinations and fre[-] quent follow-up examinations with removal from exposure to vibration of all subjects whose symptoms were not transient.

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Some Considerations in Design of Exhaust Systems

By W. C. L. HEMEON

Industrial Hygiene Foundation

Costs are intimately related to the success of a plant improvement program. Major, individual, cost savings may spell the difference between *rapid* accomplishment of a *broad* plant improvement program and *slow* accomplishment of a *narrow* one, especially in plants where the project costs strain the departmental or plant budget.

Economy in such matters as ventilating systems does not mean inadequate control. *It means superior engineering.*

It is relatively simple to design exhaust systems with extreme factors of safety, i.e., in which all possible and many impossible sources of contamination are included in the system, and at excessively large air-flow rates.

1. If the cost estimate based on such a design is so great that it is tabled by the management, then that is faulty engineering.

2. If such a system is constructed and results in such a high loss of heat in wintertime that the capacity of the existing boiler plant is exceeded—that is poor engineering.

3. If an excessive exhaust rate interferes with the normal functioning (or most advantageous functioning) of the process to which it is applied, that, too, is bad engineering.

The relatively undeveloped character of this branch of engineering, poses the problem of how exhaust systems and industrial ventilation systems generally, could be most effectively purchased.

1. A favored procedure consists in requesting competing equipment manufacturers not only to quote prices on a system but also to indicate the design of the system. This procedure is advantageous only if one can select bidders who have ha[d] extensive experience with the problem. Th[e] disadvantages are obvious where one o[r] more of those selected do not thoroughl[y] understand the problem. More importan[t] still, no two bidders will have the sam[e] ideas on an appropriate design. The cost quoted, therefore, will not be based on th[e] same end result. One, then, is in a quandar[y] as to whether to accept the lowest bi[d] which may result in an inadequate syste[m] or the highest bid which may be wastef[ul] and not successful.

2. A second common method especially i[n] larger companies is to assign the who[le] problem to a staff engineer. He may be [a] machine designer or a general plant eng[i-] neer. If he has had no experience in th[e] field, the results may be sad. It is t[oo] frequently assumed that any staff engine[er] should be equipped to handle such desig[n].

3. A third method is to assign the wh[ole] problem to a local installation contractor, procedure which is similar to the first o[ne] mentioned and subject to the same disa[d-] vantages.

The best answer to the question of h[ow] to purchase exhaust systems I have alrea[dy] implied. The system should be engineer[ed] and specifications produced therefrom.

Testing Safety Equipment

WEDNESDAY MORNING SESSION

October 9, 1946

Presiding: R. H. Ferguson, Mgr. of Safety, Republic Steel Corp.

Testing Respiratory Protective Devices[1]

By H. H. SCHRENK, Chief Chemist, and S. J. PEARCE, Chemist
Health Division, U. S. Bureau of Mines

One phase of the Bureau of Mines work in the field of health and safety is the approval testing of a wide variety of equipment and explosives. This includes such varied items as mine locomotives, and numerous other types of electrically operated mechanisms, flame safety lamps, and respiratory protective devices which are used widely in the mineral industries. The Bureau initiated its work on respiratory protective devices because of the need of such devices for protection against harmful atmospheres in the mineral industries.

Before any equipment can be tested for approval or permissibility under Bureau of Mines procedures, a schedule giving the conditions under which the equipment will be tested and the requirements to be met must be formulated and published.

In the preparation of a schedule for a respiratory protective device, available information on the field of use, application, and performance of the device in question is reviewed. This is supplemented by research work in the laboratory. From the information obtained, a tentative schedule is prepared, based on the following requirements:

1. The device must give adequate protection for a suitable period;
2. It must be reasonably comfortable and convenient to wear;
3. It must be constructed of durable and suitable materials.

[1] Presented by permission, Director, Bureau of Mines, U. S. Department of the Interior.

The tentative draft of the proposed approval schedule is usually sent to manufacturers, users, and others who have knowledge of the particular device for their comments, criticisms, and suggestions. A final draft for official publication is then prepared, taking into consideration the information obtained.

The schedule gives in detail the conditions under which the Bureau will accept a device for approval testing and the test conditions to which the device will be subjected and which it must pass in order to receive approval. The device is approved as a unit; the approval does not apply to individual parts. It is emphasized that the tests pertain chiefly to performance requirements and in general are not of the nature of specifications for constructing the device. Submittal of a device is voluntary on the part of the manufacturer.

Respiratory Protective Devices for Which Schedules Have Been Issued

Numerous types of respiratory protective devices have been developed for various fields of use. These devices may be classified as follows:

I. Contaminant-removing (air-purifying) respiratory protective devices.
   - A. Gas masks and chemical cartridge respirators.
   - B. Dispersoid respirators (dust, fume, and mist respirators).

II. Atmosphere-supplying respiratory protective devices.

A. Self-contained type (oxygen or air breathing apparatus).
B. Hose type (supplied-air respirators—hose masks, air-line respirators, and abrasive blasting helmets, hoods, and masks).

The following schedules for approval testing of all the major types of respiratory protective devices have been issued:

Schedule	Title
13C	Procedure for Establishing a List of Permissible Self-Contained Breathing Apparatus.
14E	Procedure for Testing Gas Masks for Permissibility.
19A	Procedure for Testing Supplied-Air Respirators for Permissibility.
21	Procedure for Testing Filter-Type Dust, Fume, and Mist Respirators for Permissibility.
23	Procedure for Testing Nonemergency Gas Respirators (Chemical Cartridge Respirators) for Permissibility.

Pretest Requirements

Before the Bureau will undertake the active investigation of any respiratory protective device, the applicant must file an application that contains: (1) A description and complete drawings of the device; (2) a statement that the device is completely developed and of the design and materials which the applicant believes suitable for a finished marketable product; (3) a statement that the device has been subjected to inspections and tests of the nature described in the schedule and that it has met these requirements when tested by the applicant or his testing agency; and (4) a statement describing the nature, adequacy, and continuity of control of the quality of the respiratory protective device. A reasonable fee is required for the tests.

The main purpose of the pretest requirements is to assure that the device is fully developed and that the manufacturer is equipped to test satisfactorily at all times the performance of his device.

Inspection and Performance Requirements

Before the start of the Bureau performance tests, the device is inspected carefully for conformance to good mechanical and physiological principles and for its comfort, safety, durability, ease of inspection, repair and disinfection, and general practicability.

The pretest inspection not only permits checking the device for general conformance to the schedule, but also affords an opportunity for making suggestions that would make the device more comfortable or more efficient. The manufacturer can then make changes in the device before the laboratory and man tests are conducted by the Bureau.

The main test requirements for the various types of respiratory protective devices except self-contained breathing apparatus are given in the following sections. For complete details, the pertinent schedule should be consulted.

Gas Masks

A gas mask is an air-purifying respiratory protective device consisting of a facepiece, flexible breathing tube, carrying harness, and canister which removes gaseous contaminants from the inspired air of the wearer by such processes as oxidation, chemical combination, or sorption. Its use is limited to atmospheres that contain sufficient oxygen to support life and not more than a total of 2 per cent by volume of all gases, except ammonia for which the limit is 3 per cent.

Main items to be considered in the approval testing of a gas mask are the efficiency, life, and chemical stability of the canister, gas tightness and protection afforded by the complete mask, and its resistance to the inhalation and exhalation of air.

Devices are subjected to both machine and man tests to evaluate performance under simulated conditions of use. In canister tests, air flows of 32 and 64 liters per minute are employed. A flow of 32 liters per minute represents the volume of air an average-size man breathes when doing a moderate amount of work and 64 liters per minute represents the volume of air he breathes when doing heavy work. A flow of 85 liters per minute is used in testing resistance to inhalation and exhalation; this high rate of flow is used because rate of flow during inhalation or exhalation is approximately twice the minute volume.

Machine Tests

Four types of machine tests are conducted: (1) High concentration-high rate of flow; (2) low concentration-low rate of flow; (3) chemical stability; and (4) resistance of canisters to air flow. The high concentration-high rate of flow tests measure the protection afforded the wearer in high concentrations of gases or vapors at high rates of breathing. The low concentration-low rate of flow tests determine primarily the chemical characteristics of the sorbents used in the canister. Such tests are made to determine the effect of dry and moist air on the activity of the sorbents, not only during the time they are worn but also during storage. These are made on apparatus constructed to allow the test atmosphere to enter the canisters continuously at predetermined concentrations and rates of flow, with accessory equipment for determining the initial leakage or breakpoint of the canister. Resistance to inhalation and exhalation are determined because of their importance in regard to fatigue and efficiency of the wearer.

High concentration-high rate of flow tests.—Canisters for protection against acid gases or organic vapors are tested by passing a 2 per cent concentration of the gas or vapor through the canister at a rate of 64 liters per minute. The effluent from the canister is tested continuously to determine the initial leakage or breakpoint. The time elapsing between the start of the test and the breakpoint is a measure of the protection afforded by a canister and must be a minimum of nine minutes. Canisters for protection against ammonia are tested in exactly the same way except that the concentration of gas is 3 per cent; the life requirement is the same. In testing the universal canister which provides protection against limited concentrations of all toxic gases, the procedure and concentration of gases is the same as for the other canisters; the concentration of carbon monoxide is 2 per cent. The life requirement is five minutes for all gases except carbon monoxide, which is 15 minutes. The life requirement for acid gases, organic vapors, and ammonia is decreased in the universal canister in order to have a canister of practical size. Otherwise, the amounts of chemicals needed for a longer life would necessitate an excessively large canister to protect against all types of gases. The universal gas mask also contains a filter which adds to the resistance. These are tested against specially prepared smokes.

Low concentration-low rate of flow tests.—Canisters for protection against acid gases or organic vapors are tested by passing a 0.5 per cent concentration of the gas or vapor through the canister at a rate of 32 liters per minute. The effluent from the canister is tested continuously to determine the initial leakage or breakpoint. The time elapsing between start of the test and breakpoint must be a minimum of 72 minutes. Canisters for protection against ammonia are tested in the same way, except that the concentration of the gas is 2 per cent and the life requirement 27 minutes. In testing the universal canister, the procedure and concentration of gases are the same as for other canisters, but the life requirement is 40 minutes for acid gases and organic vapors and 15 minutes for ammonia. Two tests are conducted with carbon monoxide. In one the canister is tested at room temperature against a concentration of 1 per cent; the minimum life requirement is 240 minutes. In the other the canister is cooled to 0° C., and a concentration of 0.5 per cent carbon monoxide is used; the minimum life requirement is 60 minutes. Carbon monoxide is oxidized to carbon dioxide by a catalyst, the activity of which is decreased with lowered temperatures. This test, therefore, determines activity of the catalyst under very unfavorable conditions.

Chemical stability tests of the sorbents in a canister, air at 25 per cent relative humidity is passed through the canister at a rate of 64 liters per minute for six hours. Air at 85 per cent relative humidity goes through additional canisters at the same rate and for the same period of time. Canisters are then tested by the procedure outlined in the low concentration-low rate of flow tests. These give information on the ability of the canister to function, even though the sorbent has lost or absorbed considerable moisture.

The life of a canister designed for protection against carbon monoxide is directly related to the ability of the drying agent or agents in the canister to protect the catalyst from contamination by water vapor. Absorption of water by the catalyst inhibits its ability to promote oxidation of carbon monoxide to carbon dioxide. The canister should contain enough drying agent to protect the catalyst adequately from water vapor during a two-hour period of use. Hence, air of 85 per cent relative humidity is passed through such canisters at a rate of 25 liters per minute for two hours. They are then tested to determine their ability to remove carbon monoxide from a two per cent carbon monoxide-air moisture at a rate of 64 liters per minute. A timer is used with the universal gas mask to indicate the end of the two-hour service period of protection against carbon monoxide.

Resistance to air flow of the canisters at 85 liters per minute is determined before and after the machine tests and man tests. The resistance of the canisters shall not exceed three inches of water (3.25 for universal type) at any time. The inhalation resistance of the complete device shall not exceed 3.5 inches of water (3.75 for universal type), and the exhalation resistance shall not exceed 1.25 inches of water.

Resistance to inhalation and exhalation must be kept as low as possible to prevent fatigue and reduced efficiency of the wearer. The lower exhalation resistance is allowed because resistance to exhalation is more fatiguing than resistance to inhalation, and practically, a low-exhalation resistance is much easier to attain than a low-inhalation resistance.

Man Tests

Facepiece tests of the gas mask are made to check its ability to fit a wide variety of faces. It is attaching it to an ammonia canister and several men of varying facial shapes and sizes wear the mask for a short period in a 1 per cent concentration of ammonia gas. No leakage of ammonia is permitted. Not only the fit of the facepiece but also the gas-tightness including the exhalation valve is checked.

The final criterion for judging a gas mask for approval is the protection afforded by the complete mask when worn by two men in the highest concentration of gas for which the approval is to be granted. Some of the gases, such as chlorine and ammonia, are so irritating to the skin in this concentration that men remain in the test atmosphere for only two minutes. They return to fresh air, attach the canister to a tube connected to the test chamber, and continue to wear the mask in fresh air while drawing the test atmosphere to the canister.

During this period they carry out a schedule of exercise and rest equivalent to a man doing a moderate amount of work, including such movements as walking, stationary, running, calisthenic arm movements, and pumping with a hand-operated tire pump. This schedule is repeated until leakage of the gas is detected by the test subjects.

All types of gas masks, except the universal mask, must give complete respiratory protection to the wearer for at least 30 minutes under these conditions. The universal type must give complete protection for 30 minutes against 2 per cent carbon monoxide, 25 minutes against 2 per cent carbon tetrachloride, 15 minutes against 2 per cent acid gases such as chlorine, phosgene, or sulfur dioxide, and 15 minutes against 3 per cent ammonia. In other words, all gas masks approved by the Bureau of Mines have been worn by Bureau personnel in the maximum concentration of gas for which approval is granted. The universal gas mask also is tested for the protection it affords against specially prepared smokes.

Chemical Cartridge Respirator

A chemical cartridge respirator, also called a nonemergency gas respirator, is an air-purifying device designed to remove small quantities of gases or vapors from the inspired air. The present Bureau schedule covers chemical cartridge respirators designed for protection against organic vapors only in atmospheres not immediately dangerous to life and containing not more than 0.1 per cent organic vapors by volume. Machine and man tests similar to those described for gas masks are performed on these devices.

A concentration of 0.1 per cent by volume of carbon tetrachloride is passed through the respirator at a rate of 32 liters per minute, and the minimum life requirement is 90 minutes. The same concentration is used at 64 liters per minute, and the minimum life requirement is 40 minutes.

In the chemical-stability test with low and high humidity, the same concentration is used at 32 liters per minute, and the minimum life requirement is 45 minutes. The inhalation resistance of the complete device at 85 liters per minute shall not exceed two inches of water at the end of the test, and the exhalation resistance shall not exceed one inch of water. The facepiece is tested for its ability to fit a wide variety of faces by having several men of varying facial shapes and sizes wear the complete respirator for a short period in a concentration of 0.01 per cent isoamyl acetate vapor. This vapor has a marked odor and permits detection of even a very small leak.

In the man test, the device is worn in 0.5 per cent carbon tetrachloride vapor and must give protection for 30 minutes. This high concentration was chosen to shorten the man test to a reasonable time. The use of this concentration under carefully controlled laboratory conditions by experienced personnel does not in any way alter the maximum concentration for which approval will be granted, namely, 0.1 per cent.

Dispersoid Respirators

A dispersoid respirator is an air-purifying respiratory protective device consisting of a half facepiece to which is attached one or more filter elements that remove dispersoids (dusts, fumes, or mists) from the inspired air of the wearer by physical trapping on the fibrous material of the filter. It offers no protection against gases or vapors or atmospheres deficient in oxygen.

The main items to be considered in approval testing are efficiency and capacity of the filter, facepiece fit, and resistance to inhalation and exhalation. Tests made on various types of respirators to determine their ability to remove the dispersoids efficiently for an adequate period before resistance to inhalation becomes excessive and the ability of the facepiece to fit a wide variety of facial shapes and sizes.

A controlled concentration of the test dispersoid is drawn through the respirator at a rate of 32 liters per minute. Any of the dispersoid that leaks through the filter is collected by means of an electric precipitator, and the amount is determined by weighing or by chemical analysis. The maximum allowable leakage is based on the safe or permissible limit for each test dispersoid; that is, the leakage shall not exceed the amount considered safe to breathe. For example, in testing a pneumoconiosis-producing or nuisance dust respirator, silica dust at a nominal concentration of 50 milligrams per cubic meter, representing a high dust concentration) is pulled through the respirator at a rate of 32 liters per minute for 90 minutes. The maximum leakage permitted is an average of 1 milligram per cubic meter of air. This value has been correlated with the accepted permissible limit for silica dust expressed as millions of particles per cubic foot for an eight-hour working day. In the second test a nominal dust concentration of 5 milligrams per cubic meter (representing a moderate dust concentration) is used, and the test is conducted until 10 cubic meters of air (volume breathed in an eight-hour working day) have been pulled through the respirator. The maximum leakage permitted is an average of 1 milligram per cubic meter of air.

These tests give information on the efficacy of the respirator against high and low concentrations of dust for short and long periods. The amount of dust pulled through the respirator in each case is approximately 150 milligrams; with a dust load of this magnitude the resistance at a flow of 85 liters per minute must not exceed two inches of water. The resistance for these devices is lower than for gas masks because they are used routinely and for long periods of time whereas gas masks are usually used for emergency purposes or for short periods. In the tests against lead a nominal concentration of 15 milligrams per cubic meter is used, and the maximum leakage permitted is 0.15 milligram per cubic meter, which is the maximum allowable limit for lead usually accepted for an eight-hour working day. Similar tests are conducted to check efficiency against chromic acid and silica mists and against fume produced by burning lead.

The facepiece of the respirator is tried on many persons having a wide variety of facial shapes and sizes. If it seems to fit the test subjects, it is tested further by blowing air containing a high concentration of coal dust toward the respirator when worn by three subjects representing lean, average, and full types of faces. If it fits properly, there is a sharp line of demarcation at the point of contact of the facepiece with the face. Any leakage around the edge of the facepiece is indicated by dust streaks and a deposit of dust in the nostrils.

Hose-Type Supplied-Air Respirators

These are atmosphere-supplying devices that provide the wearer with respirable air from a source outside the contaminated region. They include the devices commonly referred to as hose masks, air-line respirators, and abrasive blasting helmets and hoods.

Type A Supplied-Air Respirator (Hose Mask)

The Type A respirator consists of a tight-fitting full facepiece, breathing tube or tubes, harness, comparatively large diameter noncollapsible hose line, and a hand-operated blower. The devices are sturdily constructed as they are designed to be worn in atmospheres immediately dangerous to life and to afford protection against all types of atmospheric contaminants and atmospheres deficient in oxygen.

Hose.—The hose must not collapse or show permanent deformation when a force of 200 pounds is applied between two planes three inches wide on opposite sides of the hose. This test simulates a heavy man stepping on the hose. The hose and couplings must not show any separation or failure when tested with a pull of 250 pounds.

As this device is used in extremely dangerous atmospheres, it is essential that the hose be so constructed that it will not separate even under unusually adverse conditions. There must be no leakage when the hose and couplings are immersed in water and subjected to an internal air pressure of five pounds per square inch. As hose masks are used in cleaning gasoline tanks, the hose should not be readily permeable to gasoline. Hence, 25 feet of the hose and a coupling are immersed in liquid gasoline, and air is passed through the hose at the rate of eight liters per minute for six hours. The air emerging from the hose at the end of this period must not show more than 0.01 per cent of gasoline vapor by volume. The maximum length of hose that will be approved is 150 feet. No multiple system whereby more than one man is supplied by one blower will be approved unless each hose line is connected directly to a manifold at the blower. The diameter of the hose is usually one inch.

Blower—The hand-operated blower must deliver 50 liters of air per minute to the facepiece through the maximum length of hose at not more than 50 revolutions of the crank. The maximum flow of air through a complete assembly with 50 feet of hose shall not exceed 150 liters per minute, and the pressure at the hose connection to the blower or manifold shall not exceed five inches of water. The power required to turn the blower at the proper rate must not exceed 1/60 horsepower. The blower is operated at the above rate six to eight hours daily for 100 hours and must show no failure or indication of excessive wear of bearings or other working parts.

Harness.—The body harness is tested for strength of material by applying a pull of 250 pounds to the shoulder straps and 300 pounds to the belt and D-ring. The hose must be attached to the harness so that it will withstand a pull of 250 pounds without separating and so that the pull or drag of the hose behind an advancing wearer does not disarrange the harness or exert a pull on the facepiece.

Complete device.—Although the Type A hose mask is designed to require the presence of a blower operator, it must also be so constructed that the wearer can breathe respirable air through the blower, 150 feet of hose, and the facepiece, even though the blower is not operated. The resistance of the complete hose mask to an air flow of 85 liters per minute must not exceed two and one-half inches of water. In other words, even though the blower is not operated, the wearer could obtain air with less resistance than would be encountered in breathing at the same rate through an average gas mask.

A check valve, included in a connection to the facepiece or in a hose fitting near the facepiece, allows flow of air toward the respirator only and prevents rebreathing. The protection afforded by the complete mask against gases is determined by men wearing it in a 1 per cent ammonia-air mixture with the blower stationed in respirable air and with 75 per cent of the hose in the ammonia-air mixture. Each man spends 20 minutes in the ammonia atmosphere, 10 minutes with the blower operating and 10 minutes with blower not operating. The device must afford complete respiratory protection; that is, no odor of ammonia shall be detected by the wearer.

Type B Supplied-Air Respirator

This respirator is similar to the hose mask except that it has no blower, the length of the hose is limited to 75 feet, and the body harness is less rugged than that for the hose mask. It is not approved for use in immediately harmful atmospheres. Tests of the hose and facepiece are the same as for the Type A device. Harness tests, however, are less severe and are limited to a pull of 100 pounds. Inhalation resistance of the complete device at a flow of 85 liters per minute is limited to one and one-half inches of water because with this device the wearer must pull the air through the hose by means of his lungs alone. The exhalation resistance shall not exceed one inch of water. In the final test of the complete device it is worn in an atmosphere of 1 per cent ammonia for 10 minutes with the wearer and 75 per cent of the length of the hose in the chamber and with the intake in ammonia-free air.

Type C Supplied-Air Respirator (Air-Line Respirator)

A Type C supplied-air respirator (air-line respirator) usually consists of a high-pressure air-supply system, a hose of relatively small internal diameter, a detachable coupling, and either a full- or half-mask facepiece, or even a helmet or hood. As the air for this type of respirator usually is supplied from a high-pressure compressed-air system, it must be checked to see that it does not contain objectionable or harmful contaminants. Rust particles, oil mists, odors, and even carbon monoxide may be present if the compressor becomes too hot; therefore, careful attention should be given to the air supplied to these devices. The air supply is the responsibility of the user. Respirators are approved, however, only when used with respirable air and at pressures and quantities required.

Although this type can furnish respiratory protection against all types of contaminants, it is designed for routine protection against concentrations of contaminants that are not immediately dangerous to life or health. Its application is thus limited, owing to the possibility of leakage around the half-mask facepiece and also to the fact that no provision is made for the wearer to breathe respirable air should the air supply fail.

Laboratory tests on these devices are made mainly to obtain information on volume of air supplied to the facepiece, helmet, or hood when the length of the hose, setting of the air-regulating valve, and the air pressure applied to the inlet of the hose are

varied. From these data, the maximum and minimum length of hose and pressure permitted are specified. These values are set so that with the maximum length of hose and the minimum pressure the air flow is at least four cubic feet for tight-fitting facepieces and six cubic feet for loose-fitting respiratory-inlet coverings. With the minimum length of hose and the maximum pressure, the flow to the respiratory-inlet covering should not exceed 20 cubic feet per minute. The resistance to exhalation is measured at an air flow of 170 liters (six cubic feet) per minute and must not exceed one inch of water. The hose is tested for non-kinkability, strength of hose and couplings, tightness, and gasoline permeation.

Man tests of the respirators are made in an atmosphere containing 1 per cent ammonia to test the fit of the device. No leakage of ammonia shall be detected. This device is also worn for 30 minutes in an atmosphere containing 50 milligrams of silica dust per cubic meter, and air is sampled continuously at a rate of 32 liters per minute from the respiratory-inlet covering at a point near the wearer's nose. The amount of dust collected from the air withdrawn from the respiratory-inlet covering shall not exceed that collected from the air withdrawn simultaneously from the source of air supplied to the respirator by more than 0.5 milligram for the 30 minute test period.

Type CE Supplied-Air Respirator (Abrasive Blasting Respirator)

A Type CE supplied-air respirator, or abrasive blasting respirator, is essentially the same as the Type C device except that it has a suitable covering to protect the head and shoulders against impact and abrasion by rebounding material. Tests of this device are the same as for Type C, except that the Type CE device is worn for 30 minutes during sand blasting with dusty sand in a poorly ventilated chamber. The interior of a hemispherical kettle is blasted so that the stream of rebounding abrasive is directed at the wearer of the respirator. Sampling during this test is the same as for the Type C, as is leakage permitted. The head and neck of the wearer shall be protected against impact and abrasion from the rebounding material.

Summary

Approval of a respiratory protective device is granted by the Bureau of Mines only after it has met the Bureau's published minimum requirements which are chiefly of a performance nature. The significance of approval is dependent on the suitability and thoroughness of the tests that are applied. A knowledge of the approval requirements and the prescribed field and limitation of use of the device should enable the wearer to judge whether a device would afford satisfactory protection for a particular application.

Visual Aids

WEDNESDAY MORNING SESSION

October 9, 1946

Presiding: JOHN S. SHAW, Dir. of Safety, Hercules Powder Co., Inc.

How to Use Visual Aids

By HENRY B. DUFFUS
Safety Engineer, Westinghouse Electric Corp.

The use of visual aids in accident prevention programs is just about as old as the safety movement itself. All of us, in fact, have been influenced by visual aids ever since we were "knee high to a grasshopper." But there is a vast difference between the visual aids of the past and those of today. Science and engineering have utilized the electronic tube to give us audio-visual projection equipment, applied the photo-cell and neon tube to the display board, and color photography.

To evaluate visual aids properly, we must realize that approximately 80 per cent of human knowledge is acquired through the sense of sight. Therefore, the proper gearing of the several types of visual aids is highly important in any effective program.

Some of the more common types of visual aids are: posters, charts, display boards, demonstration units, tabloids, silent and sound movies, sound slidefilms, safetygraphs, and other mediums used to focus attention, create interest, and illustrate the principles of accident prevention.

Visual aids are equally effective in induction training, job instruction, discussion of specific hazards, and training in related subjects such as fire protection and first aid. They are of major importance in creating and maintaining interest.

There is a wealth of visual aids available for industrial safety. The job of the safety director or training supervisor is to select the correct type of aid for the specific need and to present it to the workers under favorable conditions at the psychological time.

Too many safety engineers have viev their failures on the premise that the pr entation was perfect but the audience fai to appreciate it.

The evolution of visual aids in industi safety started with a simple poster. Many you who have spent twenty or more ye in industry will remember the old post tacked on storeroom partitions. One of classics was a picture portraying a ha with parts of four fingers missing—blo dripping from the stumps. The capt read something like "This Could Hap to You." Rather gory, but it was not far out of step with the times. Rememl the blood and thunder storybooks, movie thriller serials, the Shakespeare dramas. They, too, were rather on the g side. We have come to recognize t "Safety First" era, with its negative po ers, as the "horror" stage in the evolut of safety methods.

Times have changed. The stereoty poster, with its negative approach, has evolved into a picture that portrays rewards for safe work, or a cartoon l those by Walt Ditzen. Many modern po ers are symphonies of color.

Visual aids can be divided roughly i two groups—advertising and educatio There is a certain amount of overlap, l for our discussion, we can hold to th two general classifications. The visual a in the first group—advertising—incl posters, display boards, demonstration un tabloids, and yard signs or bulletin boar

In the use of this type of visual aid, it those with handicaps or deficiencies, the problem involves a search for a job which the analysis has indicated he can do. For specialized problems of this sort an advisory placement committee, made up of the heads of various personnel and operating departments has been found very helpful.

The improvement of personnel placement procedures represents a challenge to industry, since the benefits accrue not only to production, efficiency, and lowered costs, but in the personal well being of employees and the satisfactions to management of a job well done.

"Swinging Into Step"

(Motion Picture)

The motion picture, "Swinging into Step," photographed by the U. S. Army at Percy Jones Hospital, was presented. It dealt with the rehabilitation of amputees.

TUESDAY AFTERNOON SESSION

October 8, 1946

Presiding: DR. DUDLEY IRWIN, Medical Dir., Aluminum Co. of America.

Hazards Involved in Using Heat in Processing Metal

By WARREN A. COOK
Director, Division of Industrial Hygiene and Engineering Research, Zurich Insurance Companies

In any consideration of heat-treating, the question of cyanide always is raised. It is generally recommended that cyanide pots be hooded and exhausted. However, many such pots have no such ventilation, yet cases of injury to health, either slight or serious, on cyanide exposure in heat-treating departments are rarities. There is the danger of getting cyanide into the mouth, and hydrocyanic acid gas will cause poisoning either on inhalation or absorption through the skin. However, the possibility of production of such gas, which does not result from simple heating and melting of the sodium cyanide, is greater in plating departments where acids are present than in heat-treating operations. The practice, widely enforced during the war, of keeping cyanide supplies under lock and key is to be recommended as an excellent one even in the heat-treat department.

In one cyanide treating operation where the worker removed the basket of metal parts from the cyanide pot and walked a few feet with them to a quenching bath, the exposure was in the order of one to two milligrams per cubic meter of air, appreciably less than the maximum allowable concentration of 20 milligrams per cubic meter, or 20 parts per million parts of air computed as hydrogen cyanide.

Cadmium is one of the best commonly used corrosion resistant coatings for metal. Plants in the automotive industry have been operating cadmium plating departments for many years without much apprehension over possibilities of cadmium poisoning, as such cases have been virtually non-existent in connection with these operations.

But what happens when heat processes are applied to cadmium plated metal? At one plant, neither management, supervision nor the operators were aware that cadmium fumes could have injurious action. Accordingly, when it was necessary to apply hand torches to tubing coated with cadmium to prepare it for flanging, the operation was set up and two men put to work on the job with no more thought for their protection than if the tubing had been black iron with no coating.

These men found the fumes much more irritating to their lungs than in usual torch cutting operations but stuck it out for four hours. They were replaced by two other men who also became ill on the job. A fifth worker 10 feet removed from the flanging crew was made ill by the general contamination of the room with cadmium fume.

Usually a simple irritant of the respiratory tract, such as lime dust, causes only a temporary inflammation and, after the initial discomfort, there is no further injury. This is not true of cadmium fume. The five workers exposed were made very ill. One worker was so affected that he became progressively worse, and, five days after his brief exposure, he succumbed to the action of the cadmium fume. A point to be kept in mind is that even though this worker was distressed by the cadmium fume exposure, he voluntarily continued to subject himself to it until its action had become severe enough to result in eventual death.

In view of the possibility that heat processes may be applied at any time to cadmium plated metal—oxy-acetylene cutting, welding by torch or electrically, brazing or soldering—supervisors and operators who may be in contact with such processes should be informed so that adequate precautions may be introduced before the operation starts. These precautions should be sufficient to avoid irritation and the worker should be told to report to his supervisor if any irritation occurs, without proceeding further with the job.

If an operation involving application of heat to cadmium coated metals is to be placed into production, or is to continue more than a few hours, atmospheric analyses should be made of the exposure of the worker to make sure that it is within the limit of a single milligram of cadmium per 10 cubic meters of air. This exceedingly small amount of material is appreciably less than that which causes irritation. However, prolonged exposure even to non-irritating amounts greater than the maximum allowable concentration may cause injury to organs of the body other than the lungs and are to be avoided.

Where metal is subjected to heat for annealing purposes, the surface must of

course be protected against oxidation. A number of non-oxidizing atmospheres are used for this purpose. It is to be kept in mind that an atmosphere which is non-oxidizing will not support life.

Cases of injury exclusive of burns and explosion but including both impaired health and actual fatalities have resulted from the carbon monoxide constituent of these non-oxidizing gases. Fatals have usually been the result of an accidental high exposure due to a broken pipe-line fitting or to operation of the gas producer itself. Headaches and other evidence of moderately excessive carbon monoxide exposure are a more frequent occurrence.

In annealing departments, where producer gas or other gas containing appreciable percentages of carbon monoxide is used and this gas is allowed to escape into the annealing room, which may have no mechanical exhaust ventilation, checks should be made on the carbon monoxide concentration breathed by the workers during various unit operations and under differing weather conditions. Even where electrically heated covers are used over piles of steel, there may be sufficient carbon monoxide escaping around sand seals at the base or during removal of the cover to exceed the accepted limits for carbon monoxide exposure.

Where annealing furnaces are gas or oil fired, the products of combustion may be used as the reducing atmosphere and frequently pass directly into the annealing room to escape through openings in the roof. This system works well during most atmospheric conditions on account of the elevated temperatures of these gases, but checks should be made on days favoring accumulation of gases to make sure that natural draft is in fact adequate. It may be found that efficiency and comfort of workers is impaired on sultry days.

Extension of flues through the roof may interfere with temperature control within the furnace, but installation of a vertical duct with a conical opening placed just above the short furnace flue will provide a positive exit for products of combustion and not disturb the conditions within the flue itself.

Another high carbon monoxide exposure in heat treating operations may occur when furnaces and ovens are started on a cole

Monday morning. The impingement of combustible gases against cold plate may interfere with the completeness of combustion and introduce more carbon monoxide into a room than normally is present. And it is on such mornings that doors and windows are kept tightly closed. The job of getting the equipment started may be conducted by one man and if he should become dizzy and fall, his injury might be aggravated if he were not spotted for an hour or so.

Another of the metals which may be the cause of injury to health in heat processes is lead. The more usual exposure to the metal is due not to treating metals containing lead but to the use of molten lead baths in the heat treat department. Such baths can be used without exhaust ventilation, even where the temperature is as high as twelve and thirteen hundred degrees Fahrenheit, without resulting in lead poisoning. Whether or not the amount of lead absorbed by the operator is excessive depends upon a number of factors. Since this is so, it is considered wise to install a partial hood enclosure on a slot opening around part of the periphery of the lead pot and provide mechanical ventilation through the exhaust duct.

The principal factors in causing excessive lead exposures in such operations are the extent to which the surface of the lead bath is disturbed by the metal parts being treated and the handling of lead dross.

The average exposure of the worker while at the pot or while carrying on operations incident to the lead bath treatment of the metal can be obtained by sampling the air at his breathing area and this should be done whether or not exhaust ventilation is provided. A further check should be made on the amount of lead absorbed by workers handling lead pots, namely, analysis of the urine for lead.

The worker's exposure at these pots varies widely during the day and from day to day. The exposure may be well within safe limits during normal handling of metal parts in and out of the bath, but when the operator skims the pot or brushes off the dross, he may inhale in a few minutes enough lead dust to raise his average exposure beyond safe levels. Since such operations may be conducted at times other than during air sampling, or as they may be conducted more carelessly, the great value of the urine analysis for lead is apparent as this tends to represent the average exposure throughout the day and the week. Too much dependence should not be placed upon a single spot determination, but if successive analyses show more than 200 micrograms of lead per liter of urine, investigation should immediately be made for the source of the excessive exposure. It is probable that careless handling of dross and failure to keep the dross in a covered container will be found to be the principal cause. If air samples show that exhaust ventilation should be installed or improved, a fume type respirator should be worn by the operator until this installation is completed.

As it is a comparatively simple matter to avoid excessive exposures at lead baths, the operation should be so carried on that respirators are not necessary. As the condition is hot, very little success will be met in enforcing use of respiratory protection, except where the worker is told that it is a temporary expedient and that exhaust ventilation is soon to be installed or where it is found necessary that the worker wear the respirator only while handling the dross. During such time a respirator approved by the U. S. Bureau of Mines for protection against toxic dusts may be recommended.

This operation should be conducted in such a manner that urinary lead excretion is kept generally under 100 micrograms of lead per liter of urine. A safety factor is thus provided in the event exposures should be temporarily increased between checks. Where excretions are maintained below this level, there is a high degree of certainty that symptoms of excessive lead absorption will not occur due to the occupational exposure.

Molten metal spraying is being used in an increasing number of plants for providing a surface of some other metal on steel or for building up the surface with the same metal. Although iron and iron oxide are not specifically injurious, it is considered desirable to provide exhaust ventilation even where the metallizing operation involves only steel wire. Such precaution is of increased necessity and must be more efficient where zinc or brass are sprayed in order to avoid metal fume fever,—in this case "zinc shakes." Although only a transitory condition with no lasting effects of more than a day or so, it is exceedingly discomforting.

Where the more injurious metals such as lead or cadmium are to be used in the metallizing process, a very thorough study should be given to means of protection of the operator and of those in the vicinity to avoid serious poisoning even where there is to be only very short duration of exposure, —that is, in terms of hours, not days. If a metallizing equipment is available in a plant, the foreman and operator should both be cautioned of dire results which might occur if some job, even a quick one, was slipped into the production set-up designed to give adequate protection only for some of the more innocuous metals.

High frequency heating is being utilized more extensively and the possibility of injury due to radiation has been questioned. It is the opinion of those best in position to be well informed that with frequencies at their present levels, insufficient radiation is produced to cause injury, but that this matter should be further investigated if we go to super-high frequencies which may be employed in the not too distant future. For a further discussion of potential hazards both in regard to radiation and thermal burns on using high frequency heating, reference is to be made to a paper devoted to this subject by Mr. A. T. Lattauzeo, Consulting and Application Electronics Engineer of the Westinghouse Electric Corporation, before the Electric Hazards Session of this National Safety Congress.

For this year's industrial requirements, we need not consider nuclear energy as a source of heat with its attendant radiation hazards. But it is to be kept in mind that chemists and metallurgists are constantly working for advances which involve the use of heat for metal processing. It can be definitely prognosticated that some of these will include health hazards with which we do not now have to contend. It would be most unfortunate if the first disclosure of the presence of a new health hazard in a plant should be through the development of a case of occupational disease or accidental poisoning. Many such new processes involve materials which the originators of them wish to keep secret. It is to be hoped that on introducing new processes into industry, the users will make as specific inquiry as possible into hazards involved and that both the originator of the process and the user of it will include any necessary precautionary measures and see to it that these are strictly observed.

Occupational Hazards in Metal Processing: Control of Air Movement

(Outline of Talk)

By W. N. WITHERIDGE
Ventilation Consultant, General Motors Corporation

1. Natural ventilation; seasonal problems; effect of natural ventilation on mechanical ventilating equipment.
2. General ventilation; dilution of air contaminants; considerations influencing the choice of general ventilation in preference to local exhaust systems.
3. Local ventilation; coordination with general ventilation; local exhaust compared with local dilution methods; advantages of local exhaust systems in the control of air contaminants; disadvantages of local exhaust systems from the view point of expense, maintenance, and production interference; systems offering a compromise between general and local ventilation.
4. Air supply to replace the air exhausted; seasonal implications; recirculation through competent air cleaning equipment.
5. Successive or progressive ventilation; use of air for several purposes in succession as a means of conserving power and reducing the total amount of equipment to be maintained or serviced.
6. Cross-ventilation; location of air inlets and outlets to avoid short-circuiting; planning building or structure to facilitate cross-ventilation; influence of

weather on-direction of natural and mechanical cross-ventilation.

7. Recontamination of air supply by improper location of air inlets in relation to points where contaminated air is discharged outdoors.

8. Fans, blowers, ejectors, and natural draft stacks; reverse flow through fans by improper exposure to winds; reverse flow through centrifugal fans by erroneous electrical connections; reverse flow through natural draft stacks in air-bound buildings; failure of ejectors improperly designed or located on high-resistance exhaust systems; wind-driven ventilators; temperature requirements on natural draft stacks.

9. Equipment maintenance; futility of good design that operates as intended only for a few months; necessity of visualizing air as a fluid that resents confinement, is difficult to predict, is eccentric and easily disturbed, and commonly ignores the layman's concept of gravitational and thermal forces controlling the flow of fluids.

10. Tests of natural and mechanical air movement can be deceptive; they rarely are precise; they must be done at several seasons to determine the influence of weather; if equipment is installed in summer, tests of its performance are not conclusive until winter arrives, or building conditions can be arranged to simulate winter operation.

WEDNESDAY AFTERNOON SESSION

October 9, 1946

Presiding: O. F. Lehman, Safety Eng., Chrysler Corp.

Fundamentals of Safety

Round Table Discussion

Principles of Accident Prevention

By B. D. KUNKLE
Vice President, General Motors Corporation

Although the problems encountered in promoting a safety program in a Corporation whose operations are decentralized such as those of General Motors are many and varied as compared to a centralized organization, the basic principles upon which the solution to these problems rest are fundamentally the same. It should be emphasized that the one most important factor which has made our program successful has been the wholehearted, active, energetic support of top management in establishing definite safety policies and procedures for the individual plants.

Most of the subjects with which we have to deal in our industrial operations are tangible things, such as buildings, equipment, materials, processing, schedules and other things which have to do with our industrial work. Most of these things are matters to which we can assign some physical measure. But, the all-important subject of safety, which concerns all of us vitally, is one of the intangible things. Unfortunately, the measure which we apply to safety is the measure of accidents. It is a measure based upon an after-the-fact record. But safety means safety of our friends and associates from avoidable injury to body and health.

So, in its real meaning, safety is something to which we cannot apply a measure. We provide safety devices and attempt to study the various phases of our operations and apply mechanical safeguards against human accidents and injury to health. However, the basic element of safety is mental, and not physical. I think we are all aware of the fact that 88% of industrial injuries are termed as unsafe acts. I am sure that if we can by our persistent efforts cause employes to think more definitely about present hazards that we will accomplish more than by any other process.

Those of us who are interested in and charged with the responsibility of developing and promoting safety programs need be aware of the necessity for keeping people constantly conscious of hazards which are always present.

One of the greatest ways of promoting safety is to generate an atmosphere of *safety at work.* Surround employes with the physical evidence of things being done to guard against hazards. The very fact you put a safety device on a punch press indicates to the operator that a hazard is present and the safety device, aside from restraining against dangerous movements, is a means of helping him recognize potential hazards.

Accidents stem from one of three causes:

First: A deliberate disregard for hazards in the face of ample warning.

Second: Failure to be alert to known hazards.

Third: Being completely unaware of the existence of a hazard.

The first of these calls for definite action if we are to check deliberate disregard for safety warnings of safety devices. These actions must be dealt with as positively as any other infraction of the rules of conduct.

The second cause is perhaps the place where the most good can be done. Signs and notices and other devices used in calling attention to safety regulations are only as effective as the individual makes them. The third cause is lack of knowledge of the existence of a hazard. The supervisor in charge should make sure the employe thoroughly understands the potential hazards before he is permitted to start working.

In General Motors plants, the principles which guide our safety activities rest upon this conviction, that as long as one of General Motors employes gets hurt or is affected by an occupational disease, our job is not done.

This attitude of General Motors towards safety can best be explained by a statement made by General Knudsen in 1934 when, as Executive Vice-president of General Motors, he said "Safeguarding our employes is the *most important task before us at all times.*"

In looking back over our safety experience, we find that our safety record is largely due to the balanced application of six general principles which we have recog-

nized for a long time. These principles were formalized by Mr. C. E. Wilson, president of General Motors. In 1925 he spent more than three weeks visiting various GM plants to compliment the supervisory organization and employes on the splendid job they had done in reducing accidents. He found the following principles to be in use in those plants that were having the best safety records. These principles are now considered in General Motors to be minimum standards for safe plant operation.

Principle No. 1 is interest in safety on the part of top management.

It is essential that the men who have the responsibility for the operation of the plant and the authority to change bad safety conditions should have a sympathetic attitude towards safety and recognize it as a management responsibility.

Therefore, it is recommended that the General Manager hold scheduled safety meetings once a month with certain members of his top supervisory staff. This group should include the following: factory manager, personnel director, superintendents, plant physician, plant engineer and safety director.

The functions of this group are:

First: To review the safety performance of the plant.

Second: To discuss prevailing safety problems and make decision for correction.

Third: To formulate safety policies for guarding equipment, education, etc.

Principle No. 2 is a definitely established safety organization throughout the supervisoty organization to reach each individual employe.

The general manager should meet with the top supervisory staff periodically to review the safety situation; discuss major safety problems and make decisions for correction; formulate safety policies for mechanical safeguarding of equipment; good housekeeping, education, etc. Superintendents should meet with their foremen at least once a month to explain the general safety policies of the division as approved by top management.

Foremen should talk to *two employes* daily regarding the safety policies and the safe practices necessary on their particular operation.

present. In a machine, it is possible to change pipes which have become clogged. In the human being it is impossible to replace the old arteries which have become narrowed. The so-called entity of coronary thrombosis or "heart clot" may occur while the blood is passing through an extremely narrow portion of one of the arteries of the heart and the further flow of blood through this area is halted. Such a condition has its own flag symbols that are typical of the condition, the most common one being pain in the chest, shortness of reath, and profuse perspiration. I mention this condition particularly because it is one of the frequent causes of death today in certain age groups. Furthermore, this condition is undoubtedly dependent on the manner in which the individual has lived during the past twenty or thirty years. Every drop of food and drink which passes his lips, undoubtedly plays a role in the production or absence of these conditions. Too much food or drink can be as harmful as too little food and drink. High pressure and nervous tension over periods of time, without relief play a major role in the production of coronary thrombosis. This is only one of the major conditions with which we have to deal.

Tuberculosis is becoming less frequent primarily because we are able to diagnose this disease in its early stages. More enlightened and intelligent living is wiping out many of the early cases. Undoubtedly the introduction of the small stereoscopic chest films will make it possible to x-ray greater numbers of people at a lower cost. The basic cost of a 14x17 chest x-ray which cost in the vicinity of one dollar has now been cut down to about 10 cents. Improvement in x-ray techniques, machines and equipment has decreased the incidence of poor x-rays and increased the percentage of diagnostic films. Only 20 per cent of early pulmonary tuberculosis has been diagnosed by physical examination and history alone, thus in 80 per cent of cases, the diagnosis is clinched by the use of the x-ray.

Cancer deaths are on the decline because the diagnosis is being made earlier and because the treatment, both surgical and x-ray, has been materially improved. The main point in the early diagnosis of cancer is the education of the public as a whole and not just those in the older age groups. The cancer problem is far from being under control. Undoubtedly, the splitting of the atom will play some major role in the eradication of cancer or at least certain forms of it. Every individual who for the first time is aware of a tumor, or sees bright fresh blood or who notices unusual symptoms which he has not previously had, should get in touch with his family doctor immediately for a complete examination. Early diagnosis in many instances means cure.

A great deal has been written about heat sickness. In heat cramps and heat exhaustion, the conditions are precipitated primarily by the loss of water and salt from the body which has not been replaced. If every individual followed the rules of common sense, moderation, proper rest, elimination, daily cooling baths, adequate diet and the prompt replacement of salt and water, there would be no such condition as heat sickness.

Syphilis is now better understood both as to diagnosis and treatment. The intensive campaign in Chicago during the past five years has brought to light thousands of unknown and untreated cases of syphilis. Many cases have been cured and others have been brought under control as far as the patient himself, and passing the disease on to others is concerned. Great strides have also been made in prenatal syphilis.

Pre-employment physical examinations bring to the attention of the employee conditions which he may not have known were present. Prompt care and treatment may prepare him for a better job or give the employer an indication as to the type of work he is qualified to do. The employee should be referred to his private physician for the care and treatment of all abnormal findings.

There are still certain processes in some industries which are known to be hazardous. These conditions can only be eliminated by first removing the cause and making all such processes non-hazardous. Secondly, if hazardous conditions are present, then it is imperative that the individuals who work in these environments be properly protected and instructed. They should have constant supervision and regular, periodic, physical examinations.

A regular check-up in any line of work is the safest kind of common sense, still I know of many individuals who would never go to see a doctor for a general check-up unless something was radically wrong. Yearly periodic physical examinations have brought to light minor ailments which may yield promptly to simple care and treatment. Let us stress that phyisical fitness is up to each individual.

For the sake of the future generations, it is up to all of us then to stress, more than ever, fitness—both mental and physical.

THURSDAY AFTERNOON SESSION

October 10, 1946

Presiding: EARL H. FYLER, Supt., Industrial Relations, Carnegie-Illinois Steel Corp.

"The Employee's New Job Is Our Job"

QUESTIONS AND ANSWERS
(Panel Discussion)

Moderator: J. L. RIDINGER, Safety Dir., Inland Steel Co., East Chicago, Ind.

Participants:

J. E. CULLINEY, Chief Safety Engr., Bethlehem Steel Co., Bethlehem, Pa.

DANIEL A. FARRELL, Supvr. of Safety, Industrial Relations Dept., Carnegie-Illinois Steel Corp., Pittsburgh.

R. H. FERGUSON, Mgr. of Safety, Republic Steel Corp., Cleveland.

FRANK KELSEY, Mgr. of Safety & Welfare, Jones & Laughlin Steel Corp., Pittsburgh.

G. O. GRIFFIN, Safety Dir., Dravo Corp., Pittsburgh.

H. G. HENSEL, Safety Dir., The Youngstown Sheet & Tube Co., Chicago.

FRANCIS R. HOLDEN, Head Industrial Hygienist, Industrial Hygiene Foundation of America, Inc., Pittsburgh.

DR. WILL F. LYON, Personnel Dept., International Harvester Co., Chicago.

J. F. COLLINS, Supvr. of Safety, The Youngstown Sheet & Tube Co., Youngstown, O.

C. M. ALLEN, Staff Supvr. of Safety, The American Rolling Mill Co., Middletown, O.

CHAIRMAN TYLER: Today's program is made up of two parts. First a demonstration by people from Carnegie Steel Corporation and second, a question and answer period.

Demonstration Participants: Supt. C. K. Turman, Director of Training, Gary Works; Foremen: J. L. MacKenzie, Director of Safety; J. L. Mason, Director of Training; and, B. Vergoinoff, Assistant Superintendent, Alloy Bar Mill, South Works; A. Z. Doubleday, Training Bureau Staff; J. Cremer, Assistant Director of Safety; N. E. Watkins, Director of Safety, Sheet & Tin Mill; H. S. Pyle, Director of Training, Sheet & Tin Mill; and H. C. Hague, Assistant to Division Superintendent, Maintenance, Sheet & Tin Mill, all of Gary Works.

This was followed by a film exhibit entitled "Safety Rule No. 1," with both acting and filming by the employees of the South Works.

As the last part of this section of the meeting, a demonstration was given of the development of a job breakdown sheet, with R. Rompf, Assistant Director of Training, Gary Works, shown instructing an employee in lathe operation.

MODERATOR RIDINGER: We will start out with this question: "What should a safety man or foreman look for when he inspects a department in any plant?"

I think I am going to ask Bob Ferguson to answer that question.

MR. FERGUSON: I believe that inspection of a plant or the inspection of a department to be the Number 1 essential. We don't take it for granted that when instructions are issued, those instructions are followed.

What should a foreman look for when he is in to inspect his department for safety? The Number 1 job is good housekeeping—that is, order and cleanliness. If a foreman can't maintain order and cleanliness he can't run his department. The next thing that he looks for is accidents, caused by tripping and falling. For they can be eliminated by proper and good housekeeping.

Proper apparel and proper eye protection, as the needs warrant, must be worn by the men. If certain fundamental safety rules are being followed, they tend to lessen the accident rate. When thorough inspections disclose errors, corrections should follow.

This is not a five-minute job, but is something that must be carried on from hour to hour in each shift and continue from week to week. It must be done continuously. Of course, the foreman has to know his men. He has to be able to follow up instructions he has issued and he has to be sure they are understood by the man that has to enforce them.

MODERATOR RIDINGER: "A new employee reporting and placed in work for the first time is injured enroute from the employment office to the department. What department and supervisor should be charged with the accident?" Campbell Allen, this is a little tough, so I will turn it over to you.

MR. ALLEN: A new employee reporting to his place of work for the first time is injured while enroute to the department where he has been assigned for work will have that injury charged to the employment department.

A new employee injured after completing the day's work and on return from his place of work to the clock house will have that injury charged to the supervisor he last reported to.

MODERATOR RIDINGER: We have one that has caused us a lot of trouble. The question is as follows:

"If men refuse to wear safety protecting equipment furnished them, what is the next move?"

MR. FARRELL: I think the man is insubordinate. In order to be fair, he should probably be taken into the assistant superintendent's or superintendent's office, if there is no general foreman available.

He should again be impressed with the importance of wearing protective equipment and that without using such equipment he cannot remain as an employee of the company.

MODERATOR RIDINGER: The next question: "If the department superintendent conducts monthly or semi-monthly safety meetings with the top supervisors, what method do you employ to pass on information of interest to sub-foremen and workers?"

MR. HENSEL: In our plants we try to pass safety information through weekly bulletins to foremen. The safety department stresses safe and unsafe practices in the plant. Secondly, through the medium of sound slidefilms, we reach many of these people either in safety meetings held by the foremen, or the superintendent and those directly interested in the program so that foremen are helped directly.

Then through a system of posters, both small and large—Jumbo posters—we reach many employees. In fact, we reach practically all of them as these posters are shown at the entrance to the plant.

In addtion we have what is known as a central safety committee, comprising assistant superintendents of all the plants. One of their duties is to hold weekly meetings of their foremen at which various items of safety information are passed on from the monthly meeting of the central safety committee.

The foremen are reached through many media. It is pretty hard for them not to pick up information we want them to have. In addition to that, of course, there are such things as rules and personal instructions for department heads.

MODERATOR RIDINGER: "Are vitamin tablets recommended for distribution to the employee, and if so, how are they distributed?"

DR. LYON: I suppose you get a different answer from every doctor to whom the question is thrown. The answer is "No."

MODERATOR RIDINGER: That is a direct answer. "How can the problem caused by a natural reluctance on the part of the production workers to stop their bonus work to perform repair work or do chores for accident prevention to be overcome?" Mr. Griffin.

MR. GRIFFIN: That depends upon the size of the plant or operation. If the operation is big enough, I believe that a central maintenance department or a certain defined maintenance man in each department should look after those problems.

If the operation isn't big enough, the foreman or superintendent has to devise some absolutely fair system of rotation so that no man will lose more than his share of the bonus work.

MODERATOR RIDINGER: "What is your personal opinion as to the awarding of prizes to individuals for safety records?"

MR. KELSEY: We have felt that perhaps the awarding of individual prizes to the group in any particular department or sections was the answer. For instance, we say this: If a certain section or department will work 300,000 hours, or 500,000 hours, or 750,000 hours or 1,000,000 man-hours without a lost time case, then we will make an award of a pin, a pen and pencil set or a watch fob or something of that nature.

MODERATOR RIDINGER: "What is the significance of particle slides in an appraisal of dust exposure?"

MR. HOLDEN: If you are appraising the exposure to dust you must know these things: The amount of dust in the air, usually done by dust count; the composition of the dust; and, thirdly, you must know the length of time to which men are exposed to the dust.

It seems perfectly obvious that if you threw chunks of material into the air, they would settle very rapidly. But by sampling, the presence of very high concentrations of contaminating material could be disclosed. This, however, would have no relation whatsoever to its effect upon the man simply because it couldn't get by his defenses and up the bronchial tree. It all boils down to how much material is in the air, in such condition that it can get into the lungs where it can cause damage.

Hatch has coined an epigram that focuses attention on that particular point. He said that "silicosis does not arrive from dust in the air. It comes from the dust in the lungs. "Therefore it is most important that you can sort out that portion of air-borne dust which can get down into the lungs and thereby cause damage.

MODERATOR RIDINGER: "Do you have or have you organized an off-the-job safety program in individual plants and does it tie in with any community or home safety activity? Mr. Culliney.

MR. CULLINEY: We do have such a plan, but it is not enforced in all our plants. It does, of course, tie in with your community activities. The main obstacle in any kind of study of this kind is the lack of proper records.

For one thing, we have in our company a relief plan whereby we are able to keep track of the man who loses time from other causes than accidents. That is one of the first things, and the thing that has done more good than aything else. We distribute a number of National Safety Council circulars. We try to get one of our plants to give out one of these circulars weekly for six weeks. Then we watch our off-the-job accident curve.

We were very much pleased as well as surprised to find that our off-the-pjob accidents dropped a third the first week and continued down over the next couple of weeks until our off-the-job accidents are down to just about one-third of what they usually run.

MODERATOR RIDINGER: Our next question: "What steps should top management take to better the safety record when it is found that the safety experience is going in reverse through no fault of the safety program?" Joe Collins.

MR. COLLINS: They want to fire the safety man, but I believe he usually knows what he is doing or he wouldn't be there.

Sometimes it is the fault of management if the program isn't going right or if it is going in reverse. It takes more than lip service on the part of management to make the safety program work efficiently.

Most people are looking for new ideas and new ways of doing the job.

cate the same hazard is most desirable in order to gain greater understanding through standardization."

You may have noticed that I used the term "practical hazard" rather than the term "toxicity," as the information necessary in writing the proper label. I should explain that the term "practical hazard" implies a great deal more than does the term "toxicity." Unfortunately there is no simple mathematical term for the practical hazard. It is a general summation of the toxicity, physical properties, and conditions of handling which result in a conclusion which can be used in actual practice. The relative practical hazard of two different products may well be quite different than the relative toxicity of the two materials.

You can get a notion of the method of using the schedule 3 in Manual L-1 if you will compare the information on this schedule with the two labels which have been furnished you. On the hydrofluoric acid label you will note the choice of a signal word, "DANGER!", from Column A, as the hazard is quite great in this substance. The statement of the hazard is chosen from Column B and placed next in order. The statements for precautionary measures are chosen from Column C and placed below the statement of hazard. On many labels there are reasons for having statements concerning the handling of containers. In this case, the statement "For Drum Handling and Storage" is an important part of the label. Instructions in case of accident are chosen from Column D and placed at the bottom of the label.

In the case of ethylene dibromide we have a very different material. The problem is not as acutely serious as with hydrofluoric acid and the signal word chosen is "Warning." The major hazard in this case is "Harmful Vapor" rather than the corrosive action as in HF. The label follows closely the phraseology of Schedule 3.

I believe we have, with this work of the M.C.A., a good practical basis upon which to write satisfactory precautionary labels. The uniformity to be attained by using this common basis for precautionary labeling is a great advantage. Most of the chemical companies are adopting this type of label on their chemical products. It is hoped that they will receive widespread use. Every product which has a potentially significant practical hazard should have a precautionary label. Very little will be gained, however, unless the workmen read and follow the precautions which are on the label. You can make a very significant contribution to the safe handling of chemicals by an educational program within your area of influence to get the workmen to read and follow the precautions which we already have on the labels.

Practical Problems in the Development of New Safety Clothing for Chemical and Other Industries

By ROY. G. BENSON
Benson and Associates

Four years ago it was my privilege to address the Petroleum Section of the National Safety Congress to outline a proposed safety program for use in more than 25 aviation gasoline plants which were then being built. A careful study had been made of the hazardous materials which were to be handled in these plants and protective clothing selected which we believed would cover every situation.

Theoretically, the plan sounded swell, and there were no questions from the audience which would lead us to believe that any of our ideas were impractical. Operations were charted and safety clothing for each classification of hazard was specified. Protective clothing was so important to these operations that safety equipment storerooms with attendants on every shift were required to keep the ball rolling. There were problems of neutralizing, washing, drying, disinfecting, and what we thought at the time the simple chore of getting the men to wear the protection provided. All the chemical and mechanical operations of caring for the garments were easy and where one plant might work out a very effective method of neutralizing and washing, another engineer at another location might design just the dryer we needed for quickly making the clothing ready for reuse.

The men and their affection for our selection of their protective working wardrobe was another question. They did not hesitate to tell us in their characteristic independent and democratic American workman way that our choice of body protection for a certain job stank, for a very obvious reason. It might have been a job which required some climbing and our classification of clothing for that job limited their movement. Perhaps, it was face protection which fogged up so quickly that efficient performance of duty was impaired. At every plant we learned to listen and from the criticisms we obtained an indication as to ideas which were just no good and those which could be modified to work more effectually.

I do not intend to condemn the clothing we had to use. Much of it was made under wartime restrictions and was not up to normal peacetime quality. When the urgency of our protective need was recognized as a possible hindrance to the flow of vital war materials, we could obtain just what we needed in the way of fabrics and special items to carry out our modified program.

To best illustrate our original plan versus what we found was practical and acceptable to the safety program, let us take one part of the body, the head and face, and study the problems involved in providing protection in the simplest operation. In this case, we had very concentrated acid and hydrocarbon plant outdoors.

The original plan called for full face shield and head protection at all times in the restricted area. The face shield was to prevent any chance of splash of hazardous material into the eyes, mouth, ears, or nose, and a rain hat to prevent any chance acid material from falling onto the top of the head. The rain hat and the face shield could not be used in combination because the brim of the hat interfered with the raising and lowering of the window. We had head covering of the style of a baseball cap made of impervious material and worn backwards. The bill protected the back of the neck. This, however, left a gap between the cap and shield and a chance for material dropping from overhead to fall into this gap and perhaps into the eyes.

I next visited a plant where the men had found that by fastening a long face shield to a hard hat, they could get good neck and ear protection and if the face shield hinge was carefully rivetted to the hat, there would be no aperture over the eyes. The hard hats were too heavy to wear for just acid splash exposure and were constantly being knocked off when their brims would catch on projecting valves, structural members, or when men would have to climb up ladders with cages around them.

Looking for an idea which would have all the features of this combination, we found that there were available a number of rejected army helmet liners. These plastic liners were of the same design as the regular army helmet and as a result of the government's careful study on this problem gave maximum head protection with complete freedom for movement of the head.

In addition, these helmets were provided with a chin strap which we found was very necessary because men in the Gulf coast area had had head protection blown right off by the Gulf winds. Down in that country, wearing a full length face shield made a man feel like a full rigged ship. If you don't think wind can be a factor in safety protection, I might cite one instance when the wind blew a gantry crane down the track and pitched it over a control room.

We thought we were in pretty good shape until we started receiving complaints about men not wearing their face shields in place. Observation made us realize that on plant operation it was necessary to discuss instrument readings, pump performance, and many of the other details which are necessary in the running of a plant. Men could not hear each other with the face shields in place. They had to raise the shield to converse. This happened so often that in a very short while face shields were a farce.

Safety and operation were not meshing properly and unless some new measures were taken, the safety program would lose face. The records showed that in normal operation, there was little danger of chemical splash but eye protection was still important. The helmets would be worn religiously because overhead danger over which the wearer had no control might occur. Goggles, we were certain, would receive the same treatment the moveable shield had received, so we passed that natural step. We designed a helmet which was rigidly affixed to an eyepiece, with enough clearance so that the headpiece could be easily removed and our problem was solved. The men liked and wore the helmets, and when they did they were forced to wear the eye protection. They could converse and carry on their work without hindrance and, most important, could chew tobacco and spit without it ricocheting in their face.

Kicking this idea around made me realize that with careful analysis of the problem involved, we could go over most of our personal protective equipment, discover its inadequacies and see what could be done for its improvement.

Chemical injuries are either cumulative or acute. We have volumes of information, all sorts of tests, and many fine instruments for checking on the probabilities and possibilities of workmen receiving chemical injury from hazardous materials over prolonged periods of time. There are, I know, some materials on which it is difficult to obtain information on the physiological response of individuals. Cumulative injury is not what I am concerned with in my present discussion. Acute injury, which cannot be forewarned by blood, urine, or atmosphere tests is the problem at hand.

How and in what kind of safety equipment can we clothe our workmen so they will continue to wear it during the entire performance when we believe such protection is necessary? We all know the many objections we receive to various pieces of equipment. Can we intelligently use these objections to develop equipment which will be more readily acceptable and in the same process provide protection that will do a better job. That is the task I am attempting to perform.

We try to take advantage of many factors in the design of new equipment to make it have more utility, be more serviceable, easier to look at, and wear, and consequently make the task of selling the idea of protection to men less difficult. To clothe yourself in an impervious garment to prevent contact with a not too apparent hazard is like trying to swallow stale beer to most workmen. They will play ball when the safety man is looking, but as soon as he is gone they take fate by the hand and shed the odorous clothing. When I say odorous about impervious protection, I mean odorous in its strongest scents.

I wish I could come before you and say that I could show you a fabric which was impervious to acids, caustics, and other harmful materials, but was still porous to the air, but if it exists, I have not seen it, or it has not been fully tested. Very recently, I was given a material which was supposed to have some of these qualities but data were not available for this meeting. I know that the army impregnated fabrics to neutralize the effects of mustard gas so this idea is not an impossibility.

If we cannot have this ideal fabric, we must make the best of the materials that are available.

Let me start with the effect of color in clothing on workmen. If you don't think men are color conscious, look around the room at the neckties worn by our fellow conventioneers. Even when wearing protective equipment, men are well aware of their appearance. For many years we were forced to accept black rain garments as protective equipment because that was all that was produced. The rubber mills had so much lamp black around their mills and rolls that to make any other color required so much careful operation that the price would have been prohibitive.

Today this situation is changed and rain garments are as varied in hue as the rainbow. This makes almost any color we would like to use available to us. The importance of color in protective clothing was forcibly brought to our attention when I had the opportunity, a few years ago, to introduce two identical acid hoods to workmen in a number of plants in several states. One hood was made of black impregnated fabric and the other was of clear plastic. The two air-supplied hoods were almost identical in their working parts, and the black hood, being smaller, was probably a little easier to put on and wear. Without fail the men would completely ignore the black one, exclaim about the virtues of the light colored hood, and insist that management purchase that item for their use.

Any of us who were close to shipyards during the war can recall workers wearing their aluminum hard hats uptown, doing their shopping or pushing the baby buggy through the crowded streets. If you had tried to sell these men on a dark insulated hat with careful explanations of conductivity and dielectric strength, you would have probably gotten just a clammy stare. I heard that at some yards where silver hats were not available, the boys were giving ten bucks and their dark hard hats for one of the more glamorous jobs.

One manufacturer had available a few years ago some very durable silver fabric. He introduced a number of garments but very shortly realized that the fabric was such that perforations made by stitching tended to weaken seams at the shoulders and other stress points. He pointed out this fact to the few individuals who had purchased this clothing and recommended that although he could manufacture sleeves and other smaller protective pieces satisfactorily he did not recommend using the fabric for coats and pants. By this time, the men had worn the suits and were so insistent that the silver color made them cooler to wear that he was forced to continue to manufacture and supply these plants. These were men working in a refinery and their argument or conclusion was, all the tanks and vessels were painted with aluminum paint for its insulating value, why shouldn't they be treated as well. Correct color can make a big difference in willingness to wear.

Let me cite another reason for incorporating lighter, more pleasing colors into protective wear. The Ethyl Corporation in their very careful safety program to prevent lead intoxication insists that all men blending tetra-ethyl lead fluid with gasoline wear white coveralls. The fluid is dyed and the workman is immediately aware of any contact he might have had with this toxic material by examining his clothing after he has completed his work. By the colored smudge on his clothing he knows which area of his skin he should give extra cleansing.

The Ethyl Corporation inspectors check this clothing on their visits and pity the superintendent in whose plant is found coveralls, unless they are being used at the time, that are not sparkling white. This clothing idea combined with many other measures has enabled the Ethyl Corporation to set up a safety record in plants which only receive periodic visits by other representatives which is enviable.

Let us learn a little from this fine example. If it has been found good practice to know when men come in contact with hazardous materials in one type of operation, certainly it would be equally wise to adopt this idea for other jobs. Many of our operations do not lend themselves to the simple protection of coveralls. Impervious materials are necessary to offset the corrosive effects of acids, caustics, and other harmful chemicals in the skin.

The problem of neutralizing, cleaning and putting the clothing back into service are often the duty of an individual who knows very little about the hazardous materials involved. If the garment is dark in color or black, it is difficult to see when a thorough cleaning job has been done. If made of light colored fabric he and the safety department that inspects the clothing is certain when the protective piece is ready for reuse. Of course, there are many materials which are light colored or clear and no alarming discoloration is possible, but I do not believe this is important enough to overcome the preference workmen have shown for more pleasing appearing garments.

The weight of the protective equipment is another factor which produces a big objection from workmen. I can recall when acid gloves made of natural rubber were so large and cumbersome that you felt like you had a catcher's glove on each hand when you tried to work in them. Synthetic rubbers, because of their resistance to chemical corrosion, have made it possible to considerably lighten the weights of protective gloves until now we have chemical hand protection which does not interfere with even laboratory manipulations.

In garments, we felt it was necessary to combine heavy coatings and fabrics to insure absolute impermeability to hazardous materials. I was guilty of securing samples of coated fabric and exposing it to corrosive chemicals over a long period of time to determine the relative effectiveness. Of course, on such severe tests only the heaviest impregnations could survive. It was only after years of listening to objections of men who had to wear the clothes that I realized that although the heavy clothing could stand the exposure, men could not work or even live in such exposures as I had used in my tests.

The foolishness of this severe destructive testing of protective fabrics was clearly pointed out to me when one of my friends was splashed in the face with an acid strong enough to swell his head to twice its normal size within about two hours. His plain white shirt, hastily removed after the accident, was enough protection to prevent any burn below the neckline. Of course, if he had continued to wear it, it would have been quickly penetrated and he would have had more extensive burns, but it stopped the acid. The shirt wasn't much good for later wear, but the close weave had been enough to prevent further attack at the time. This made me realize that it was infinitely more important to provide lightweight fabrics which men would accept and wear, than to use burdensome materials which might resist a hose stream of concentrated sulfuric acid for hours but would make such cumbersome clothing that men would be fatigued just looking at them.

What if a single onslaught of acid destroys the protective clothing, but the clothing performs the duty for which it was intended—protecting a man against a probable injury to his eyes, his lungs or his skin. The equipment has done its job as well as a pair of hardened lens safety goggles which shattered under the impact of a steel sliver. Because these lenses were manufactured and sold to meet certain specifications which we consider today as ample we would not condemn the lenses if they were shattered within a few minutes after the workman put them on.

We have learned in the matter of hard hats, safety goggles, and safety shoes that to avert an accident through the loss of a piece of safety equipment is an economical procedure. In fact, we are so proud that when this happens we display the ruined piece of equipment as a part of our safety propaganda campaign. If, however, the same should occur to clothing which cannot be made to specification we often condemn the piece for future use. I wish we could make rigid standard tests for garments, but we cannot at present, and I believe the reason is obvious.

A works with concentrated sulfuric acid and exposure only occurs in an emergency. *B* works with sulfuric acid but it is only a 20 per cent solution and the man often comes in contact with the material; how are we going to set up a standard which will cover both situations. This is only a single hazardous material and there may be hundreds of variations on exposure and concentrations in many other different plants. Add to this the many hazardous materials we handle and we realize that setting up a standard test would be difficult—almost an impossibility.

When I accepted this engagement, I believed that I could accumulate data on all the important impregnating, coating, and sheeting materials from which protective equipment is now being made, and make up charts showing comparative data on corrosion, tensile strength, burning rate, and other important qualities. I wrote to the leading manufacturers and I received a wealth of information but it was impossible to line it up side by side and say one material should be used for one specific purpose and another would fail under the same conditions. Take the case of neoprene alone, there are close to a thousand different ways this material may be compounded to withstand corrosive action, weathering, flame, mildew, or any other desirable qualities you might wish incorporated. The plastic situation is, if anything, even more complex because many of the newer compounds have not been fully tested in industry.

Asbestos cloth is an old standby that we have used for years for much of our hot work. Gloves made of this material in the past had a comparatively short life because the fiber was short and soon disintegrated. This was expected and we replaced the short life gloves by the thousands. The weave was coarse and even if the gloves were much too heavy for the job, you had to accept them as that was all that was available. Protection in the way of leather or coating materials added life. Now finer weaves are being produced and glass, cotton, linen, nylon, and other threads are being interwoven with the asbestos fiber threads to give greater strength. Coating materials can be calendered right into this lighter, stronger fabric to give additional life. Asbestos cloth has now become so durable that ironing board covers made of these new lighter weaves are being manufactured.

Glass cloth is now being produced at a price which makes it competitive with asbestos for many applications. This inert material with its high tensile strength will find many uses where asbestos was used in the past. It lends itself to coatings of various kinds even better than asbestos because of its smooth, even texture.

A few years ago, the research director of one of our large rubber laboratories told me that never again would natural rubber be as important as it had been before the war. I could not dispute his word, but I wondered if he might not, in the face of the tremendous synthetic rubber program being launched, have waxed a little too enthusiastic. Now I know he was right. I doubt very much if there is a piece of protective wearing apparel now being produced made of pure natural rubber. The rubber companies who were forced and reluctantly accepted the challenge to work with synthetic materials have made such strides that they now admit they can produce many products better with these new compounds than when natural rubber was the primary raw material.

With the war-developed synthetic materials now available, greater safety and more colorful clothing and other appealing types of safety equipment are now possible. Many new and attractive items are now appearing on the market. Equipment and materials must be chosen to adequately accomplish their purpose, and at the same time must be sufficiently comfortable and colorful to have wearer appeal. Weight and porosity of clothing to shield the body from harmful materials, either chemical or mechanical, will probably continue to plague the designer of safety clothing.

It is difficult in many instances either to eliminate weight or provide porosity and continue to maintain the proper safety factors necessary, but new designs will undoubtedly be forthcoming which will minimize greatly the discomfort of the equipment as well as the wearer's objections to it. This is especially true when proper methods of education concerning the life and health saving factors of the equipment are an integral part of industry's safety programs.

same piece is being done. Wherever it is possible a round head should be used.

The safety engineer needs to be thoroughly familiar with these code provisions and should continually check the wood working machinery in his plant to see that its guarding conforms at least to these minimum standards.

Safety Exposition Exhibitors

EXHIBITION HALL—STEVENS HOTEL

Alphabetical List of Exhibitors of Industrial Safety Equipment

Acme Protection Equipment Co., Chicago, Ill.
Gas Masks.

All American Safety Equipment Co., Chicago, Ill.
Power and Kick Press Guards.

American Abrasive Metals Co., Irvington, N. J.
Safety Treads, Abrasive Paints.

American Allsafe Co., Inc., Buffalo, N. Y.
Industrial Safety and Fire Protection Equipment.

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

American Mat Corp., Toledo, O.
Safety Mattings.

American Optical Co., Southbridge, Mass.
Industrial Safety Goggles, Respiratory Devices and Protective Clothing.

Ampco Metal, Inc., Milwaukee, Wis.
Beryllium-Copper Non-Sparking Safety Tools.

Ansul Chemical Co., Marinette, Wis.
Fire Protection Equipment.

Automatic Canteen Co. of America, Chicago, Ill.
Supplementary Automatic Feeding Units.

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

Bear Manufacturing Co., Rock Island, Ill.
Motor Vehicle Inspection and Correction Equipment; Static and Dynamic Balancing Machines.

Bradley Washfountain Co., Milwaukee, Wis.
Group Washfountains and Multi-Stall Showers.

John H. Breck, Inc., Springfield, Mass.
Protective Creams and Hand Cleaners.

Brusan Products Co., Milwaukee, Wis.
First Aid Cabinets and Industrial Medical Supplies.

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

Cardox Corporation, Chicago, Ill.
Fire Extinguishing Systems, Fire Trucks and Mobile Extinguishing Equipment.

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

Columbus-McKinnon Chain Corp., Tonawanda, N. Y.
Chains and Chain Hoists.

C-O-Two Fire Equipment Co., Newark, N. J.
Carbon Dioxide Fire Extinguishers, Hose Units, Manual-Automatic Systems, Smoke Detecting Systems.

M. E. Cunningham Co., Pittsburgh, Pa.
Safety Marking Tools.

Davis Emergency Equipment Co., Inc., Newark, N. J.
Respiratory Protection, Combustible Gas Indicators, General Safety and First Aid Equipment.
Dilley Manufacturing Co., Cleveland, O.
Magnetic Grip-Shields and Transparent Machine Guarding.
Diversey Corporation, Chicago, Ill.
Oil and Grease Absorbents, Cleaning Compounds, Hand Cleaners.
Dockson Corporation, Detroit, Mich.
Industrial Head and Eye Protection.
C. B. Dolge Co., Westport, Conn.
Fungicides, Protective Creams, Skin Cleaner, Cutting Oil Germacides.
Dunn Products, Chicago, Ill.
Industrial Protective Clothing Made from Rubber, Asbestos Cloth and Leather.
Duo-Safety Ladder Corp., Oshkosh, Wis.
Safety and Fire Ladders, Ladder Shoes.

E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Protective Creams, Neoprene Products, Fire Retardants, Safety Color Code.
E. & J. Manufacturing Co., Philadelphia, Pa.
Resuscitator Inhalator and Aspirator.
Elliott Service Co., New York, N. Y.
Safety and Work Improvement Displays, Supervisory Training, Suggestion Systems.
J. H. Emerson Co., Cambridge, Mass.
Respiration and Rsuscitation Equipment.
Employers Mutual Liability Insurance Co., Wausau, Wis.
Workmen's Compensation, Public Liability, Automobile, Group Accident, Health and Other Casualty Insurance.

Finnell System, Inc., Elkhart, Ind.
Floor Care Machines and Floor Treatments.
General Detroit Corp., Detroit, Mich.
Fire Protection Equipment.
Gro-Cord Rubber Co., Lima, O.
Non-Slip Soles and Heels.

Hild Floor Machine Co., Chicago, Ill.
Floor Cleaning and Maintenance Equipment.
H-M Folding Stretcher Co., Medford, Ore.
First Aid Stretchers.
Holcomb Safety Garment Co., Chicago, Ill.
Protective Clothing Made of Asbestos, Leather and Fire-Proofed Duck.
Huntington Laboratories, Inc., Huntington, Ind.
Floor Maintenance Materials and Industrial Germicides.
Hynson, Westcott & Dunning, Inc., Baltimore, Md.
Mercurochrome, Thantis, Pharmaceutical Specialties and Sterile Ampule Products.

Industrial Gloves Co., Danville, Ill.
Protective Clothing, Gloves, Mittens, Handguards, Leggings, Flame-Proofed Suits.
Insto-Gas Corp., Detroit, Mich.
Torches and Furnaces.
International Shoe Co., St. Louis, Mo.
Safety Shoes.
Iron Age Div., H. Childs & Co., Inc., Pittsburgh, Pa.
Safety Shoes.

Jackson Products, Detroit, Mich.
Insulated Electrode Holders, Cable Connectors, Face Shields and Goggles.
Junkin Safety Appliance Co., Inc., Louisville, Ky.
Interlocking Barrier Gate and Swinging Die Closure Guards.
Justrite Manufacturing Co., Chicago, Ill.
Safety Cans, Safety Flashlights, Electric Lanterns.

Karel First Aid Supply Co., Chicago, Ill.
Industrial First-Aid Supplies and Equipment.
Keystone View Co., Meadville, Pa.
Industrial Visual Testing Equipment.
Walter Kidde & Co., Inc., Belleville, N. J.
Fire Extinguishing Equipment.
Kimball Safety Products Co., Cleveland, O.
Protective Clothing, Gloves and Goggles.

Walter G. Legge Co., Inc., New York, N. Y.
Non-Slip Floor Polishes and Treatments, Non-Sparking Floor Treatment.
Lehigh Safety Shoe Co., Inc., Allentown, Pa.
Safety Shoes and Rubber Boots.
Lien Chemical Co., Chicago, Ill.
Health Protective, Sanitation and Maintenance Supplies.
Lightfoot Schultz Co., New York, N. Y.
Powdered Hand Soaps, Skin Cleaners and Conditioners.
Lonn Manufacturing Co., Inc., Indianapolis, Ind.
Blow Guns, Spraying and Cleaning Guns, Water Savers.

Macwhyte Company, Kenosha, Wis.
Wire Rope and Wire Rope Slings.
Marsh & McLennan, Inc., Chicago, Ill.
Insurance Brokers and Agents.
Martindale Electric Co., Cleveland, O.
Dust Respirators, Voltage Testers and Insulation Meters.
Thom McAn Safety Shoe Co., New York, N. Y.
Safety Shoes.
B. F. McDonald Co., Los Angeles, Calif.
Industrial Safety Equipment.
Medical Supply Co., Chicago, Ill.
First Aid Kits and Supplies.
Melflex Products Co., Akron, O.
Flooring Materials, Treads and Standing Mats.
Metropolitan Life Insurance Co., New York, N. Y.
Life, Health, Accident, Annuities and Group Insurance.
Milburn Company, Detroit, Mich.
Protective Creams and Plastic Safety Clothing.
Mine Safety Appliances Co., Pittsburgh, Pa.
Safety Equipment for Personal and Plant Protection.
Minnesota Mining & Mfg. Co., St. Paul, Minn.
Reflective Sign Material and Non-Skid Floor Surfacing.

National Assoc. of Insecticide and Disinfectant Mfrs., Inc., New York, N. Y.
Household and Industrial Insecticides, Disinfectants and Allied Products.
National Industrial Launderers and Cleaners Assoc., Youngstown, O.
Coverall and Wiping Cloth Laundry Service for Industrial Plants.
National Safety Council, Inc., Chicago, Ill.
Accident Prevention Service.

National Society for the Prevention of Blindness, New York, N. Y.
Conservation and Utilization of Eyes in Industry.
Oil-Dri Corp. of America, Chicago, Ill.
Oil and Grease Absorbent.
Onox, Inc., San Francisco, Calif.
Athlete's Foot Preventive.

G. H. Packwood Manufacturing Co., St. Louis, Mo.
Industrial Skin Cleansers.
The Patent Scaffolding Co., Inc., Chicago, Ill.
Safety Ladders, Scaffolding and Work Stands.
Peda Spray Co., Inc., New York, N. Y.
Athlete's Food Preventive.
Phister Manufacturing Co., Cincinnati, O.
Maintained Air Pressure Liquid Fire Extinguishers.
Portable Products Corp., Pittsburgh, Pa.
Safety Hats and Safety Belts.
Protectoseal Co., Chicago, Ill.
Safety Devices for Hazardous Liquids.
Pulmosan Safety Equipment Corp., Brooklyn, N. Y.
Industrial Safety Equipment.
Pyrene Manufacturing Co., Newark, N. J.
Fire Extinguishers, Compounds and Systems.

Reece Wooden Sole Shoe Co., Columbus, Neb.
Wooden Sole Safety Boots, Shoes and Sandals.
Rose Manufacturing Co., Denver, Colo.
Industrial Safety Equipment.

Safety Clothing & Equipment Co., Cleveland, O.
Industrial Clothing, Gloves and Equipment.
Safety Engineering, New York, N. Y.
Publishers, Safety Engineering Magazine.
Safety First Shoe Co., Holliston, Mass.
Safety Shoes.
Safway Steel Products, Inc., Milwaukee, Wis.
Tubular Steel Scaffolding, Suspended Scaffolding, Grandstands, Bleachers.
W. H. Salisbury & Co., Chicago, Ill.
Linemen's Rubber Protective Equipment.
A. Schrader's Son, Brooklyn, N. Y.
Pneumatic Safety Control Devices.
Scott Aviation Corp., Lancaster, N. Y.
Self-Contained Breathing Apparatus.
Sellstrom Manufacturing Co., Chicago, Ill.
Face and Eye Protective Equipment.
Spencer Turbine Co., Hartford, Conn.
Industrial Vacuum Cleaners and Dust Collecting Equipment.
Standard Safety Equipment Co., Chicago, Ill.
Personal Safety Protective Equipment.
Steel Scaffolding Co., Inc., Brooklyn, N. Y.
Sectional Steel Scaffolding.
Stepan Chemical Co., Chicago, Ill.
Skin Cleansers.
Stonehouse Signs, Inc., Denver, Colo.
Accident Prevention Signs.

Sugar Beet Products Co., Saginaw, Mich.
Skin Cleansers and Cleaners.
Surty Manufacturing Co., Chicago, Ill.
Safety Appliances for Machines and Underfoot Hazards.

S. G. Taylor Chain Co., Hammond, Ind.
Iron and Steel Welded Chains.
G. H. Tennant Co., Minneapolis, Minn.
Floor Cleaning Machines, Floor Seal and Floor Wax.
The Toidey Campany, Fort Wayne, Ind.
Safety Aids for Babies.
Trimont Manufacturing Go., Roxbury (Boston) Mass.
Forged Steel Safety Tools.

United States Safety Service Co., Kansas City, Mo.
Industrial Safety Equipment.

Wahlert Products Corp., Brooklyn, N. Y.
Industrial Safety and Fire Equipment.
Watchemoket Optical Co., Inc., Providence, R. I.
Industrial Eye Protection.
Waverly Petroleum Products Co., Philadelphia, Pa.
Oil Absorption Materials.
Weaver Manufacturing Co., Springfield, Ill.
"Safety Lane" Automatic Service Equipment.
Welsh Manufacturing Co., Providence, R. I.
Industrial Eye Protection Products.
West Disinfecting Co., Long Island City, N. Y.
Personal Protection Safeguards and Plant Sanitation Products.
F. H. Wheeler Manufacturing Co., Chicago, Ill.
Industrial Protective Apparel.
Wiesman Manufacturing Co., Dayton, O.
Power Press Guards, Guide Pin Cover.
The Wilkins Company, Cortland, N. Y.
Lens Cleaner and Dispenser Cabinets.
Williams Jewelry & Manufacturing Co., Chicago, Ill.
Safety Awards, Badges and Trophies.
Willson Products, Inc., Reading, Pa.
Personal Protective Equipment, Instruments.