# SYLLABUS

of material presented at the

## INSTITUTE ON INDUSTRIAL ACCIDENT PREVENTION

University of California
Berkeley

February 4-6, 1948

Department of Institutes
UNIVERSITY EXTENSION
UNIVERSITY OF CALIFORNIA

# S Y L L A B U S

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INSTITUTE ON INDUSTRIAL ACCIDENT PREVENTION

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February 4-6, 1948

presented by

UNIVERSITY OF CALIFORNIA
Division of Engineering Extension
School of Public Health
Institute of Industrial Relations
Department of Institutes, University Extension

in cooperation with

San Francisco Chapter of the American Society of Safety Engineers
Department of Industrial Relations, State of California
Bureau of Adult Health, Department of Public Health, State of California
East Bay Chapter, National Safety Council
San Francisco Chapter, National Safety Council
Western Region, National Safety Council
Sacramento Chapter, American Society of Safety Engineers
East Bay Industrial Safety Society
Contra Costa County Safety Council

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(Outline)

# The Relationship between Accident Prevention and Industrial Relations

William H. Jamison, Partner, Bay City Iron Works

I. Reasons for having an Industrial Relations Program

- a. Employee hiring
- b. Employee Testing Indoctrination
- c. Employee Training
- d. Grievance Procedures

II. The Relationship of Accident Prevention to Hiring, Testing, Indoctrination and Placement.

III. Production loss and cost through improper selection and training

IV. The Price of an Inadequate Industrial Relations Program

V. Common causes of Employee Grievances

VI. Accident Prevention as an Economic Factor in Production costs.

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# Physiological Factors in the Industrial Environment

Craig L. Taylor, Associate Professor of Engineering,
Department of Engineering, Los Angeles, California

The general title assigned to me gives a generous latitude for selection of specific topics, and I shall continue, as in the past meetings, to choose subjects which, if not always precisely in the category of accident prevention, are nevertheless closely related in the general concern for human safety, efficiency and well-being in industry.

## I. Diet and Industrial Efficiency with Special Reference to Industrial Feeding

After a hundred years of nutrition research, supplemented by clinical and field studies of human dietaries, it is now possible to specify, with a satisfactory degree of confidence, the energy foods, proteins, vitamins and minerals required for normal growth and maintenance of the individual. The minimum requirements have been determined by experiments and observations in which minimum balances of the quantities of food elements necessary to sustain health, efficiency, body weight, etc. have been discovered. It is customary to define optimal levels which are equal to 150% of the minimal requirements. These are called the recommended allowances. Such allowances for the principal dietary elements are given in Table I.

TABLE I. Standard Allowances* for Nutritional Factors in Adult Men

| ITEM | DAILY ALLOWANCE |
|---|---|
| Energy foods | Light Manual Work.....2450-2940 Cal./day |
| Carbohydrate | Moderate Manual Work..2950-3520 Cal./day |
| Fat, Protein | Heavy Work...........3620-5230 Cal./day |
| Protein | 1 gm./Kg body weight, day = 70 gm./ 70 Kg (154 lb.) man, day |
| Vitamin A | 1750-3850 International Units / day |
| Vitamin B, (thiamin) | 20 International Units / 100 Cal., day |
| Vitamin C, (ascorbic acid) | 80 - 100 mg / day |
| Vitamin D | Unknown |
| Nicotinic Acid | Unknown |
| Calcium | 1 gm./ day |
| Phosphorus | 1.32 gm./day |
| Iron | 12-15 mg./day |
| Copper, Iodine, etc. | Traces |

It is unnecessary in the present instance to develop a detailed description of the tabled allowances. They are included here to show that dietary requirements can be stated quantitatively. With this background, we can approach the subject of industrial feeding by asking the questions: How do the conditions of industrial labor alter these needs? What is the evidence that special feeding produces higher efficiency, reduces fatigue and absenteeism, or promotes employee morale?

* Ref. (1) and (2)

It may be assumed that the typical industrial worker, consuming a typical mixed diet, obtains the required allowances, although in individual cases there may be deficiency. Stiebeling and Coons (3) have shown this for minerals and vitamins. While generalization is hazardous, it may be assumed, that provided income and food availability are reasonably adequate, the energy allowance is usually met by obeying hunger and appetite.

1. Evidence from supplementation of diet.
   This is drawn from controlled experiments in which dietary elements are varied, while the reactions of human subjects to measured work output, to the fatigue resulting therefrom, and general well-being, spirits and alertness, are studied. Some conclusions are:
   (a) Protein intake, much folklore to the contrary, is not influenced by type or intensity of work. Heavy meat claims appear to be unfounded, since authorities find no nutritional evidence for a meat allowance greater than 0.1 lb. per day for the average man. Gelatin, a protein, was widely advertised as a fatigue reducer and an outstanding energy food about seven years ago. All such claims have now been refuted, and gelatin returns to its position as a food of undoubted but not exceptional value.
   (b) Vitamin supplementation upon normal mixed diet has not been shown to affect work output, absenteeism, turnover, or personnel rating. See references (4), (5), and (6). While it is noted that some of the vitamin requirements are based upon energy value of diet, and thus upon intensity of activity, in practice the normal dietary increases take care of the vitamin requirements. In exceptional cases individuals may be helped by vitamin supplements within the framework of medical care.

2. Industrial feeding experiments.
   Considerable experience has been accumulated with the effects of between-meals feeding in industry. Experiments vary so greatly in the degree of control, the duration, the type of food served, and the populations of workers involved, that results are difficult to summarize and evaluate. In drawing conclusions, it is necessary to bear in mind that any alteration in the routine of work may increase production and elicit favorable responses from workers, particularly if they are led to anticipate a favorable effect. For this reason such experiments should be adequately controlled and of sufficiently long duration to outlast the novelty effect.
   (a) Effects of altering the time and number of meals upon industrial production were studied by Haggard and Greenberg (7). In general, they found that numerous feedings, i.e. a 5 meal regime, produced highest output. Some of their physiological findings have been disputed, but the work output data must be credited. In another study, these authors found that between meals feeding reduced absenteeism and improved morale of clerical workers (8). Similar results were obtained by Comstock and Eddy (9).
   (b) Summarizing the evidence, it appears that midmorning and mid-afternoon lunches improve morale, reduce absenteeism and may increase production. Late morning and afternoon restlessness and feeling of fatigue is reduced by these feedings, even when compared with rest pauses with no feeding. The physiological explanation for this is still controversial, but empirical and psychological benefits are generally in evidence over the periods of observation.

(c) Haggard and Greenberg (10) discuss the desirable type of food for industrial feeding. They stress that provision should be made for vitamin and mineral intakes as well as "quick energy" foods. They expose fallacious notions about "spoiling the appetite", and reduction in work capacity caused by the digestion following such snacks.

References

(1) H.C. Sherman Chemistry of Food and Nutrition (1941)
(2) Yearbook Dept. Agriculture (1939) Food and Life.
(3) H. K. Steibeling and C. M. Coons Food and Life
(4) A. Keys and A. F. Henschel J. Nutrition 23:259 (1942)
(5) H. Borsook Milbank Memor. Fund Quart. 23:113 (1945)
(6) A. F. Henschel Minnesota Med. 25:974 (1942)
(7) H. W. Haggard and L. A. Greenberg Diet and Physical Efficiency (1935)
(8) H. W. Haggard and L. A. Greenberg J. Am. Diet. Ass'n. 15:435 (1939)
(9) L. Comstock and W. H. Eddy J. Am. Diet Ass'n. 11:239 (1935)
(10) H. W. Haggard and L. A. Greenberg J. Am. Diet Ass'n. 17:753 (1941)

## II. Lifting and Load Bearing in Industry

Notwithstanding the progressive mechanization of load lifting and transporting in industry, and much of this type of work is still done by workers without aid of machinery, yet paradoxically the incidence of reported back-strain seems to be on the increase. The control of this disability raises numerous problems ranging in nature from education of workmen in safe and efficient lifting to the adjudication of "industrial back" cases. Even if we should confine our attention to the physiology and mechanics, a large number of variables within the individual, as well as within the nature of the lifting task, make the formulation of simple rules exceedingly difficult, In the interest of industrial efficiency, health and safety, however, this should be attempted. The rational basis for such regulation lies in the study of biomechanics and physiology; its administration is a duty of the safety director.

1. Is there a physical capacity norm?

Again, we should like to be able to state a norm with which industrial tasks could be compared, as a basis for defining the hazard. Such a norm would specify both force and work capacities for the various categories of body size, sex, age, state of training. It may be stated at once that adequate data do not exist to formulate such standards, and it remains to be seen whether their administration would be feasible.

Table II presents a miscellaneous collection of maximum strength and work performances:

TABLE II Feats of Work and Strength

| TASK | PERIOD (hr) | TOTAL WORK (ft.-lb.) | POWER (HP) |
|---|---|---|---|
| Continuous Work* | | | |
| Human treadwheel | 8 | $1.67 \times 10^6$ | .105 |
| Hand capstan | 10 | $1.63 \times 10^6$ | .082 |
| Hand piledriver | 10 | $.58 \times 10^6$ | .029 |
| Raising water | 6 | $.56 \times 10^6$ | .047 |
| Weight Lifts: (World Almanac) | | | |
| Military Press | 310 lb. | World Hvy wt. record | |
| Two hand clean and jerk | 368 lb. | " " " " | |
| Dynamometer Lifts: (Rogers) | | | |
| Back Lift | 308 lb. ) | (Average high | |
| Leg Lift | 516 lb. ) | (school boys | |

*Reference (1)

These figures give evidence that strength and work capacity of selected and trained men may be relatively enormous, and far exceed the demands of most industrial jobs.

The British Home Office (2) recommends the standards given in Table III.

TABLE III Maximum Loads Recommended

| | | |
|---|---|---|
| Men | 130 lb. | (Compact Load) |
| Women | 65 lb. | (Intermittent work) |
| " | 50 lb. | (Continuous work) |

According to some authorities these recommendations appear excessive, although when compared to the records in Table II they are well within the maximal limits of physically trained and fit men. Numerous instances of authenticated back strain, however, have occurred under loads that are a small fraction of the above. These facts stress that what is a safe load depends upon a large number of variables.

2. Biomechanical and physiological variables.

   (a) Muscle force is a function of the cross-section of the muscle (Fisk factor = 142 lb./$in^2$). It is at its maximum when muscle is approximately at its resting length, i.e. not shortened (contracted). Thus, other things equal, the man with large cross-section muscles will be strongest, independent of weight. He will exert more force if his muscles do not have to shorten unduly in the performance of the work.

   (b) Lifting should utilize leg muscles as much as possible and the back should be flat. These facts follow from the maximal records of Table I and from occasional back strain when the back is rounded during lifting.

(c) In load bearing, work is most efficiently performed when the center of gravity is shifted as little as possible from its normal locus in the body, thus a minimum strain is put upon the postural muscles.(3)
(d) Training, "warm-up" and other devices for muscle conditioning improve efficiency for lifting and load bearing and reduce the possibility of back strain. (4)
(e) Valsalva effects, high intrathoracic pressure, accompany all lifting and load bearing. This is a potential debilitating strain upon the cardiovascular system, as shown by E. Asmussen and O. Hansen (5). Its effect, not serious in young, healthy and well trained men, increases with intensity and duration of the stress. It may be moderated by learning to "breath while under load", and by avoiding long continued dead loads borne on hands.
(f) Interposing of rest periods in load bearing has a fatigue allaying effect. Thus F. W. Taylor found that with 40% of time devoted to rest, and with efficient methods of handling, laborers tripled their handling of pig iron.

3. Evidence from back strain experience.

(a) In spite of declining lifting and weight bearing by workers the amount of alleged back strain in industry is on the increase. Johnstone (4) has strongly condemned the uncritical diagnosis of backstrain. He found, after thorough clinical and laboratory study of 2018 "backstrain" cases, that 57% of them were attributable to causes other than strain or contusions, thus 14% throat infection, 33% defective oral hygiene, 6% common cold, 3% kidney disease, 25% gonorrhea, and 10% abnormal prostate.
(b) Popular notions to the contrary, much, if not most, back strain occurs as the result of an accumulation of slight strains, rather than an acute sprain. The causes may therefore be lost in individual history, and are by no means certainly industrial in origin. Thus, off-the-job stresses may be fundamentally at fault. According to Johnstone (4) many of the serious back injuries, such as herniated intervertebral discs and anterior slips of the lumbar vertebrae, develop over a period of years, and seldom result <u>de novo</u> as a result of a sudden wrench of the back
(c) Quite similar opinions are held about hernia. Chronic, slow onset of dilation in the inguinal ring typically sets the stage for the final stress which creates the definitive symptoms.(4) Congenital malformation, as well as off-the-job stresses, may be important in the history of hernia.

4. Safety Rules for Lift and Load Bearing.

(a) Lift with flat back, legs slightly spread, and utilize leg straightening as much as possible.
(b) Handle loads with minimum displacement of the center of gravity.
(c) Minimize the extent and duration of fixing the chest under load.
(d) Select workmen to fit heavy jobs. Probably a load factor of 50% may serve as a guide in selection.
(e) When "team lifting and load bearing", match heights and strengths so that stresses are approximately equalized.
(f) Train workmen in the mechanics of lifting and carrying. Stress physical conditioning exercise.

(g) Interpose rest periods.
(h) Arrange job to minimize awkwardness in load handling.

5. Summary

It is evident from the above that the practical management of heavy lifting and load bearing is a complex affair which is not reducible to simple formulas. It devolves upon the safety inspector, engineer, or industrial physician to study tasks of this type in the industrial plant, and with the rules suggested above, work out the problems to the best interest of worker and management.

References

(1) J. Amar The Human Motor (1919)
(2) Great Brit. Home Off. Safety Pamphlet No. 16 (1937)
(3) Industrial Health Research Board (1927)
(4) R. T. Johnstone Occupational Diseases (1942)
(5) E. Asmussen and O. Hansen Skand. Arch 78:273 (1938)

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(Outline)
# Effective Use of Injury and Accident Reports

M. I. Gershenson, Chief, Division of Labor Statistics
and Research Department of Industrial Relations, State of California

Universal agreement on need for factual data concerning industrial accidents as basic tool for effective accident prevention program.

1. Heinrich names "fact finding" as one of the three basic principles of scientific accident prevention. 1/

2. In Industrial Safety, edited by Blake, Keefer lists "discover causes" as the first of four fundamentals of industrial accident prevention. In this he includes--investigate, record and tabulate, and analyze the records of all accidents. 2/

3. Blake himself says, "Adequate reporting and recording of accidents are essential to first-rate safety performance. 3/

4. Kossoris of the BLS points out, "In the process of accident prevention, accident reports and records are extremely useful tools." "Records are no substitute for accident prevention, nor should accident prevention stand inactive until records are compiled. But accident records are indispensable aids toward accident prevention. Their important function is to use the past as a guide for the future." 4/

## Purpose of Records

To determine causes of accidents so that they can be eliminated.
To determine effectiveness of safety program - trend.
To compare with other plants in industry.
To sell management on need for action.
Others.

Not only is there general agreement upon the need for facts but also on kind of facts. We will mention a few:

| Types of records: | | |
|---|---|---|
| | Report of accident | - foreman, supervisor |
| | Investigation report | - safety engineer |
| | Doctors', nurses' report | - doctor, nurse |
| | Summary report | |
| | Recommendations | |

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1/ Industrial Accident Prevention, by H. W. Heinrich, McGraw-Hill, N.Y. 1941, p. 6

2/ Industrial Safety, edited by Roland P. Blake, Prentice-Hall, N.Y. 1946, p. 42.

3/ Safety Subject, U.S. Department of Labor, Division of Labor Standards, Bulletin No. 67, p. 21.

4/ Accident - Record Manual for Industrial Plants, U.S. Bureau of Labor Statistics, Bulletin No. 772, pp. 1, 18.

Let us not take time to elaborate on kinds of records to be kept but concentrate on the subject of this talk--effective use of records, etc.

We will discuss from two points of view

1. Effective use of plant records for internal purposes.

2. Effective use of records in a general statistical program such as that carried on by a state agency as ours.

3. We will cover highlights only in view of time limitations.

## RECORDS FOR INTERNAL USE

Objectives:

Formulate program, design forms, etc., in light of objectives:

1. Facts for use in accident prevention work.

2. Facts for workmen's compensation insurance.

Program can become fuzzy and expensive if this principle is not carefully adhered to. Keep objective always before you. Ask at every step, "What relation does this have to objective?" "Will it yield required information?"

Forms

Tabulations and analyses no better than original data on which they are based.

Therefore, most important that techniques for original collection be good. Essential for effective use of records.

Some basic principles in form design:

1. Simple, concise, explicit questions.

2. Use as many direct questions as possible and avoid broad catch-all questions.

3. Logical order of questions - for ease in preparing report and tabulation.

4. Include provision for all required data.

    a. For accident prevention

    b. For workmen's compensation insurance

    c. For official report

5. Exlude irrelevant questions (applies to us too)

Who shall prepare reports?

Effective use of information requires report of an accident be made by competent person best able to give essential facts - not by a stenographer who has been given a few meager facts.

What to do with reports?

1. Effective use requires something be done with reports - not filed away

2. Summarize data - involved tabulations - probably not feasible for small firms.

3. Analysis of individual reports and of summaries.

4. Study cumulative reports.

5. Presentation of analysis and recommendations for action to be taken. Must get points over to all concerned.

Comparisons:

Use data for comparisons

a. between departments

b. with other establishments - industry

c. over period of time

Summary - (in reverse order)

1. For effective use of records - <u>use them</u>

2. Analysis

3. Prepared by proper parties

4. Proper forms and procedures

5. Procedures and techniques in light of objectives

RECORDS FOR GENERAL STATISTICAL PROGRAM

Basic principles same as previously discussed for internal records

Internal program of records and reports where possible should be such as to facilitate comparisons with data compiled by others

Can best discuss from point of view of new program of Division of Labor Statistics and Research.

Inadequacies of former program

1. inadequate analysis of causes of accidents
2. no cross-tabulations available
3. data not available until 9 months after close of year
4. no enforcement of filing requirements due to budget inadequacies

New program designed for more effective use of injury and accident reports.

1. Primary objective
   a. compilation of data on causes of accidents for use in prevention work.
   b. standardized procedures; to facilitate comparisons.
2. Techniques and procedures
   a. ASA practice adopted
   b. new reporting form - advantages: simpler, reduction in number of questions, standard form for all carriers

      limitations: detail on unsafe conditions and acts not requested except for mechanical guards.
   c. change in rules and regulations governing filing of reports to speed up filing by requirement that injury be reported within 7 days.
   d. Processing of reports changed from semi-annual to monthly basis to provide up-to-date material.
   e. codes adopted based on ASA "Recommended Practice for Compiling Industrial Injury Causes" with modifications to suit conditions in the State.
   f. use of Hollerith punch card system for flexibility in tabulation and speed in processing.
   g. monthly tabulations on agency, unsafe mechanical or physical condition, unsafe act, and other factors now being issued promptly - used by State agencies and others interested in accident prevention work to focus attention on causes of industrial accidents.

Special analyses - prepared for special industry groups, for Division of Industrial Safety, and for other agencies.

Improvements effected or to be effected

1. Data on causes - expansion of list of agencies, unsafe acts, unsafe conditions, etc., being coded.

2. Additional data on nature of injury, industry, occupation, sex, age, and county to be developed with pertinent cross-classifications.

General limitations

1. Response deficiencies

    a. incompleteness

    b. reports not prepared by proper person

2. Fear reports will be used against employer

3. Limitations of staff and budget

Future plans

1. Frequency and severity rate statistics

2. Special studies

Summary.

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(Outline)
# Employee Selection and Placement

Harry W. Case, Associate Professor of Engineering, University of California, Los Angeles

A. Accidents and their relationship to correct employee selection and placement

B. The basic steps involved in employee selection

C. The relationship of job analysis to employee selection

D. The use of job specifications

E. Establishing the selection procedure

1. Steps in the selection procedure

   a. Reception
   b. The application
   c. Employment tests
   d. The interview
   e. Final selection
   f. The physical examination
   g. The sign up

F. Making the interview more effective

1. Common sources of error

2. Methods of improving the interview

G. Using psychological tests

1. Determining whether tests are justified

2. Areas which tests may aid in measuring

3. Using tests

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(Outline)
# PERSONAL PROTECTIVE EQUIPMENT
## Selection, Use, and Maintenance

Clinton W. Dreyer, Managing Director, East Bay Chapter, National Safety Council

I. Review of methods of handling Personal Protective Equipment in industry.

II. The role of the Safety Engineer in the Personal Protective Equipment Program.

III. Job Analysis

A. Hazards and need of Personal Protective Equipment
B. Supervisor's knowledge of Equipment and its use
C. Selection and standardization of Equipment.

IV. Use and Care

A. Authorization from Supervisor
B. Instructions at time of issuance on care
C. Inspection and Check up by Supervisor.

V. Facilities for issuance of Equipment

A. Type of control
B. Distribution duties of Control Department
C. Layout of dispensary
D. Inventory records.

VI. Maintenance

A. Tools and equipment needed
B. Cleaning and sterilization
C. Maintenance of Goggles, Respirators, etc.

VII. Training of personnel on use and care.

VIII. Conclusions.

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(Outline)

# What Management Expects From the Safety Director

James R. Moore, Vice-President, Moore Dry Dock Company

(A) Introductory remarks.

(1) Determination by management of objectives of safety program.

(2) Importance of reciprocal loyalty between management and safety director.

(B) Desiderata in a safety director's qualifications.

(1) Organizing ability in safety director.

(2) Technical competence.

(3) Good physical condition -- health, agility, poise, etc.

(4) Personality -- ability to sell, enthusiasm, tact, persistence, thoroughness and initiative.

(5) Character.

(6) Participation in outside activities, e.g., safety societies, cooperation with government agencies.

(C) Concluding remarks.

(1) Standing and position of safety director in contemporary society.

(2) Future trends in safety engineering.

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(Outline)

# Essential Elements of a Complete Accident Control Program

R. E. Donovan, Chief Safety Engineer, Standard Oil Company of California, San Francisco

I. Management's Responsibility in the Safety Program

A. Relationship of Safety and Operating
B. Supervisor's Role in Accident Prevention

II. Elimination of Physical Hazards and Control of Work Habits or Practices

A. Safety in Design

1. Legal requirements and recognized standards
2. Cooperation with the Purchasing Department and the manufacturers
3. Cooperation with design engineers, including preparation of a construction guide.

B. Discovery by Inspection

1. Work area
2. Materials handled
3. Machines used
4. Hand tools used
5. Clothing worn

C. Correction after Inspection

1. Remove the hazard
2. Protect the worker against the hazard

a. By guarding
b. By personal protective equipment (Guide for the Purchasing Department)

3. Develop a safe practice to avoid injury from the hazard

a. Operating standards
b. Safe practice regulations

III. Educational Media for Furthering Accident Prevention

A. Safety Meetings
B. Workmen's Safety Committees
C. Workmen's Safety Suggestions
D. Accident Prevention Bulletins and Other Publications
E. Safety Posters
F. First Aid Training
G. Safety Awards -- Certificates, etc.
H. Motion Pictures and Film Strips

IV. Statistical Records and Analyses

A. Classification, Coding and Recording of Accidents
B. Periodical Accident Reports
C. Exchange of Accident Rates
D. Special "Breakdown" Analyses

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# THE ROLE OF THE SUPERVISOR IN ACCIDENT PREVENTION

Talk by

A. A. Agnew, Foreman, Shipping and Receiving Department,
Nordstrom Valve Division of Rockwell Manufacturing Company, Oakland, California.

Well I don't know why I have been asked to address you on this subject unless it is because I have been a supervisor for about 20 years, about half of this in charge of various material handling activities, the balance in charge of office personnel engaged in material procurement and accounting for same.

Probably most supervisors would rather talk about what they think the safety director should do or not do in preventing accidents. But if this feeling exists with the supervisors of any plant I feel it is just as much the fault of the safety director as it is the fault of the supervisor.

I feel that there is room for both of us in the field of accident prevention and not only room but a serious need for not only good safety directors but safety minded supervisors. The scope of each of our operations are usually or should be defined in the operating policies of the company we work for.

I feel the ideal policy would be for the safety director to do the over-all planning and the line supervisors do the doing. The supervisor should, of course, participate in the planning, including

Serving on general safety committee
Participating in training program (if one exists)
Consulting on plant layouts and changes
Recommending changes in existing facilities or equipment to reduce the accident potential
Assist in planning the safety program

and he certainly should have a part in writing the safety manual for the plant.

If we were discussing the duties of a safety director I would list first in the order of importance interesting the supervisor in accident prevention. I know it probably seems sometimes that you safety directors could accomplish more by taking your program to the employees direct, but I don't think you will get the desired result unless you sell the supervisor first.

My discussion should of course be confined to the subjects as outlined, but I warn you I might place, what you feel is, too much emphasis on the prevention of accidents in material handling. But I am sure this is not time wasted when we consider the percentage of industrial accidents directly attributed to material handling. This gives me a chance to talk about my job and everyone likes to do that.

You have presumably been furnished an outline of this discussion but I will not promise to follow the exact sequence.

I. The Supervisor as the Example of Management Leadership in Accident Prevention.

A. The Yardstick by Which the Employees Judge the Management's Abilities in Fact Finding and Corrective Action.

The supervisor represents management as a whole to the worker, and that includes most of you present. And by his actions ye shall be judged. If the supervisor in correcting an unsafe act merely yells at the man something like "Hey, don't throw the castings on the pile Joe is counting", he is merely taking a negative approach. If he will stop the operation and suggest that they place a skid on the truck on which they can both unit pile the castings and remove the loaded skid with crane or fork truck, he can point out that this is less fatiguing, allows a more accurate count, saves one manual handling and removes the possibility of Joe getting hit with one of the castings. All right, now what has he done? The supervisor has invested, for the company, the cost of his time and the time of the two men listening to him, to better their own working conditions and at the same time make his point on safety. All safety instructions should be do's and not don'ts. You will note I said safety instructions and not rules. This is a pet gripe of mine: teachers instruct, leaders lead, but policemen police the observation of rules, and I don't want to be a policeman.

B. Supervisor Responsibility.

The supervisor is directly responsible for the accidents and their prevention regardless of whether the action required is some that he can take himself to eliminate the hazard or entails recommendations to higher levels for corrective action. His responsibility does not cease with this recommendation. He must follow through, maybe presenting it in a different manner to attract attention. The supervisor must recognize the fact that top management is continuously confronted with recommendations involving expenditure of money. They know that some of us are prone to tie up our pet projects with safety merely to get attention, when actually it is probably something to make our job a little easier. Now don't misunderstand me;this is also commendable. But we should not use safety as an excuse for our recommendations that we want to put over to expedite production. Now the reverse is not true. If, as is very often the case, the safety recommendation will also expedite production and/or reduce costs we should highlight these facts in our recommendations. In fact, if our particular top management is interested in production for costs to the exclusion of safety, which I hope none of them are, we could even make these features the main theme of our recommendations. Also, the supervisor must never feel that by his written order to the maintenance department to repair defective equipment he has discharged his responsibility. In the final analysis he is in charge and if he feels that the continued operation of such equipment is hazardous he must have the initiative to take the equipment out of service.

The only cases that excuse the risking of life or even personal injury are those that require such risks in emergencies to save other lives. The meeting of a production schedule must never be blamed for even a mashed finger requiring only a visit to the first aid room.

I. C. The Supervisor Must Use Good Judgment In All Cases But Specifically In

1. His criticisms of work habits
2. Emergencies
3. His analysis of the cause of accidents, and
4. his actions or recommendations for cures and prevention of accidents.

I know a lot of the supervisors, and probably some of you will say, but how about the emergencies? Isn't it more important to do something? For my money the answer is NO. The important thing is to do the right things promptly. The supervisor must have himself trained to take prompt action, but it must be the correct action. When a man is unconscious from a fall, the supervisor may think he is impressing his subordinates with his quick judgment when he says, "All right, don't stand around, pick Joe up and get him to the First Aid Room." Now I am not going into a first aid discussion with this group as it certainly would be over my head. But I certainly think you will agree that if the plant nurse is within 500 feet the supervisor's first duty would be to see that she was called immediately. Certainly the injured person should not be moved until some qualified person has determined the type of injury.

D. Use of Knowledge Gained.

By this knowledge I am not necessarily referring to the formal knowledge of safety practices that he might gain through training courses conducted by professional safety men but I am thinking of the knowledge he gains through his own experience. While a lot of this knowledge can be gained by analyzing accidents this is or could be costly learning. By the proper observance and analyzing of his operations he will certainly be able to determine most of the unsafe conditions and unsafe acts that in his opinion might cause an accident, and then use this knowledge in:

Making safety inspections,
Analyzing accidents, and
Making recommendations on taking corrective action to his superiors.

E. The Sales Manager in Charge of Selling Safety.

We can certainly assume that any supervisor worthy of the name is sold on safety;but does he know how to get it sold to his assistants and through them to the actual operators? I always feel that a sale goes over better and easier if we can convince the customer that what we have is something he needs or something that will make life more pleasant for him or his family. Now if we can convince the customer that what we have for sale will make money for him then he will take the product away from us faster than we can produce. Bring out to him the saving in lost time. If the supervisor can sell the safety program to his department they will run away with it and it will start showing up as a decrease in his accident rate.

F, Production Versus Safe Production.

I know we as supervisors are prone to blame top management for the accident rate, especially when the accident can be attributed to crowded and congested conditions which are actually caused by increased production rates.

I. F. But it is our job to bring these conditions to the attention of top management and not just drop the matter when we have recommended a plant expansion to take care of increased production. It is our job to hold out for safe production and not just production. Because we know what accidents can do to the production rate.

G. Developing the Safety Program.

I hope most of us supervisors feel that we are the key people in a safety program. But we must consider it not only our privilege but our right to have a hand in setting up the safety program. If we are unfortunate enough to be burdened with a safety director that feels he should run the entire show then we should insist on our rights. We must be given an opportunity to become competent in accident prevention. The fact that you as safety directors have the staff function of actually coordinating the entire safety program does not change the fact that each and every supervisor should know something about safety engineering the same as he does about personnel management, time and motion study and other staff functions.

H. Department Meetings.

Some companies have a policy opposed to department safety meetings. I feel a lot can be gained from them. When I was a general foreman with a railroad I held department safety meetings monthly. They were very short, usually about 20 minutes, never over 30. We discussed and analyzed the accidents and solicited suggestions, told them what the company was doing in the way of providing safe guards, repairing or replacing tools and equipment to reduce accidents. At each meeting we attempted to sell the group on doing just one more thing in a safer manner. At these meetings I always inspected goggles and shoes.

## II. Analyzing the Accident

A. The Supervisor Must Recognize The Importance of Properly Describing The Material, Tools and Equipment Involved In an Accident.

Just saying the man dropped a casting on his foot is not enough, he must realize it is important to state what the casting is, its shape, weight and etc.

B and C. Unsafe Acts and Unsafe Conditions.

Some of us are rather prone to blame unsafe acts when the accident is actually caused by unsafe conditions. Of course some of this is caused by your failure to train the supervisor in recognizing the difference between an unsafe act and unsafe conditions. But regardless if the accident is caused by an unsafe act, practice or condition, it is our responsibility. I have had about five toe injuries in the past year and a half that would not have happened had the men worn safety shoes; but I still feel that I and my supervision are responsible for these accidents.

D. In Interviewing Employees to Develop Cause and Cure:

The first requirement is that the supervisor be required and allowed to make his own report. I think he should be trained to make proper accident reports, but it is his responsibility and he should insist on carrying it.

II. D. Some safety directors feel that only they or other people connected with the safety department are qualified to investigate and report accidents. Sometimes they break down and let the supervisor sign the report (and sometimes they don't).

The supervisor should be sure he does not start the interview by criticising the employee for the accident. This should be the last thing he does, preferably the next day and certainly not until he has all of the facts. The first and most important point is to put the employee at ease and remove any fear he might have of being disciplined or reprimanded. Only then will we be able to get the facts, otherwise we will get excuses. The supervisor must approach the interview with the idea of preventing accidents and not for the purpose of blaming some certain person for the accident. In other words, find out what happened before we worry about who did it.

III. Personal Protective Equipment

A. Choosing the Proper Equipment.

The supervisor has a definite responsibility in recommending protective equipment. I realize this is primarily a job for the professional safety personnel. But very often the line supervisor has had to use protective equipment and clothing and is in a position to know whether the objections to them are real or fancied. We will not start a discussion on what protective equipment to use for certain jobs, again I can only say you people are experts on this and I have no desire at this time to play a game of stump the experts, but I will say we should try to furnish comfortable protective equipment. It makes more possible our job of getting the equipment used.

B. Creating a Desire to Use the Equipment.

The most important part of the safety equipment is getting it used. Sure you can write safety rules and I guess you have to cover certain hazardous occupations and operations where goggles or other protective equipment must be worn. In certain cases the only way we can enforce the rules is by discipline. The other cases where the hazard is not evident enough to require a definite rule for safety equipment, but wearing or using them may prevent an injury, are equally important and they are the cases where the supervisor must do a real selling job. Again we must not shirk our responsibility because it is a stubborn case.

We recently got three men on our receiving dock to agree to purchase and wear safety shoes but we still have one man that we have been trying to get safety shoes on for nearly two years and we cannot quit trying till the job is accomplished. This is another case where we often overlook one of the best ways to sell something to the worker and that is set the example. This is especially true of goggles and safety shoes. Wear them yourself.

IV. First Aid

A. The Supervisor's Part.

Certainly the first part we as supervisors have in the first aid program is to ourselves have completed a first aid course. How many of you can say that all of your supervisors have completed a Red Cross First Aid Course?

IV. A. Firstaid is of course handled by the professionals in the larger plants but I feel that we supervisors should in all cases know what or what not to do in the emergencies. Secondly it is our responsibility that every injury, regardless how small, goes to the first aid room for treatment.

B. Supervising Application of First Aid.

It may seem superfluous to say the supervisor must not get excited when an accident occurs. But some of us do get excited and recognizing this fact our job is to train ourselves to overcome it. All of our personal hard work on safety, our record in accident prevention, elimination of hazards, good housekeeping, etc., can be entirely wiped out by our failure to function properly in an emergency. We must keep control of the group, see that the nurse, doctor or safety supervisor, is notified promptly and in plants where these services are not available, see that an ambulance is called. It is our responsibility to see that only the proper emergency first aid is applied and correctly. Our attitude and our ability to command these situations can do a lot towards creating, in the minds of our workers, a feeling of confidence in us and through us in the entire management group.

V. <u>Material Handling</u>.

A. Hazards and Methods of Controlling or Eliminating.

Some supervisors think when we talk of material handling that we mean only receiving, storing, issuing, moving and shipping, and material handling accidents as occurring only in departments that perform these particular functions. Of course all of you know this is not true. Again I do not want to quote statistics. But presumably the primary material handling hazards are as follows:

1. Lifting - These of course can be controlled by providing proper material handling equipment, instructions in weight lifting and careful selection of personnel assigned to duties requiring lifting, as well as close supervision to see that men do not lift articles that should be handled by mechanical means.

2. Finger and hand injuries caused by falling objects or objects striking together - Most of these can be reduced by proper job instruction and supervision to see that such instructions are carried out. Some of these are indirectly caused by other hazards, such as crowded conditions, improper lighting and etc. The supervisor must not feel that he can discharge his responsibility by continually warning the men to be careful. The responsibility continues to be his, the careless worker must be changed into a safe worker or not retained in service.

3. Objects falling or rolling on toes and feet - We all know a lot of these accidents can be prevented by safety shoes, but this is a protection against and not an elimination of the hazards. This problem of getting the worker to wear safety shoes must be recognized and set up as a never ending campaign. At the same time we must be careful not to oversell the safety of the safety shoes to the extent that the men depend on them and get careless.

V. A. 4. Nails, wires, splinters, etc.,protruding from boxes and kegs - This of course should be covered by adequate instructions but requires constant supervision to see that the instructions are always carried out. We must remember that this is a job that cannot be properly performed without proper tools, and see that they are furnished. Here again supervision can set the example. When the superintendent asks a man to open a box to see if it contains the machine part he needs so badly he should never be in too much of a hurry for the man to pull the nails out before removing the contents.

B. Selection of Material Handling Equipment.

This is another definite responsibility of supervision and I think we can say all supervisors and not only those in the material handling departments. Too many times we place all the emphasis on the actual production equipment and the guarding of it, but fail entirely when it comes to selecting the proper handling equipment to be used with the machine. We are getting a much better break from top management nowadays on material handling equipment, but most of it is due to the actual savings possible, and not necessarily for the purpose of reducing accidents.

C. Instructions in Use of Material Handling Equipment.

The installation of modern material handling equipment and methods creates new hazards, but most of these can be controlled by training and supervision. We have recently prepared a set of instructions for fork truck operators which I was privileged to help prepare.

VI. Housekeeping.

A. Setting the Example.

In housekeeping not only we as supervisors but all levels of management are certainly putting ourselves on the spot when we let the man stumble over a waste paper basket leading into our office or talk to him across a cluttered desk and then go out to instruct the men on rearranging his work area.

B. Departmental Housekeeping Program.

All of you are more familiar with the lists of accidents caused by poor housekeeping than I am. The supervisor's immediate concern is good housekeeping in his own department. He must know that poor housekeeping can be a definite deterrent to the production schedule. I would not say that we should never have any grand clean ups. We need these semi-annual or quarterly cleanup and paintup programs, but we must make housekeeping an everyday job. We need not go into the details of the items to watch for and correct. I am sure all of you have the numerous check lists to be used for this purpose. We must consider housekeeping one of our responsibilities as supervisors. That means actual cleanliness as well as having a place for everything and everything in its place. I know some of us think, that as long as there is a plant janitor department, this is not our concern. But we as supervisors, not the janitor, are responsible for the men having a clean place to work. However I am in favor of the janitor being assigned to the department.

VI. C. Employee Co-operation.

We know that no housekeeping program can be successful without the co-operation of the employee. Some of them just naturally keep their work area clean and orderly, others have to be trained. But through good supervision and seeing that the men start work in a clean area, we usually need only hint that we expect it to be left in the same condition. We must also take the initiative by actually assigning them to duties of straightening up the department. We cannot have safe production unless we keep our house in order.

VII. General Health and Morale.

A. Gaining Employee Confidence.

The supervisor should be the first person the employee goes to with his troubles, and the supervisor must lend a sympathetic ear. If he is too busy today to listen, tomorrow he may have the job of training a new employee just because the trained worker decided it was a hell of a place to work. In properly assigning employees to tasks we have to know their physical and mental condition at that time. There is no better place to get the employee's opinion of how he feels than from him, and he won't talk if we don't listen.

B. Correcting Ill Feelings Within the Department.

We know that accidents can be caused by personal factors, such as worry over health, family, finances and etc. But they are also caused by ill feeling among the workers. A spirit of co-operation is vitally necessary for a well-run department. Here again the supervisor should set the example by close co-operation with other supervisors.

C. Breaking up Crews That Are Quarrelling.

Some of the intra-departmental squabbles require positive action. The supervisor must be able to recognize those people that are better satisfied working by themselves, and also the others that become very dispirited if assigned to part of the plant where they may not see other people for two or three hours. The supervisor must always keep in mind that he is dealing with people. He cannot expect the same definite reaction in every case from his actions in dealing with the people under his direction.

VIII. Inspections.

A. Departmental Inspections.

The departmental supervisor must be the departmental safety inspector every hour of the day. If he will again just listen he will have the aid of his men. He has to take immediate corrective action on their reports or complaints of hazardous physical conditions, unsafe tools and equipment. Delay can be serious, not only from the standpoint of the immediate hazard but the men will think you do nothing regarding the recommendations or are merely delaying to get the credit yourself. But in addition to this I feel that the supervisor should have a definite program of periodic inspection of physical conditions, tools and equipment.

VIII.B. The Supervisor's Part in General Plant Inspection.

I know that to have a plant inspection group consisting of all supervision would be impossible. I do feel that such inspection committee should at all times include at least one line foreman. I know of no better way for him to get the proper training for making his own departmental inspections.

IX. Machine Guarding.

We will not be able to spend much time on this subject but I feel that the supervisor must participate in the decisions on what should be guarded and the types of guards. He is certainly the one that is responsible for instructing the worker in its use and if necessary see that it is used. He must also be responsible for the proper maintenance of such guards in his department with a view to accident prevent.

ETERNAL VIGILANCE

This problem of accident prevention is one that the supervisor has to contend with forever. This does not mean that we should not have regular inspections. Certainly the supervisor should set aside the necessary time for periodic all around safety inspections of his department and give this his entire attention at this time. But in addition to this we must never relax in our search of ways and means to prevent accidents. We cannot accomplish our purpose by just continually preaching to the men. In the final analysis it is we who should and must take the actions necessary to make the employee's job a safe job. I realize we as supervisors do not have the time for research that the safety director has, but we can and should read. I not only read the pamphlets, circulars and magazines that come to my desk, but also try to read some of those that by-pass the supervisor's desk. I realize that a lot of the material written on safety is repeat stuff, just like what I have said today has all probably been said before. But the very piece of paper we throw away without reading might relate someone else's experiences in removing an accident hazard that practically parallels one of our own. The unsafe acts can be stopped and unsafe conditions can be corrected by management, but only by constant vigilance and supervision. The supervisor can never, and should never attempt to escape his responsibilities. As management representative he is responsible if hazardous conditions are allowed to exist.

I know of no better motto for a safety minded supervisor than ETERNAL VIGILANCE.

UNIVERSITY EXTENSION--UNIVERSITY OF CALIFORNIA
Department of Institutes
Berkeley

INSTITUTE ON INDUSTRIAL ACCIDENT PREVENTION
February 4-6, 1948

# ACCIDENT PREVENTION OBJECTIVES OF ORGANIZED LABOR

Speech
by
John F. Shelley, President, California State Federation of Labor, and
President, San Francisco Labor Council

It is indeed a pleasure for me to speak to you on the subject "Organized Labor's Objectives in Accident Prevention." I appreciate, not only for myself, but for the one million or more AFL members in the State of California, the initiative which the University of California has shown in bringing this important subject of accident prevention to the attention of the many professional people here.

Of all groups, labor probably has the greatest stake in accident prevention work. Year after year thousands of workers are killed in industrial accidents; families lose their sole means of support, children must leave school earlier than is desirable in order to find work and make what contribution they can to the family income. The future earning power of thousands of partially disabled workers is impaired for life, while over a million workers receive temporary injuries. The tragedy behind these facts is all the more appalling when one realizes that 80 to 90 per cent of all accidents are easily preventable.

Mr. Max Kossoris is now out here in San Francisco as chief of the Bureau of Labor Statistics Regional Office, and, I believe, has attended some sessions of this Institute. He has prepared some interesting statistics on the number and severity of accidents in the United States during 1946. According to Mr. Kossoris, actual time lost from work because of disabling injuries during 1946 was estimated at about 42-3/4 million man-days, a sufficient amount of time taken out of production and services to have provided full-time employment over an entire year for about 142,000 workers. In other words, the effect of disabling work injuries was to subtract that many workers from the country's labor force for all of 1946.

Mr. Kossoris goes on to point out that if you take into consideration standard time charges for future economic losses occasioned by death and permanent impairment, the total time lost caused by the year's disabling work injuries was estimated to reach a total of nearly 230 million days, or enough to supply full-time annual employment for about 765,000 workers.

Some 16,500 workers were killed in 1946, according to Mr. Kossoris' estimates, while some one million nine hundred thousand workers received temporary injuries. These temporary injuries alone lasted an average of 17 days in manufacturing industries. If all injuries are considered, 3.2 days were lost because of work injuries by every person employed a full year. This estimate includes all people employed and incluedes standard time charges for deaths and permanent impairments.

A little study and reflection on these figures convince even the most skeptical that the continuing dreadful toll of accidents must be stopped. Labor, management, government and our scientific and technical men must all work together to reduce this terrible loss of human life and industrial production. We have made much progress during the last 15 years, for estimates of the National Safety Council show that accident frequency and severity rates among their reporting firms have declined by nearly 50 per cent since 1930. This progress is splendid, particularly in view of the millions of new young and untrained workers who entered industry during the war period. But as long as 16,500 workers are being killed annually in industrial accidents, while one million nine hundred thousand are injured, we must consider our recent achievements in accident prevention work as sound and convincing proof that the rest of the job can and must be done.

The seriousness of this loss of manpower became apparent to everyone during the acute manpower shortage which arose during the war. That shortage is still with us. If we are to meet the goals of the Marshall Plan, not a day of production must be lost.

We in organized labor feel that the people of the United States, and Congress in particular, would have done well during the last couple of legislative sessions to have concentrated on some constructive measures to reduce the accident toll,which, as just pointed out, reached a total of about 230 million days. Instead, Congress and the general public showed an intense and inordinate concern over the number of man-days lost through work stoppages, which has averaged 29 million man-days from 1939 through 1946, a relatively insignificant figure compared with the time lost through accidents.

At the turn of the century, organized labor led the fight for workmen's compensation laws in an attempt to lessen the burden of accidents to workers. We have continued this fight ever since. Here in California, through the legislative efforts of the California State Federation of Labor, I am proud to say, we have one of the best workmen's compensation laws in the United States.

Workmen's compensation, we realize, has done much to force employers to concentrate upon safety measures. We have found, however, that compensation laws and safety and factory inspection laws alone are not enough. Most compensation laws provide compensation at from 50% to 66-2/3% of weekly earnings, and in addition there is a maximum limit which is never higher than $30 a week. Average weekly earnings throughout the United States were $51 in October, so that workmen's compensation obviously does not begin to compensate the worker fully for the cost of the accident. We are learning that no matter how good a workmen's compensation law may be, safety and no accidents at all are far, far better.

We in organized labor have felt that with the passage of safety laws the problem of accident prevention is primarily one for management and for the government. We are realizing, however, that this is a lazy, do-nothing and old-fashioned idea. At best, factory safety laws are minimum standards and do not represent the best practice in the industry. Furthermore, state inspection departments are hampered by lack of funds and untrained personnel. Non-profit organizations, such as the National Safety Council and the American Council of Safety Engineers, and the many other organizations represented her today, have done much helpful publicity work, and many employers have made good use of their services. Nevertheless, the majority of employers, particularly the smaller plants of less than 500 employees, where some 69 per cent of American workmen are employed, have been largely untouched by the efforts of these organizations.

The small firm cannot afford a full-time safety department; its executives are necessarily confronted with manifold problems of production, finances, sales and industrial relations. The head of a small firm rarely joins organizations such as the

National Safety Council chapters and is relatively untouched by the publicity and accident prevention work provided by this organization. The accident rate in these firms must be extraordinarily bad before it is recognized as a problem. One accident in each of the small firms in an industry might add up to a terrific toll for the industry as a whole, but each plant would consider the matter as just an accident, more or less taken care of by its insurance agent. The accident was something extraordinary and not in the least likely to occur again.

These remarks apply equally to the farming industry. Here in California, farming is well-known to be a large-scale, highly specialized industry. An individual farm, such as the Di Giorgio Ranch in Kern County, where the National Farm Labor Union is striking for better wages and living conditions, employs some 1,000 permanent year-round workers, most of whom are semi-skilled. Mechanization is increasing on farms here and throughout the country, and with it the hazard of work accidents. The Illinois Agricultural Association estimated that 32 per cent of all fatal farm, home and work accidents were due to machinery in 1945 and 1946, compared with only 18 per cent in 1938 to 1942.

Organized labor is coming to realize that it must assume the responsibility to take the initiative in bringing the importance of safety and accident prevention work before its members and before the employers with whom it deals. I look forward to the day when every international union and every large local, city and state council will have on its staff a person well trained in the safety principles for the industry or industries with which he is dealing. This person should, if possible, be a professionally trained safety engineer employed on a full-time basis; if union finances do not permit such a position, the union should either get a part-time person, or select one of its members to act as safety official.

Every union should see to it that one or several of its members familiarize himself with the technical safety problems in his industry. This person should know what the accident rates are, how accidents have occurred, and what are the best methods of preventing them. He should be able to talk with equally well trained safety experts from management's side, and insist that all collective bargaining contracts include provisions on safety practices. He should be able to take a prominent part in presenting proposed safety orders to the appropriate government agencies, and assist in tracking down diseases due to occupational factors and entitled to coverage by workmen's compensation laws. He should work with machinery manufacturers and employers planning to install new machinery to see that all such new machinery is made safe before it is installed. The American Federation of Labor at its annual convention in 1946 adopted a California State Federation of Labor resolution on this subject. The resolution pointed to the alarming rate of industrial injuries and urged that the problem be tackled at its source by requesting the Secretary of Labor to institute a nation-wide program encompassing all manufacturers of industrial equipment and urging them to install proper safeguards when the machines are manufactured. A union safety specialist could help in working out the details of this program in each industry.

The union's safety official should also publicize the safety rules throughout the locals and see that unions themselves discipline their members on safety regulations. Carelessness resulting in an injury to one worker may well result in an injury to many. The union should not countenance workers who are too lazy to wear goggles where goggles are necessary, who refuse to wear proper helmets when they are subject to accidents from falling objects. Workers who want to prove they have a sense of humor by indulging in a lot of horseplay with intricate, potentially dangerous machinery should not be tolerated.

Some unions already have such specialists, but we must have many more. Facilities must be made available to train union people in safety work so that they may carry accident prevention principles to both employers and their fellow workers.

During the war, the U.S. Department of Labor's Division of Labor Standards and the United States Department of Education cooperated in offering special safety classes to union representatives. The courses were offered through recognized engineering colleges; classes were arranged at convenient locations for workers and held during evening hours. I understand that the course covered 64 hours of class and plant visit work. The material used was similar to that used in safety classes for production supervisors, and the Labor Department tried to have at least 30 men in each class. This type of class should be revived.

I note that President Truman in his budget message to the present session of Congress asked for some $6,000,000 to be used, I believe, for grants-in-aid to states to launch a new industrial safety program to foster safe working conditions. Scanty press reports do not make clear how this money is to be spent. It should provide for a resumption of the wartime safety training program. The United States has a national income of nearly 200 billion dollars; it lost nearly two and a half billion dollars as a result of industrial accidents in 1946, according to the National Safety Council. Six million dollars for additional safety work seems completely justifiable.

The work of specially trained union safety men should be supplemented by joint labor-management safety committees. Safety Committees should not degenerate into grievance committees, and it would be well to provide specifically that the union members of such committees should not be shop stewards or members of the grievance committee.

The safety committee should be composed of responsible workers who are familiar with the industry; in this connection, the United Mine Workers requires that safety committee-men must have had 15 years experience in the industry.

Thus the aim should be to obtain employees who are experienced in the industry and at the same time to provide for some rotation in membership so that as many employees as possible become actively interested in safety work.

The committee should utilize all possible means of publicity. It should have special bulletin boards placed in strategic spots throughout the plant. It should organize contests between workers as to who can spot the most hazards. It should set up a suggestion box system and make periodic awards to workers for outstanding contributions to plant safety. Finally, a giant scoreboard recording the plant's safety performance throughout the year might arouse interest.

An employer desiring to cut down his accident rate will find such a committee very helpful. Workers, after all, are directly concerned with the machine and its operation and have very concrete and valuable ideas on what safety devices are needed and how these devices can be improved. Furthermore, the human element in accidents is such an important factor that no management can expect its campaign to be successful if it does not have full cooperation. This cooperation can best be secured through an employee committee. You cannot expect a piece worker to appreciate a new safety device which cuts down his rate of production. If you consult the workers first and make proper arrangements for such developments, you will get 100% cooperation.

A safety committee should hold regular monthly, or possibly more frequent, meetings, pending on the amount of work it has to do. If the plant is divided into departments, each with its own safety committee, the plant-wide committee will probably have to meet only once a month. Chairmanship of the meeting might alternate between the leading union representative and the management's safety official. Attendance should be checked and those members who fail to show up regularly should be dropped. The safety director should present the month's accident record and comparison with the previous month or months. A chart showing the frequency rates might be passed around or held in plain view while the safety director points out important items on it.

The committee should then discuss the record, the particular bad accident showings in various parts of the plant, and make recommendations for removing the causes of the accidents discussed. The committee should go over the minutes of the previous meeting to see that earlier recommendations on accident prevention have been complied with. New safety campaigns and suggestions submitted directly by workers through suggestion boxes should also be considered at committee meetings. Any special features, such as seeing safety films, hearing from a special speaker and planning an exhibit can also be arranged.

In addition to its regular meetings, the plant safety committee and its members should carry on a day-to-day follow-up of the recommendations worked out at the meeting. It has become a common practice among plants having safety committees to have committeemen conduct a thorough inspection once a month. In some cases during the war war, there was a tendency to hold more frequent inspections, in many cases as often as once a week. Many committees have worked out inspection forms which serve as a check list for the committeemen during their inspection tour of the department or plant.

To secure cooperation and arouse interest, the committeemen could meet with all the workers in his department and together with the foreman work out the items which should be included on a department check list or inspection form. In general, the committeeman would be on the lookout for unsafe conditions. A typical list might include:

Unsafe work practices.
Floors, aisles, wall and hoistway openings.
Stairways and ladders.
Elevated runways and platforms.
Pressure vessels and apparatus.
Electrical equipment
Power overhead traveling cranes.
Elevators.
Machine hazards.
Transmission equipment.
Hand tools.
Illumination.
Acids and corrosives.
Explosives and inflammables.
Housekeeping.
Fire-fighting equipment.
First aid.

Different industries and operations would call for a check on additional points.

Appropriate questions on each of these items could be developed, copies of the form printed, filled in, and signed by the committeemen, turned over to the safety chairman and from him to the safety director for action.

Union contracts should contain more adequate provisions on safety and the work of safety committees. Some unions -- notably the Chemical Council of the AFL and the United Rubber Workers -- provide penalties for workers who violate safety regulations in the plant. But safety directors and union committeemen agree that education of individual workers is equally, if not more important.

The contract should provide that the safety committee make a special inspection after every accident has occurred to make sure that the conditions which caused the accident have been corrected. No employee should be penalized for refusing to work on a machine found unsafe by the safety committee.

Joint union-management safety committees have been recognized for many years in the contracts of the International Association of Machinists and the United Mine Workers. The contracts of these unions also frequently include detailed provisions on safety and health. The mining industry has long had the worst safety record of any industry in the country, both with respect to severity and frequency of accidents.

These facts were dramatically headlined last spring in the Centralia mine disaster. The miners' one-week period of mourning following this accident and their reluctance to work in unsafe mines seemed to many conservative observers just another of Lewis' shenanigans. The justification of their action, if the death of 111 miners were not sufficient, was clearly shown when Secretary of the Interior Krug himself ordered 518 Government-operated soft coal mines closed because of unsafe conditions.

These developments are indeed a sad commentary on the state of law enforcement in this country; 111 miners must be killed and 300,000 miners must remain away from work to bring about an improvement in safety conditions in mining! Safety work in all fields has all too frequently been delayed until some major catastrophe has occurred and many people have lost their lives.

I think both organized labor and management should consider approaching accident prevention from a regional level. In California and the Bay Area, employers are particularly well organized and they should consider the advisability of having their associations employ a safety engineer. Such engineer would make it possible for smaller firms, who cannot afford to employ a full-time engineer, to obtain the benefit of expert technical advice.

Some unions have already taken steps which indirectly may have an important bearing on accident prevention work. Sometimes these measures have been denounced by the general public as make-work rules and feather-bedding. For instance, the Painters Union has been attacked because it has required certain safeguards in the use of spray paint. Yet in many instances, the union practice has turned out to be needful and just and has been incorporated in state safety codes.

Unions are constantly on the watchout for speedups. It is our position that no increase in production is justified if it results in a higher accident rate. In this period of shortages and high prices, labor unions, as well as consumer groups, realize that production is the only answer, but it must be <u>safe</u> production.

Another union goal which has been indirectly responsible for reducing accidents was the campaign for the 40-hour week. Wartime studies by the Bureau of Labor Statistics showed clearly that in the absence of an adequate safety program, work injuries tended to occur more frequently under long hours. In one plant studied by the Bureau of Labor Statistics daily hours were reduced from 10 to 8 and as a result the accident rate was cut to one-third.

I have mentioned union safety specialists and joint safety committees as two objectives of organized labor in its campaign to reduce accidents. A third objective is the improvement of government safety inspection programs. Strong as organized labor is, it cannot reach all workers; many are still in unorganized plants or in shops so small that they cannot be easily organized. The only protection and assistance these workers get is through the state factory inspectors.

We feel that safety orders must be improved. As I said before, these orders are only minimum standards; they do not represent even the average practice in the industry to which they apply. The best methods as practised by a few leading firms, are applicable to all firms and must be taught to all employers in part by state safety officials.

First, however, these officials must be able to act in an effective and intelligent way. It is not enough to send some man who has earned a job as a result of some political deal into a factory and tell him to look around. He may look around, but that's not much use if he doesn't know where to look and what to look for. Or maybe he won't even look around; perhaps he'll get himself a nice free lunch and his report might just as well be gently dumped in the waste basket.

These remarks do not apply to California, for our State Division of Industrial Safety maintains a high degree of efficiency, but the procedures I have described do occur in other states. As long as such situations exist, an effective safety program is impossible. We must have well trained and conscientious people, operating under a merit system, in our state safety departments, and we must have plenty of them. Organized labor in California will continue to support and fight for the maintenance of these standards.

Once you have a good inspector, you must give him the proper information and tools to work with. The first step is a detailed report on accidents in each firm and industry throughout the area. The reports must show exactly what caused the accident and how it occurred. The California Department of Industrial Relations, Division of Labor Statistics and Research, we are happy to note, announced plans for just such a reporting plan in September 1946. I am sure the value of these reports are already being felt by employers as well as the Division. When you have to sit down and fill out a long complicated form, you think more than twice about what made the form necessary. And at the same time you do some thinking about how to avoid another accident and another form; the questions themselves suggest solutions.

For the officers of the Divsion of Industrial Safety, the reports, individually and when compiled, point up the plants and industries with the worst records and show the particular kinds of problems involved. Accidents often involve the same tool, material or equipment throughout a plant, or they may be the result of inadequate protective clothing, or improper use or construction of guarding machinery, or disregard of any one of the many other seemingly simple and commonsense precautions against accidents.

With this information in hand, the inspector can make a really practical and pointed investigation. He doesn't go around looking for oil on the floor when the reports show that overhead cranes are the principal cause of accidents. He knows which departments and operations to investigate with particular care. He doesn't have to waste time inspecting places where no accidents occur.

I think it would also be feasible and highly desirable for the Division of Industrial Safety to plan its inspection visits using these detailed accident reports as a guide. Instead of spreading its inspectors thin over all firms in the area or all industries in the area, the Division could send its men almost entirely to those industries and firms with bad records. The inspector could give such places a really thorough going-over; sit down with management, department heads and foremen and really work out the particular problems of accident prevention. He would have more time to demonstrate the effectiveness of the various methods and to check on their actual installation and use.

The firms and industries with relatively good accident records do not need inspection and assistance as much. They either have relatively minor problems or are taking effective steps to reduce accidents on their own initiative. They need occasional inspection just to keep them up to scratch, and to make sure they are continuing their good work, but an inspector's time can be spent far more effectively and usefully by concentrating his visits on the plants and industries with poor records.

I do not know to what extent the Division of Industrial Safety is already making use of these principles. I hope they will give them every consideration. The terrible toll which accidents are taking of workers must be cut down, and the only way to do it is to keep hammering away at the worst spots. Labor wants to see principles like these put into effect so that state agencies here and in other states can make their maximum contribution to accident prevention among both organized and unorganized workers.

Most of the suggestions I have made today can be applied equally well to the problems of industrial disease, sanitation and health. While at the present time the percentage of claims paid under Workmen's Compensation for occupational diseases is low -- 1 to 3 per cent of claims paid for industrial accidents -- this comparison does not give the complete picture of the relative importance of such diseases. Diseases are difficult to detect, the effects of poisoning are frequently delayed, and probably the cases of industrial diseases are not completely or adequately reported.

Organized labor, together with management and the safety engineer, must be constantly on the lookout for new diseases as well as for better legislation to prevent their occurrence and to compensate the injured workmen fully. Occupational diseases are now covered by the workmen's compensation legislation of 39 states, but in most of these states only a limited number of specified diseases are covered. For instance early in 1946, 33 states provided compensation for industrial diseases, but only 16 of these states covered all diseases, while the remaining 17 states covered only specified listed diseases. As you all realize, industrial processes are continually being improved and new substances introduced, so that one is almost justified in saying that, counting the time it takes to pass labor laws, these lists of legally compensable diseases were already somewhat out of date before the ink in the governor's signature was dry. The absence of health insurance in this country makes the passage of adequate industrial disease laws particularly important.

Health and sanitation, both in the plant and outside it, have come to occupy an increasing amount of time among the safety committees organized during the war. In part, this attention was a necessary result of the crowding, long commutes, and poor housing associated with many war plants. Union safety committeemen in some shipyards have supported the company's practice of giving physical examinations as an aid to proper placement and have urged that in particularly hazardous occupations such as welding, spraying and boiler-making, frequent and regular check-ups be given. In some instances, the safety committee in these circumstances has felt it should not spread itself too thin by trying to solve all the problems related to off-the-job safety and health.

The final point which I would like to make this afternoon is safety education. It is an unusual and progressive step for a college to call a safety conference. The wartime need for conserving manpower put so much attention on safety that colleges and universities throughout the country are beginning to establish safety engineering as a regular part of their curricula. The increasing prominence given to safety work together with the many new industrial processes that are being developed with their attendant new and unforeseen hazards, make safety engineering a must for every union, corporation and business in this country. The number of experienced men in the field is limited and more must be supplied by our colleges and universities.

I am glad to see that the University of California is taking an active interest in this field. And as the attendance at this institute shows it is a problem which engineers, safety engineers, management and labor must all work on. New machines and new processes must be safe; both labor and management have a stake in seeing that they are safe and that they are used properly. Organized labor must be concerned not only with wages and hours, but with all the details of working conditions, including accident prevention. It must make its needs felt through its own safety specialists and through representation on safety committees.

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INSTITUTE ON INDUSTRIAL ACCIDENT PREVENTION
February 4-6, 1948

(Outline)
Safety Inspections and Preventive Maintenance

Edgar N. Goldstine--Consulting Safety Engineer, San Francisco

Before discussing safety inspections and preventive maintenance, it would be well to consider what they mean.

SAFETY INSPECTION: To view closely and critically working conditions, working methods, and working people for the purpose of identifying and noting for correction those which might contribute towards causing an accident.

PREVENTIVE MAINTENANCE: Anticipatory adjustment, servicing, repair, replacement, or improvement, as required, of tools, equipment, or other agencies, to prevent accidental failures.

ACCIDENT: Any unplanned physical occurrence that interrupts or interferes with the orderly progress of human or mechanical activity.

The key words of these definitions indicate that a knowledge of what needs to be done is an indispensable preliminary in any effective program for safety inspections and preventive maintenance.

This knowledge can be obtained from a number of sources, including the Safety Orders of the Division of Industrial Safety of the State of California, the publications of the National Safety Council, various texts and publications on accident prevention and industrial hygiene, reference books, etc.

Even possessed of all this knowledge, it is still necessary to call in certified inspectors for inspection of pressure vessels, boilers, and elevators. Industrial hygienists may be needed for determining the extent of certain industrial health hazards, and the measures needed for minimizing them effectively.

Preventive maintenance on cranes, motor vehicle equipment, electric motors, power transmission equipment, etc., is performed by mechanics. Safety Engineers may be in a position to help get a better job done by assisting in the development of schedules of inspection and maintenance, with check points, so that the work will be done more thoroughly and perhaps more frequently, so as to prevent breakdowns.

Safety inspections and preventive maintenance make it possible to find most of the hazardous conditions which may cause accidents, and these conditions can then be eliminated or minimized in most instances. It is important to examine all factors affecting the work. Everyone should make safety inspections to some extent, particularly of conditions over which they have control. In addition, there should be formal regular inspections by Safety Inspectors, Safety Committees, Foremen, and others. Every place where anyone works or has to go to work warrants inspection, along with machinery, equipment, housekeeping, etc. Some inspections need to be made constantly, others at regular intervals more or less frequently. Made intelligently and competently, with the information gained used to guide accident prevention efforts, safety inspections and preventive maintenance can become one of the most important elements of a sound accident prevention program.

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INSTITUTE ON INDUSTRIAL ACCIDENT PREVENTION

Kenneth J. Wulbern, Safety Supervisor for Matson Navigation Co., United Engineering Co.

# INDUSTRIAL TRAFFIC CONTROL

1. Three Factors:

   A. Employee Operator
      (1) Selection
      (2) Training
      (3) Incentives

   B. Equipment Used
      (1) Selection
      (2) Utilization

   C. Maintenance
      (1) Responsibilities
      (2) Systematic Check System

2. Control

   A. Problems

   B. Remedies

3. Routing

   A. Problems

   B. Remedies

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# SCIENTIFIC FACTS CONCERNING ELECTRICAL HAZARDS

by

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The bizarre effects and the vagaries of electricity have commanded attention for a long time. The awesomeness of natural lightning in contrast to unspectacular death from contact with low-voltage circuits has led to conflicting theories, and confused both scientists and laymen. Observers instinctively question why some victims suffering great physical damage from contact with high-voltage circuits survive, when others are killed instantly by casual contact with a low-voltage circuit.

The public is much more aware of electrical hazards than ever before, no doubt as a result of reading press reports of electrocutions and costly explosions and fires attributed to electrical origin. Explosions and fires caused by electricity and electrocutions are commonly classified as originating from power circuits or from static electricity.

With reference to press reports, it should be stated that a rather large number of calamities are attributed to electrical origins simply because of failure to ascertain the true cause. However, many of these disasters are of electrical origin.

Costly explosions and fires caused by static electricity occur frequently in grain elevators, oil refineries, munitions plants, paint factories, motion-picture projection booths, hospital operating rooms, textile mills, printing establishments, gas-filled basements, and when petroleum products are discharged from tank cars or trucks. Many aircraft disasters, such as crash landings and fires and explosions in the air, are attributed to static electricity.

The U. S. Armed Forces report that some 25 per cent of airplane casualties in the Army and Navy during the recent war, at home and abroad, resulted directly from obliteration of radio communications and from the erratic behavior of radio flight instruments by static interference. Electrocutions, explosions, and fires are also caused by insulation failures in power machinery and associated equipment, home and farm appliances, etc.

The only practical difference between static electricity and dynamic electricity is the mode of generation. The usual definitions--that static electricity is electricity standing still, and that dynamic electricity is electricity in motion--are of little value in discussing electrical hazards. It is only when electric charges move that death or damage to property can occur. Transfer of electrical charges, regardless of their origin, constitutes an electric current, and it is the flow of electric current that gives rise to damage.

Dynamic electricity, the electric current of industry, is generated by rotating machinery or by chemical action. Alternating-current and direct-current dynamos generate electricity by virtue of the rotation of electrical conductors in a magnetic field. Storage batteries and dry cells produce electricity as a result of chemical action between dissimilar substances. These means of generating electrical energy are well understood and subject to precise control. The most important effects produced by electric power currents are the continuous production of heat, light, chemical action, magnetic forces, mechanical forces, and electric arc. Danger to life and damage to property occur only when there is a failure of insulation, misapplication of electrical equipment, or error due to faulty judgment, ignorance, lapse of memory, or carelessness.

In contrast, the generation and control of static electricity are not well understood. The reason is that static electricity is generated by the contact and subsequent separation of particules or minute projections of insulating materials or by tearing apart of water droplets. Everyone is familiar with the accumulation, noticeable especially in cold dry weather, of electrical charges as he scuffs on a carpet and the consequent shock and spark when his hand approaches a grounded metal object.

Usually the spark is harmless. The shock is annoying only because it is unexpected. On the other hand, in an industrial plant such sparks may be produced in a space which contains combustible gases or dust. Then they constitute a very serious explosion hazard. The voltages which result from rapidly moving belts, conveyors, paper stock, fabrics, and rubber-tired vehicles, as well as those which originate at nozzles from rapidly issuing steam and gases, attain amazingly high values under certain conditions.

Electric charges may also be produced when petroleum products flow through pipes and hoses under conditions of high velocity and violent turbulence. The accumulation of these charges at terminal tanks under conditions favorable to the generation of static electricity may produce voltages from a few thousand to as much as 75,000 volts.

Surprising as it may seem, one can electrify his body to a potential as high as 10,000 volts by merely scuffing over a woolen rug and consequent discharge may cause a spark of sufficient intensity to ignite a gas jet or discharge an electric blasting cap. Although fortunately not a common occurrence, many serious accidents and deaths have been attributed to the ignition of vapors from an anesthetic administered to patients on the operating table, owing to the discharge of the body charges generated by the surgeons when scuffing about on the floor during the operation.

Lightning, the most terrifying of frequent natural phenomena, is the result of vast accumulations of electric charges and their sudden discharge. The static electricity generated in a thunderhead is believed to be due to the sudden tearing apart of water droplets as they are caught in the violent, turbulent updrafts which are always present in thunderheads. The effects produced by static electricity are mechanical forces of attraction or repulsion and the spark or lightning flash.

With the exception of the violent phenomena associated with lightning, the common effects of static electricity are usually unspectacular and feeble. Static electricity is important mainly because of its capricious behavior. It may be a source of annoyance, and it may produce fire or explosion, or serious interference with communications. Because of constantly changing atmospheric conditions, static electricity is difficult to predict and difficult to investigate experimentally in the laboratory.

## Typical Electrical Hazards

Lightning: Although the energy in the lightning discharge is small, the rate of energy dissipation is tremendous. The resulting pulse of current and the accompanying mechanical forces may produce unbelievable damage in the immediate vicinity of the stroke. Just prior to a lightning stroke the electric field is intense and very large numbers of electric charges accumulate on nearby objects. At the instant the stroke occurs, the electric field between the cloud and the earth collapses, thereby releasing these bound charges, which may in turn produce secondary discharges. The secondary discharges are called induced strokes. They are much less in intensity than the main stroke, but they may break down commercial electric insulations, or, if they result in open sparks, cause fire or explosion. Protection against lightning includes lightning rods and gaps, ground wires, bonding wires, and lightning arrestors.

Static Electricity: The discharge of static electricity is similar to a lightning flash except that the charges and voltages are much smaller. Control of industrial static takes various forms. However, all methods depend upon neutralizing or discharging the static electricity so that no spark is produced. Although each problem has to be solved in such a way as to meet its own distinctive conditions, the fundamental is to provide means whereby the electric charges are led away harmlessly as fast as they are produced. When all objects concerned are conducting, this can readily be accomplished by bonding all conducting objects together and connecting them to a common ground, thus preventing the formation of sparks between conducting objects. Such sparks are usually far more intense and likely to start a fire than the feebler sparks which occur between the insulating surfaces.

This procedure has the further advantage that it provides protection against electric shock to the operator of electrical equipment--shock which might result if accidental leakage or insulation failure should occur between the energized conductors and the frame of the machine.

To be effective in discharging static electricity as fast as it accumulates, only very high resistances to ground are required; resistances of millions of ohms suffice. However, to provide satisfactory grounding against leakage from the power circuit, the ground circuit must have a resistance sufficiently low to permit enough current to flow to operate the circuit protective equipment, such as fuses or circuit breakers. Heavy conductors must be used where the ground connection may also be called upon to carry currents resulting from lightning strokes.

Recent developments in semi-conducting rubber, linoleum, and paints should be of great value in reducing static hazards of insulating materials in industrial processes. Now partially conducting floor coverings and semi-conducting shoes have reduced the static electricity hazard of hospital operating rooms. Semi-conducting belts should prove an excellent remedy for static troubles encountered by this kind of equipment.

Several types of static neutralizers have been developed for special applications. These are installed at the place where static electricity is generated. An older and possibly less successful method is the maintenance of a relatively high humidity -- high enough to permit the static electricity to discharge to ground as surface leakage currents. Proper grounding when discharging petroleum products has reduced the static hazards of tank trucks and when fueling aircraft.

Dynamic Electricity: Although years of painstaking research and scientific development have greatly increased the safety of electrical equipment and home appliances, and inspection of new installations have done much to protect the public against misapplications, poor workmanship, or defective materials, shock and fire hazards may develop from a variety of causes. Hazards due to insulation failure are minimized by bonding and grounding all metal noncurrent carrying parts, such as conduits, machine frames, etc.

It is very important that the ground wires be strong mechanically, so that they will not easily be broken, and that they have a current-carrying capacity sufficient to conduct short-circuit currents harmlessly to ground. The resistance of the ground wires and the connections to ground must be low enough to permit operation of the circuit protective equipment, such as circuit breakers and fuses. When viewed in this light, the danger of overfusing, not to mention the coppering of fuses, is immediately apparent.

The second line of defense is education. The public must be continually warned against using defective or wornout equipment and appliances. The slightest shock must be regarded as having potentialities of death; the device must immediately be disconnected and competently inspected. The public must be taught to employ extreme caution when using electrical appliances in hazardous locations. Moisture and adjacent grounded objects create serious hazards.

For example, one should cultivate the habit of standing on some insulating material, such as a rubber mat, a dry board, or a pile of canvas, when handling electrical equipment in damp basements, or when inside metal tanks. One should never touch an electric fixture when in the bathtub.

## Electrical Accidents

The frequency of electrical fatalities in this country in recent years is about constant at 1/100,000 of the population. This figure is only a rough estimate, as it is difficult to obtain accurate information on a nationwide basis. The National Safety Council reports a total of 998 electrocutions during 1945. Of these, 730 were due to power circuits and 268 due to lightning. Although some states have commissions charged with recording and investigating both nonfatal and fatal accidents, the commissions are generally restricted in their activities to industrial accidents.

Electrical accidents are classified according to the voltage of the circuit involved. Accidents on circuits below 800 volts are called low-voltage accidents. These are further subdivided into those under 150 volts and those over 150 volts but less than 600 volts. Attention is directed to the substantial number of accidents which occurred in the home or on the farm, expecially those involving bathtubs, extension cords, and lamps. Accidents involving portable tools are of special interest because of the recent change in grounding recommendations.

How many of the actual total of electric shock cases have been reported in the newspapers is difficult to say. However, a check of clippings made in one state indicated that, so far as fatal shock cases were concerned, the proportion reported in the newspapers was high. However, the small number of nonfatal shock accidents indicates that relatively few accidents of this type are reported in the newspapers.

An analysis of fatal accidents reported by the Accident Prevention Committee of the Edison Electric Institute for the year 1945 within the electric light and power industry shows that although 68 per cent of the fatalities were attributed to electric shock or burns involving circuits from 110 to 66,000 volts, only four fatalities were reported for voltages in excess of 33,000. This may be surprising in view of the fact that circuits up to and including 220,000 volts are worked "hot."

Although the hazard from contact with high-voltage power circuits is generally appreciated by both the electrical worker and the public, it is unfortunate that the danger of low-voltage shocks is not so generally recognized. While it is true that the hazard from contact with electric circuits is largely dependent upon voltage, the actual danger to life depends almost entirely upon the current produced. For example, a man accidentally coming in contact with a 60,000-volt circuit when standing on a very dry pole may cause a smaller current to flow than a person who inadvertently grasps a defective 110-volt portable appliance when in a bathtub. Ohm's law, I-E/R, applies in both cases.

The difference in the circuit resistance in the two cases may be sufficient to compensate for the great difference in the voltages. It is the ratio of voltage to resistance that determines the current that will flow and hence the danger to life. It is difficult for the layman to grasp the difference between the hazard of voltage in contrast to the danger of electric current. Current is the proper measure of electric shock intensity; damage to living tissue is caused by current and not by voltage. For a given voltage, the current that flows in a circuit depends upon the resistance of the circuit. With the exception of special constant current circuits (such as high-reactance sign transformers and certain radio circuits, the resistence of the power circuit is usually negligible in comparison with the resistance of the body circuit; the latter includes the internal resistance of the body, skin, and contact resistance.

The internal resistance of the body is difficult to determine. However, it is believed that the resistance between major extremities, such as between the arms, leg to arm, leg to leg, etc., is about 500 ohms. The resistance from temple to temple is about 100 ohms. The resistance of the body circuit when the skin is dry may be as high as 600,000 ohms. When the points of contact are wet with salt solutions or perspiration, this value may fall to 1,000 ohms.

Furthermore, body and skin resistance decrease with both time and current. In high-voltage shocks, deep burns may be produced instantly, and the protection afforded by the skin becomes negligible. In this case, the resistance of the circuit suddenly falls from its original high value to a low value of 500 ohms, or less. The protection afforded by dry skin accounts for the relatively few accidents on low-voltage circuits.

It is important to note that the normal or rated current of a circuit bears no relation to the current which may flow during accidental contact or during a short circuit. The danger from electric shock resides in the current passing through the body and not in the normal current consumption of the device. It has been shown that the current that passes through the body in accidental contact depends upon the voltage and body, skin, and contact resistance, and the resistance of the rest of the circuit (in most cases this latter item may be neglected).

Since moisture and firm contact with the circuit greatly affect the total resistance, the hazard is increased many times when moisture and well-grounded objects are involved. By way of contrast, consider your automobile. At the instant you step on the starting switch, the 6-volt storage battery produces currents upwards of 400 amperes, but there is no electric shock hazard because of the very low voltage of the battery.

On the other hand, a 110-volt circuit in which no current is flowing may be extremely hazardous when hands that are wet or bleeding make contact with it. Of course, the hazard is amplified many times during contact with high-voltage circuits because of the hazard inherent in the higher voltage, and because the higher voltage is likely to produce burns which puncture the skin and thus reduce the circuit resistence to a very low value. The current developed in the latter case may be sufficient to blow fuses or operate circuit breakers.

## Effects of Electric Shock

The following is intended to give the reader a general survey of the various causes of death due to electric shock. The treatment is confined to effects caused by 60-cycle alternating current and direct current, and many complicating factors are passed over lightly in the interest of simplicity and brevity.

The minimum current that can just be perceived is important because it is essential that the user not get the sensation of shock when using an electrical appliance. Although no electrical hazard is produced by currents slightly in excess of the threshold of perception, such shocks are startling and might cause loss of balance and subsequent injury by a fall.

Experimental results obtained on 114 men holding small copper wires loosely in their hands with 60-cycle alternating current applied indicate a threshold of perception at 1.0 milliampere. This is the response for 50 per cent of the group. Industrial experience has shown that if the current is limited to 0.3 milliampere, the chance of shock sensation is small.

On direct current the threshold of perception is about 5 milliamperes, which is five times higher than that obtained on commercial 60-cycle alternating current.

With gradually increasing alternating currents, the first sensations of tingling give way to contractions of the muscles. Sensations of heat and muscular contractions increase as the current is increased; sensations of pain develop, and finally the current is such that a person cannot release his grasp of the conductor. At this point the victim is said to "freeze" to the circuit, and if long continued, collapse, unconsciousness, and death result.

For many practical purposes the "let-go current" for 99½ per cent of the group is considered a reasonably safe current. If connections to the body are firm or wet and the shock is of short duration, currents at the "let-go" level produce no aftereffects. However, burns may be produced if abnormally large current densities are present, such as those resulting from pinpoint contacts and sparks.

Currents in excess of one's "let-go" limit are terrifying and painful. Reasonably safe "let-go" currents for 60-cycle alternating current for men and for women are 9.0 and 6.0 milliamperes, respectively. The corresponding values for direct current are 62 and 41 milliamperes.

Alternating currents in excess of about 25 milliamperes are very painful, and when the current pathway is across the chest the muscular reactions become so severe that breathing is difficult if not impossible for the duration of the shock. Death may result from asphyxiation if the current persists for more than a few minutes. However, if the current is interrupted in a reasonable time, breathing resumes automatically and no serious after effects result.

Currents considerably in excess of those causing stoppage of breathing due to muscular contractions may produce temporary paralysis of the nerves controlling respiration, a condition termed respiratory inhibition. The respiratory paralysis may last for a considerable period after interruption of the current. In this case, immediate and continued artificial respiration must be applied to prevent asphyxial death. Often, respiratory inhibition disappears in a few minutes, or in a few hours, and continued application of artificial respiration may save the victim. Mere cessation of natural breathing is not likely to produce serious aftereffects or permanent damage, as is evidenced by the many persons who have been resuscitated successfully.

Currents in excess of 100 milliamperes, if they take a pathway through the body in the region of the heart, may affect the heart, causing what is called ventricular fibrillation. Ventricular fibrillation is nearly always fatal and is commonly called instantaneous electrocution. Experimental work on human hearts is obviously impossible, and resort is made to animal experimentation. For shocks short in duration as compared with the period of the heart cycle, the probability of producing ventricular fibrillation varies with the part of the heart cycle in which the shock occurs.

The greater tolerance for shocks of short duration, together with the variability in sensitivity of the heart to fibrillate, may explain why some accident victims survive apparently heavy momentary shocks, such as those from condenser discharges and high-voltage impulse generators.

Susceptibility of producing ventricular fibrillation increases with current up to a maximum and then decreases as the current is increased. The explanation of this phenomenon is that the muscular contractions produced by these high currents cause such violent contractions of the chest and heart muscles that the heart is held still in a vicelike grip and fibrillation is prevented.

If the shock is of appreciable duration, death from heart failure is inevitable. However, if the shock is of short duration the muscles spontaneously relax upon interruption of the current, and the heart may resume its normal rhythm. This is in agreement with observed accident cases, for it has been observed that the proportion of victims of high-voltage shocks who can be resuscitated increases as the circuit voltage increases.

Although there is no known cure for ventricular fibrillation, it is believed that the abdominal massage and accompanying stimulation of the heart caused by the application of artificial respiration may be beneficial in assisting the heart to regain its normal rhythm. Since it is impossible for the layman to distinguish between respiratory inhibition, ventricular fibrillation, and heart failure, he should begin artificial respiration immediately upon rescue of the victim from the circuit.

It is very important that resuscitation be continued without interruption, because if the supply of oxygen to the brain is cut off for more than a few minutes, serious permanent injury to the brain is likely to result should the victim recover. The victim should be kept warm and a physician brought to the scene as soon as possible. Artificial respiration should be continued until the victim recovers, or rigor mortis sets in, or a physician pronounces him dead.

Relatively large currents, amperes and not milliamperes, may cause death by overheating the body. Delayed death may be caused by hemorrhages, severe burns, or other serious after effects. Of course, death may result from a combination of the causes just mentioned, or from complications such as injury by a fall, a broken neck, etc.

It is gratifying that, in a majority of cases, victims surviving serious electrical accidents suffer no permanent disability.

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PERFORMANCE REPORTS FOR MANAGEMENT
by J. H. Mathewson*

"The men who run an organization have little time to spend on reading reports. Yet, it is essential that they be fully advised of the problems and developments in personnel administration. Thus, any reports given them must be concise, interesting, and to the point." The truth of the first two sentences in the above quotation is self evident. As to the third sentence, it is my belief that overall safety reports for top management more often than not fail to be either concise or to the point. Sometimes they are interesting but there are strong indications that management, at all levels, often considers them unworthy of much attention.

With enthusiasm and sincerity, many safety directors or safety engineers start out on a program which includes monthly reports for top management. Later, upon finding the reports largely fail to command satisfactory attention from executives, the reporting period is made quarterly (with the avowed intent to make the reports more significant), then semi-annually or perhaps annually. Each change represents a move of desperation by the safety engineer; he is searching for the answer to the question, how can I obtain adequate interest from management? In many instances the safety engineer finds, either intentionally or accidentally, that he gets no reaction from management no matter how he varies either the content or frequency (of submittal) of periodic safety reports. The result is that the reports finally become stereotyped and in extreme cases, not at all rare, are no longer aimed at management but are continued as a form of self defense or for contest purposes.

During the war, accident prevention was largely accepted as a must activity in most branches of the armed forces. However, most of the men charged with the responsibility of carrying out safety programs will testify to the fact that they met with many setbacks. These setbacks were generally the result of misunderstanding and the greatest misunderstanding of all was occasioned by the use of what might be called the conventional frequency and severity formulas. Except for a handful of men trained in safety work, only a few of the officers, high ranking or otherwise, in any branch of the service had a complete understanding of the usual methods of measuring accident prevention performance. A substantial number of those who did become familiar with the procedure disagreed with it and thus prompted a variety of deviations. Here it is highly significant to point out that many of the officers if not, indeed, most of them had only recently been recruited from civilian industry. The deviations were not peculiar to the service, therefore, because safety engineers in several parts of the country had already tried to develop a new index. The fact that none of these attempts have been accorded any widespread acceptance is probably because they all had a common origin. In short they can all be traced back to the standard frequency and severity formulas. Any weaknesses in the basic measuring standards or in the methods of utilizing these standards are thus reflected in any result obtained thereby.

The point may be illustrated by the following two examples. One index used for comparative and contest purposes is obtained by taking the product of frequency and severity. It is mildly interesting, but not particularly enlightening, to see this method expressed in terms of the original formulas. Another method consists of taking the sum of the frequency and ten times the severity. These and other attempts to arrive at a single standard clearly indicate that the need for such a standard exists. They further show that neither frequency nor severity, taken separately or in combination, provide a satisfactory answer.

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The limitations of frequency and severity formulas are well known to members of the safety engineering profession. Briefly, the constants in the numerator of each formula seem to have been arbitrarily decided upon to predetermine the position of the decimal point in the answers. The frequency constant of one million has served this purpose quite well but the severity constant has not since severity rates often have to be carried out to three decimal places. On numerous instances in severity, for example, all of the significant figures come after the decimal point, thus indicating that the constant multiplier in the numerator no longer fulfills its original function.

Both formulas have a great and common weakness in that they are not valid for the small company. There is no absolute line of demarcation to distinguish large firms from small firms although in the safety engineering profession a personnel strength of 500 is considered to be a good dividing line. Now a firm with 500 employees would accumulate a million man-hours in one year's time and an exposure of a million man-hours is considered the minimum necessary to make results from the frequency formula valid. Obviously then, only the largest of the small-size firms can properly use the formula and even for them it is not valid throughout most of the year. For the thousands of companies employing considerably less than 500 employees each, the formula is not valid, but it is being extensively used by and for just such companies. The seriousness of this misapplication will be realized if we consider that of the sixty million workers in the country upwards of 60 per cent are employed by small firms.

The severity formula has even less to commend it! A minimum of one thousand injuries--disabling injuries--are required if it is to yield valid results. This requirement, one thousand injuries, is worthy of more than passing attention because it is a strange and inconsistent factor in the language of any safety engineer. That is, if it refers to the experience of any one company. But this is not the only inconsistency. The formula employs two different time units; man-days in the numerator and man-hours in the denominator. In general, workers are paid on the basis of the hour unit and management is entitled to know what the loss is in terms of this well nigh universal unit. Safety engineers seem to have missed this point for several decades but they would be well advised not to keep on missing it.

Another matter of some significance is the use of the American Standard Scale of Time Charges. Through extensive use of this Scale all sorts of fantastic dollar losses are statistically developed each year. The "Time Charges" allegedly have no relationship to injury compensation costs because of the indemnity differences in the Workmens' Compensation Acts of the various States. Actually, industry or business does not bear the costs implied by many time charge figures. The common explanation behind the charge of 6,000 days for a fatality is well known. However, just what is the present equivalent of 6,000 days in years? For most hourly rate workers, a five day week is in effect, and, in the course of a year, one individual would therefore work approximately 260 days or perhaps not more than 250. This means that the 6,000 day charge represents 24 years instead of 20 as was originally intended.

For results which give an altogether erroneous impression, however, the method of arriving at time charges for temporary total disabilities is no better than the scale of time charges. Calendar days are charged and by thus including the non-working days, Saturday and Sunday, almost 30 per cent more time is considered lost than is actually the case. At some subsequent point in the statistical chain, a portion of this 30 per cent is transformed into dollars and the result multiplied by four to get the so-called indirect cost to industry.

No portion of the day of an injury is ever charged as lost time even though the loss is real and always determinable. Strangely enough then, it is mandatory to charge Saturdays and Sundays even though they involve no loss while it is mandatory not to charge a known loss on the day of injury. On the basis of the law of averages it will be evident that every disabling injury represents a loss of one-half of a man day on the day of injury.

Reports based on the procedures and practices described above have little to commend them. Such reports fail to command proper attention from management and this apparent lack of executive interest is obviously fully justified. Nor is it to be expected that management will evince much concern about the findings or conclusions in periodic safety reports until such time as the reporting procedures are completely revised.

At the beginning of this paper it was stated that the men who run an organization must be kept fully advised of the problems and developments in personnel administration. In safety work we need to extend this statement to cover all phases of accident prevention. An important phase which has been largely neglected is that of accidents involving no personal injury. With some exceptions, such accidents are not investigated and in too many instances the safety engineer does not concern himself with such cases. In fact, many of them occur without his knowledge.

Ponder, if you will, on a situation such as the following: An accident takes place and a man is injured but there is no damage to equipment or material. The man is promptly replaced by an equally competent worker and the only loss to the company is medical and compensation payments totaling $500. Now take another accident in which there is no personal injury but damage to equipment and loss of production due to "downtime" amounts to $500. The first loss is reflected in the frequency and severity figures reported to management but no dollar loss is reported as such. Management, presumably, can gaze into the crystal ball and figure out the cost. In the second case, management gets no report on the loss, at least not from the safety engineer, despite the fact that the loss, (1) is just as great as in the first case, and (2) resulted from an accident.

The safety engineer presumably has responsibility for directing accident prevention effort. This is true regardless of the type or cause of any accident and it therefore follows that he has the further responsibility of reporting to management the losses resulting from all accidents. Many safety engineers have failed to justify their activities on a dollar basis and in particular this is the group which places all of the emphasis on the humanitarian motive. They do not believe that accident prevention can be proved to be a profitable venture in terms of money and they have ceased trying to prove it. In neglecting to get the most out of the no-personal-injury category of accidents, however, they are not alone since this area has been largely ignored by the majority of safety engineers.

Admittedly it is difficult to obtain information on all no-personal-injury accidents but this does not by any means imply that it is impossible. Every practicing professional engineer encounters occasions when he must exhibit considerable ingenuity. The safety engineer would, I believe, quickly dispute any inference to the effect that he is less ingenious than his contemporaries in other areas of engineering! Nevertheless, if he continues to admit defeat in accidents limited to equipment and material damage he will, by his action or rather inaction, be clearly indicating that he lacks the ingenuity necessary to cope with the situation.

Some aspects of first-aid cases are also worthy of comment. In terms of lost working time a first-aid case may involve anything from a few minutes up to just short of a full working day. Furthermore, there is no such thing as a personal injury without some loss of time; not if any kind of approved medical treatment is given. In spite of this, the reports furnished management give no indication of any loss from accidents which involve only first-aid cases. Such cases are blanketed under the general escape clause "non-lost-time injuries" and in most instances are not even reported to management in any form. The ratio of first-aid cases to disabling injuries has been found to range from 5 to 1, up to 30 to 1 or more. It will be readily apparent, therefore, that non-disabling injuries involve a considerable loss of production time.

Both by training and the literature they read, safety engineers are exhorted not to include first-aid cases in their computations. To impress them with the necessity of heeding this advice, dire consequences in the form of infections are held to be the inevitable result of discouraging the reporting--by workers--of minor injuries. This may have been true at one time but it is no longer tenable. Most present-day workers know that their claim rights are seriously jeopardized if they fail to report, and receive treatment for, every injury they sustain.

Certain conclusions can be drawn from the preceding discussion. Among these are: (1) Frequency and severity formulas fairly well meet the needs of

a. Government agencies concerned with mass statistics
b. Associations which sponsor inter-plant safety contests
c. Very large companies,

but they completely fail as measurements of accident prevention performance in all other areas. If further proof on the inapplicability of the formulas to these other areas it can be obtained from the following figures for one year for 6,000 Pennsylvania plants:

| Group | Number of Employees | Frequency Rate |
|---|---|---|
| 1 | 1 to 25 | 17 + |
| 2 | 26 to 50 | 11 |
| 3 | 51 to 100 | 8 |
| 4 | 101 to 200 | 5.5 |
| 5 | 201 to 999 | 5.5 ± |
| 6 | over 1,000 | 2 ± |

Now it is a well known fact that the small firm (less than 500 employees) seldom employs a safety engineer. In fact the assignment of accident prevention responsibility to anyone in a small organization is the exception rather than the rule. The first four groups in the above table are all clearly in the small firm class, and of the several thousand companies involved it is highly probable that not a single one employs a safety engineer. Nevertheless, the frequency rates roughly vary in inverse proportion to the number of employees per company. Is the answer simply that the companies with 51 to 100 employees have safety programs twice as good as the companies with 25 employees or less? Obviously such an answer would not stand up under scrutiny. Every experienced safety engineer knows that a large exposure, that is a large number of man-hours, is his forte. In a firm employing 25 men a frequency of 20 results from one disabling injury per year. Among companies employing less than 500 people each, equally ridiculous figures are an every day occurrence in both frequency and severity.

Further recognition of the influence of size of establishment on frequency and severity rates is evident in the recent action of the U. S. Navy Department. For contest purposes within the shore establishments, the Navy has developed a graduated scale in which the improvement called for, in per cent, varies with the magnitude of the initial frequency rate. In effect, this is more flexible than simply dividing the establishments into categories according to size, but size is inherently, and therefore automatically, one of the principal factors in the determination. It should be added that, under the contest rules, a reduction in frequency is not satisfactory unless it is accompanied by a more or less corresponding reduction in severity.

It is commonly contended that most of the gains in personal injury prevention (the term used invariably being accident prevention) have been made by the large firms and that the small firm offers the real problem. Certainly gains have been made but they are not all that they would appear to be. The picture is quite generally distorted and whether or not the safety engineer is enslaved by the statistician or vice versa is not quite clear. Since both subscribe to the results or conclusions it is probably a case of follow the leader without knowing who is leading.

The safety director, safety engineer, or the man in charge of accident prevention by whatever title he is known, has long been remiss in doing only half the job he claims to be doing. Omissions, serious omissions, have already been pointed out and there is little excuse for them. American business, in general, operates under the Exception Principle and of all the key members of an industrial organization probably no one has greater freedom under this principle than the safety engineer. The safety exceptions which are brought to the attention of management are all too often beclouded or inadequately presented. Seldom is management furnished with a cost study on accident prevention and a recommendation accompanied by a cost analysis is almost non-existent. It is small wonder that a stock complaint of safety engineers is that management invariably rejects recommendations involving substantial sums of money. Management would not be managing for long if it approved expenditures on the basis of reports in which propaganda takes the place of obtainable cost analyses.

A safety recommendation submitted to management is a report to management. Under the law of exception, routine matters, and this would normally include expenditures on routine safety recommendations, are not generally referred to executives for consideration or attention. This leaves the less-frequent and more expensive items in the exception category and as such considerable care should be exercised in preparing them for presentation to anyone on the higher executive level. Where the safety program has been long established, that is, the time element has been long enough to permit bringing the physical plant up to the standard of a safe environment, unrelated recommendations should not be included in the same report.

In accident prevention work many desirable changes cannot readily be supported on the basis of a cost study. Consequently, many safety engineers have slipped into the habit of thinking and acting as though this were true of all safety recommendations. Opinion based on conditions and experience may well suffice to support many recommendations but certainly not all. Where costs are a logical fraction of the problem it is quite essential that they be included. By and large, the condition of industry is good at the present time and the outlook for the foreseeable future is generally satisfactory. Nevertheless, in many areas management has already shown some reluctance to go along with diminishing returns in safety work. Most generally this has manifested itself in the form of reduction of safety personnel. By overcoming his ineptness in the use of cost analyses, the safety engineer can do much to reinforce management's faith in his work.

The safety engineer properly claims to be a specialist. As such he has built up a terminology which is not always clear to the people to whom his reports are directed. In themselves, the words frequency and severity are simple enough but safety engineers have never been fully able to justify the frequently irrational results which the corresponding formulas yield. In the entire field of personnel administration it remains for safety people to submit reports whose results virtually defy transformation into dollars or some other key measurement normally used by management. This is definitely not as it should be and some changes are certainly in order.

In this connection the following three measurements of accident prevention performance are proposed: First, that management be informed of the total primary time loss involved in all personal injury accidents; second, that the total amount of money paid out as the primary cost of injuries be expressed in terms of, or related to, the payroll and reported to management; and third, that management be similarly informed of the cost of repairing or replacing damaged equipment or material.

The first evaluation can be readily expressed as the man-hours lost per hundred man-hours worked. This Time-loss Index can be written in two ways, namely:

$$(1)\quad TLI = \frac{\text{Man-Hours Lost}}{\text{Hundreds of Man-Hours Worked}}$$

$$\text{or}\quad \frac{\text{Man-Hours Lost} \times 100}{\text{Man-Hours Worked}}$$

The second evaluation can be quite similarly expressed and may be called the Injury-Cost Index. That is:

$$(2)\quad ICI = \frac{\text{Total Cost of Injuries}}{\text{Payroll in Hundreds of Dollars}}$$

$$\text{or}\quad \frac{\text{Total Cost of Injuries} \times 100}{\text{Payroll in Dollars}}$$

The third evaluation immediately follows as the Accident-Cost Index. That is:

$$(3)\quad A.C.I - \frac{\text{Total Cost of Accidents}}{\text{Payroll in Hundreds of Dollars}}$$

$$\text{or}\quad \frac{\text{Total Cost of Accidents} \times 100}{\text{Payroll in Dollars}}$$

In (1), the man-hours lost would include all working time lost by injured employees as a direct result of the injuries. To be valid, this means that time lost in first-aid cases, both original treatments and retreatments, would be given their proper weight. The impression should not be gained that every first-aid case has to be individually evaluated. In any organization it is a relatively simple matter to determine the average length of time needed for a first-aid treatment. This average value or the average length of time the employee is away from his machine or work place should then be applied to the total number of first-aid cases. The results obtained from formula (1) can readily be shown on a simple line graph.

The injury cost index should likewise be as complete as possible. The factors entering into it should include, therefore, specific medical costs including ambulance and hospital charges, specific legal fees or costs and injury compensation. Here, too, it is relatively easy to determine the average cost of treating a first-aid case or in giving a retreatment. Hence, such costs should be included. Here also, the composite result can be shown on a line graph.

Some further comments on these evaluating procedures might be appropriate. The Time-Loss Index and the Injury-Cost Index are intended for use within any one company and not for reporting accident prevention performance to associations, government agencies or any other external organization. In any given company, the use of both indexes is advocated in reporting conditions to all levels of management. For interdepartmental competition at the first-line supervisory level or higher, both indexes would seem to have much merit. Any competition on this basis is obviously twofold in nature in that each department is, or can be competing with every other department as well as against its own previous record for any period chosen. There is some reason for believing that the use of these measurements would greatly stimulate accident prevention effort on the part of line supervision.

The use of the Time-Loss Index should be of value in obtaining greater safety consciousness among the rank and file. Similar use of the Injury-Cost Index is not generally advocated since employees customarily fail to see that they themselves bear part of any loss shown against management. In companies having sound and well established industrial relations policies, however, the use of the Injury-Cost Index has many possibilities of a beneficial nature.

It is well known that man, for the most part, resists change. Consequently, it is altogether likely that many of the procedures advocated herein will be subjected to considerable criticism and opposition. The changes are believed to be somewhat radical and constructive criticism, even though it should lead to something entirely different but more satisfactory, is looked for as a logical outgrowth of the proposals.

The rates for Workmens' Compensation Insurance are always specified on the basis of one hundred dollars of payroll. Thus it will be seen that the Injury-Cost Index has an identical relationship. It should be remembered, however, that the insurance rate includes the insurance companies overhead costs plus a profit, whereas no exactly comparable charges are included in the Injury-Cost Index.

Consideration has been given to possible obstacles which may confront those who wish to adopt the system of accident prevention measurements described in the preceding discussion. It may be contended, for example, that the paper work will be so great that the system would be promptly rejected by the small firm which has no one assigned to accident prevention. This may actually be the case and if so the situation will be no worse than it is at present. For companies having safety engineers any increase in paper work can be largely prevented by revising the system presently in effect. In short, it is believed that any increase in paper work is more imaginary than real.

For a number of reasons the problem of obtaining the Accident-Cost Index is quite complex. In those accidents involving personal injury it will not generally be too difficult for the safety engineer to determine the cost of any damage to equipment or material. The cost of machines or machine parts is readily ascertainable. Where raw material is damaged or, as will more often be the case, partially manufactured stock is damaged, the cost can be determined from the company's cost records or estimated with sufficient accuracy.

Major accidents in which there are no personal injuries but which involve substantial damage to equipment or delays in production, or both, should always be known to the safety engineer. If this belief is concurred in it follows that the cost of the damage is determinable. Thus far the obstacles do not appear to be too great and any good safety engineer should be able to develop a method of obtaining the information called for.

The securing of cost data on accidents in which there is neither personal injury nor major damage to equipment or material offers the real problem. Those responsible for such accidents will generally go to extreme measures to cover up and keep the incidents from becoming known outside the immediate area of occurrence. In many instances, knowledge of the accident will subsequently become more widespread but proof or investigation is then distasteful and often definitely undesirable.

This becomes increasingly true with the elapse of time. Even though many accidents in this category may never come to the attention of the safety engineer, those accidents of which he has knowledge more than justify the compilation of the Accident-Cost Index.

In conclusion, it is suggested that the three indexes described in this paper be periodically reported to management. Each class of measurement can and should be shown in graphical form by months. Many excellent ideas on graphical presentation are given in references 3 (appendix B) and 4 in the Bibliography appended to this paper. The report can be submitted monthly although quarterly intervals are considered more desirable in most cases. The narrative section of the report can usually be presented in the form of a summary not over one page in length. If, however, there are any abnormal conditions they should be more fully discussed on the basis of thorough analysis, in an appendix. Such an analysis cannot be considered complete if it is not followed by a description of the action taken or proposed. If proposed, the effective date and its status should be given. Since the report covers a period already passed it is important to remember that proposed action not yet started means only one thing--inaction.

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# Fire Protection In Connection With

# THE USE OF FLAMMABLE LIQUIDS AND GASES

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Not flammable liquids and vapors, but the people who misuse them, are hazardous. This statement is made, aptly, by petroleum producers, refiners, and marketers. But, if Truth is to be served, it must be admitted that they too, and their employees, sometimes misuse these valuable commodities.

Nevertheless, any true evaluation of the problem of fire protection in connection with the use of flammable liquids and gases must recognize that this classification is not limited to petroleum products. Many other valuable and useful products of the lumbering and mining industries, chemical industries, paint, varnish and lacquer industries, distillers and others, the total output numbering thousands of compounds and compositions, must be classed as flammable liquids and gases.

The two broad classes, petroleum products, and those of other industries, have many fire protection features in common and vary in others. Comprehension and evaluation of these features presupposes a knowledge of "The Threes of Fire Protection".

The term "fire protection" and the science which bears that name can be divided conveniently into three parts: fire prevention, fire control, and fire extinguishment.

Fire prevention includes the use of all the knowledges and skills exerted to prevent fires.

Fire control includes the use of all of the knowledges and skills exerted to control fires once they have been ignited and includes those steps taken before a fire starts and those taken after ignition, to minimize the spread of fire and damage resulting from it. It also includes one concept, frequently not recognized by laymen, that there are some fires that should not be extinguished but which should be permitted to burn out under control.

Fire extinguishment includes the use of all the knowledges and skills exerted to extinguish fires once they have been ignited.

Manifestly, these three factors apply to all fires, regardless of the nature of the fuel or the sources, potential or actual, of ignition.

The very definition of "fire" can be divided into three parts: Fire is oxidation occurring so rapidly as to produce heat and light.

It can be, and has been, shown that the factors which are required for fire to be ignited and to burn are three in number:

Fuel, which must be present in the form of vapor (true vapor or in a finely divided condition).

Air (or other source of oxygen), which must be mixed with the fuel vapor in certain definite proportions.

Heat, which must be present in sufficient quantity and at a sufficiently high temperature.

It is obvious that three methods of fire prevention exist: if any one of these factors is kept away from the other two, fire cannot be ignited. Similarly, three methods of extinguishment are available to the fire fighter: remove anyone of the fire factors from the other two, and the fire must be extinguished.

By a study of these three factors, the fundamental concepts of fire protection become apparent.

## The Relation of Fuel Vapor to Fire Protection

In order to burn, fuel must be in the vapor form. But to be in the vapor form, fuel must be raised to its flash point. A practical definition of this term is:

> Flash point is the temperature to which a fuel must be raised to cause it to give off vapors that can be burned. (Actually the test is performed by a standard method and in a standardized apparatus.)

The flash points of petroleum and coal tar products can be related to boiling points by an equation published in Industrial and Engineering Chemistry, Vol. 32, No. 6, for June, 1940 at page 880 by The Associated Factory Mutual Fire Insurance Companies.

$$F = 0.73\,B - 122$$

Where: F = Tagliabue Closed Cup Flash point in °F.
B - Boiling Point (initial for mixtures, actual for compounds) in °F.

The authors claim that the formula is applicable for hydro carbons boiling between -150° and +550°F. The substantial validity of the curve for pure compounds and petroleum products boiling between 0 and 450°F is demonstrated in Figure 1. Reported data for flash points of some non-hydro carbon organic compounds also are shown to indicate the fallacy of attempting to use the curve for them.

Actually, the fire points of substances govern their burning in the standardized method. However, the variations between flash point and fire point are great among different classes of compounds. Since a definite hazard is present at the flash point, it usually is taken as the classifying criterion in most practical situations and in legislation.

Care also must be taken in using flash point data. Thus, solvents meeting the Bureau of Standards specification for Stoddard (dry cleaners') Solvent are considered reasonably safe for use since their flash points lie above 100°F. and, as liquids, will extinguish matches dropped into them. When materials possessing high area-volume ratios such as fabrics and finely divided clays and diatomaceous earth are wet with the solvents, the rate of vapor generation is sufficiently high that ignition at temperatures well below the normal flash point is possible. Similarly, many persons fail to take cognizance of atmospheric temperatures in the use of solvents. For example, a certain solvent possesses a flash point of 105°F. In a well ventilated location it would be perfectly safe to use, even reasonably near to small open flames, at ordinary atmospheric temperatures. On the other hand, even good ventilation would not be an adequate safety factor, with or without the known presence of open flames, if the atmospheric temperature reached values well above 100°F. as occurs, for example, in the San Joaquin Valley or the desert areas of California.

In this connection, it cannot be stressed too strongly that gasoline never is safe for use in cleaning anything. From Figure 1 it is evident that gasoline, possessing an initial boiling point of 100°F. or lower possesses a flash point of -50°F. or below. Thus, for all practical purposes, it is always above its flash point and always is hazardous to use for any other than its intended use, as a fuel for internal combustion engines.

## The Relation of Fuel Concentration to Fire Protection

The terms "explosive limits" and "flammable limits" once caused confusion and their use probably accounts for the discordance observed in the available published data. Latterly, the use of the term "explosive limit" has been abandoned since it is recognized now that a fuel explosion and a fire are identical except in the rapidity of flame propagation.

In order that burning can occur, it is necessary that the vapors of the fuel be in the proper proportion to air (or other source of oxygen). This is clearly evident in the operation of an automobile engine in which even slight derangements of the fuel-air ratio may cause the engine to operate poorly or not at all.

Every substance that will produce flammable vapors possesses a characteristic lower and upper flammable limit, and flammable range, which are defined as follows:

> Lower flammable limit: the lowest volume percentage concentration of vapor in air that will support combustion or permit flame propagation through the mixture.
>
> Upper flammable limit: the highest volume percentage concentration of vapor in air that will support combustion or permit flame propagation through the mixture.
>
> Flammable range: the range of volume percentage concentration of vapor in air between the lower and upper flammable limits.

Earlier investigators have found that the lower flammable limits of all hydro-carbons can be related to the heating value. Better correlations recently were obtained, however by using, instead of the experimentally determined heating values, those calculated by the method described by Nelson in Petroleum Refinery Engineering, First Edition. The summation of the heating values for the various bonds within the molecule gives the heating value, in BTU/lb.-mol according to the following scheme:

| | | |
|---|---|---|
| C - H | = 94,800 | BTU/lb-mol |
| C - C | = 95,220 | " |
| C = C | = 219,240 | " |
| C ≡ C | = 365,760 | " |

By converting these data for various hydro carbons to BTU/cu. ft. at 60°F. and 760 mm. Hg. (a more generally useful figure) the lower flammable limits for all hydro carbons may be calculated by the equation:

$$\text{Log } H + \text{Log } L = 3.7396$$

Where H = heating value in BTU/cu.ft. @ 60°F. and 760 mm Hg.
and L = Lower flammable limit in volume % in air.

Similarly, critical analyses of published data demonstrate that, for paraffins only, the upper flammable limit may be calculated by the equations:

$$\text{Log } U + 0.5241 \text{ Log } H = 2.7624$$

Where U = Upper flammable limit in volume % in air and H has the value shown above.

Data for other series are so few that only trends can be determined. However, it appears that unsaturated compounds may have higher upper flammable limits than the corresponding saturates.

Since these data are cumbersome to handle, the curves in Figure 2 have been developed to relate flammable limits to boiling point and the data presented evidently are good to within a maximum deviation of 0.2 volume % at the upper ends of the curves.

In practical applications, the flammable ranges are of little value to users of flammable liquids and vapors except in engineering design of ventilation equipment. In the final analysis, if <u>any</u> flammable vapors may be present, a hazard exists and should be guarded against. In this connection, mention should be made of the various flammable vapor indicators, recorders and alarms that are available on the market. Large users of flammable liquids should own, or have available, such equipment to eliminate any question regarding fire hazards under any conditions. Moreover, such devices are essential in problems of personnel safety under present rulings of the State Division of Industrial Safety.

## The Relation of Heat Sources to Fire Protection

It is axiomatic that, if all sources of ignition could be eliminated, there would be no fires. But sources of ignition do exist and, as long as humans lack information or take stupid chances, they will permit sources of ignition to encounter flammable vapors. Time and space do not permit a complete evaluation of sources of ignition but certain fundamental facts are available which will, if properly applied, minimize the likelihood of fires.

In order that ignition of a flammable mixture of vapor and air may occur, heat must be present, not only in sufficient quantity, but also at sufficiently high temperatures. Likewise, high temperatures alone do not suffice; the heat must be present in sufficient quantity to cause the flame to be propagated.

Ignition temperatures of flammable vapors may be defined:

<u>Ignition temperature</u>: is the temperature to which a flammable vapor-air mixture must be heated to cause it to ignite.

Probably more mis-information exists regarding this single factor than any other. The National Fire Protection Association quotes, and the Navy gave wide publicity during the war to, the value of 495°F. for the ignition temperature of gasoline.

Similarly low values are quoted for other petroleum products. Yet the apparatus and method used for determining these values could not possibly represent the normal (or even abnormal) conditions of storage, handling and use of petroleum products. Actually, it has been found to be impossible to ignite vapors of gasoline at temperatures as high as 1,200° - 1,500°F. under industrial conditions.

On the other hand, some vapors, such as those of carbon bisulfide as an outstanding example, can be ignited at very low temperatures. Electric heating elements which will not ignite gasoline vapors easily ignite carbon bisulfide and acetone vapors. Petroleum products possessing identical flash points to those quoted for linseed, tung, rape and other paint oils positively will not undergo spontaneous combustion with resultant ignition of low-ignition temperature Class "A" (Miscellaneous combustible) substances such as paper, rags, and wood products such as shavings and excelsior.

Small sparks, from the fine grinding of ferrous metals, which are formed at high temperature but with low heat contents and which do not ignite petroleum vapors, easily ignite finely divided Class "A" materials and low ignition temperature Class "B" materials.

Sparks from ferrous hand tools sometimes are reported as having been responsible for igniting petroleum vapors. Actually, a large number of such reports have been investigated and, in no case, has proper authentication been obtained. Possibly, ferrous tool sparks may ignite low ignition temperature materials which, in turn, may ignite petroleum vapors. However, thorough wetting down of the area in which work must be done prevents such secondary ignition. Underwriters' Laboratories completed nearly a year ago, for one of the bronze tool manufacturers, an investigation of the validity of the use of their tools in petroleum operations. The fact that this manufacturer refuses to make available the conclusions reached is a pertinent commentary.

Electric sparks can ignite petroleum vapors but frequently are inaccurately blamed for ignition. Actually, it is impossible to cause an electric spark at less than 300 volts while, unless the amperage is relatively high (to give a high wattage) even 300 volt sparks lack the heat content to cause flame propagation. Electric arcs, on the other hand, when caused by the interruption of high amperage circuits, may cause ignition of petroleum or other vapors when voltages are sufficiently high. Incidentally, the fusing of fine wires may generate sufficient heat at sufficiently high temperatures to ignite petroleum. In this same connection, ordinary flashlights will not ignite petroleum vapors. As shown in Bureau of Mines R.I. 3231 of May, 1934, voltages and amperages involved are too low. Specially constructed "approved" flashlights may have some value in other industries but in the petroleum industry, vendors who base their sales talks on safety lay themselves open to charges of ignorance or unscrupulousness.

Static can cause ignition of petroleum and other flammable vapors under narrowly restricted conditions of atmospheric humidity, i.e., at relative humidities below 40%. All static hazard in the use handling of flammable liquids can be eliminated, however, by insuring that containers from and to which such liquids are being transferred are bonded together and that the relative humidity in working areas is maintained at values preferably well above 40%. Grounding is unnecessary but bonding is essential. In passing, it is pointed out that drag chains on tank trucks serve no useful purpose. Their use, like the use of bronze tools in the petroleum industry, was conceived in error and has been perpetuated in ignorance.

It hardly seems necessary to mention such obvious sources of ignition as smoking and other uses of matches. Nevertheless, people still check gasoline tanks and look for gas leaks with matches. People still try to heat Stoddard Solvent on stoves to improve its solvency or use it in closed kitchens or laundry rooms with pilot lights burning on stoves and water heaters. People do attempt to light, or to speed up fires with kerosene or other light oils. People will try to start gasoline engines by priming through the carburetor air inlet. People will carry single-action cigarette lighters in petroleum and other flammable liquids' properties even though their hazard is demonstrable and proven.

In the final analysis, it is not flammable liquids and vapors, but the people who misuse them, that are hazardous. Regardless of the mechanical safeguards that are established through good engineering, design, construction, and maintenance, one unsafe act by one untrained person may add additional millions in 1948 to the $700,000,000 fire loss suffered in the United States in 1947. Let us train ourselves so we can train our workers!

CHVM:ejc
Feb. 2, 1948

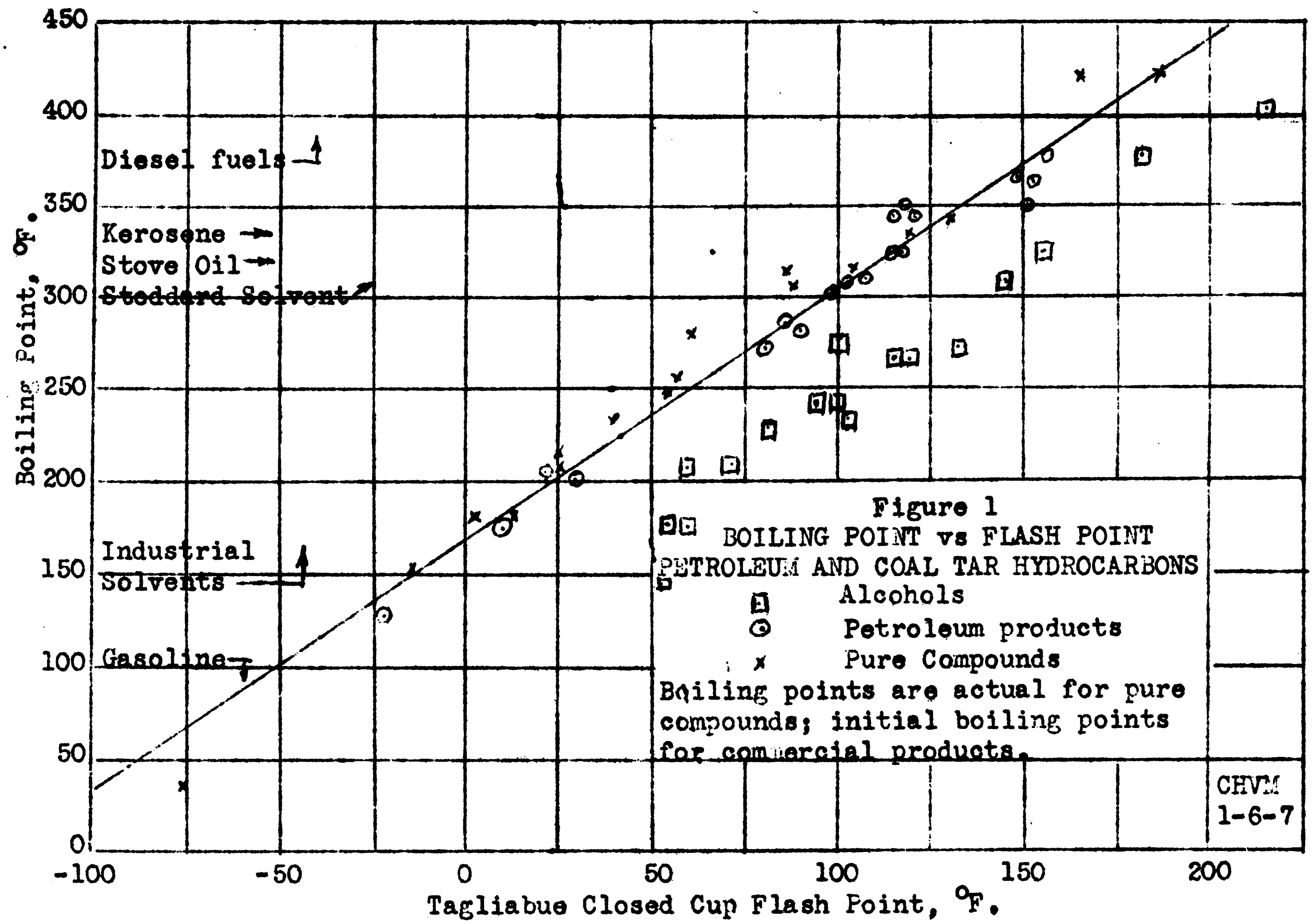


Figure 1
BOILING POINT vs FLASH POINT
PETROLEUM AND COAL TAR HYDROCARBONS
Alcohols
Petroleum products
Pure Compounds
Boiling points are actual for pure compounds; initial boiling points for commercial products.
CHVM
1-6-7
Diesel fuels
Kerosene
Stove Oil
Stoddard Solvent
Industrial Solvents
Gasoline
Boiling Point, °F.
Tagliabue Closed Cup Flash Point, °F.
450
400
350
300
250
200
150
100
50
0
-100
-50
0
50
100
150
200

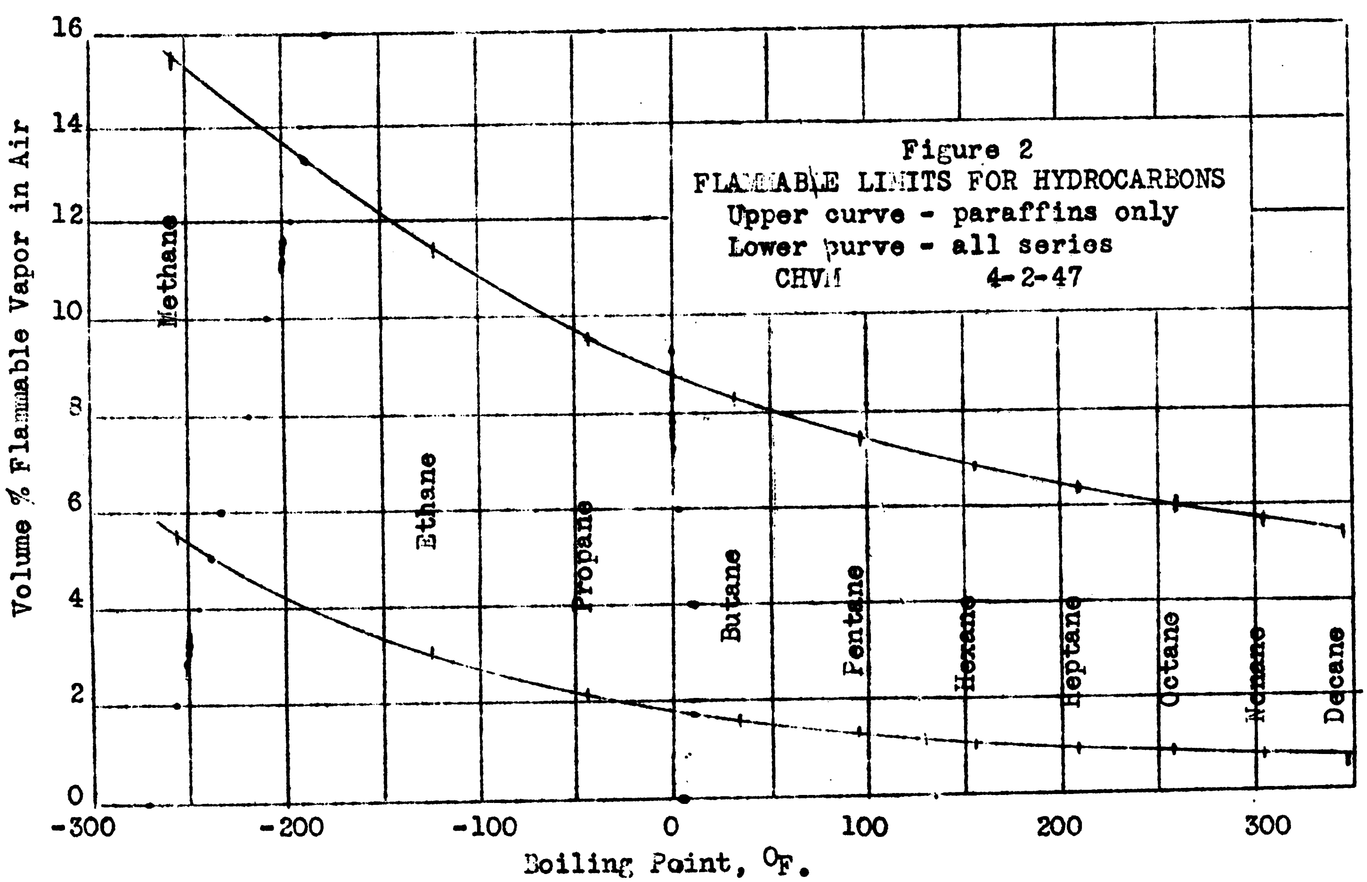


Figure 2
FLAMMABLE LIMITS FOR HYDROCARBONS
Upper curve - paraffins only
Lower curve - all series
CHVM 4-2-47
Methane
Ethane
Propane
Butane
Pentane
Hexane
Heptane
Octane
Nonane
Decane
Volume % Flammable Vapor in Air
Boiling Point, °F.
16
14
12
10
8
6
4
2
0
-300
-200
-100
0
100
200
300


## IS . . .

Rapid oxidation of any substance resulting in the evolution of heat and light (flames).

## WILL RESULT . . .

When three factors are present simultaneously:

FUEL must be in the vapor form

AIR must be in the proper proportion

HEAT must be at a suitable temperature and in an adequate quantity

## CAN BE PREVENTED . . .

By keeping any one of these factors from the other two.

AIR is nearly always present and cannot be eliminated by any practical means.

FUEL, in vapor form, must not be liberated in the presence of heat.

HEAT must not be permitted in areas where the presence of vapors is known or suspected.

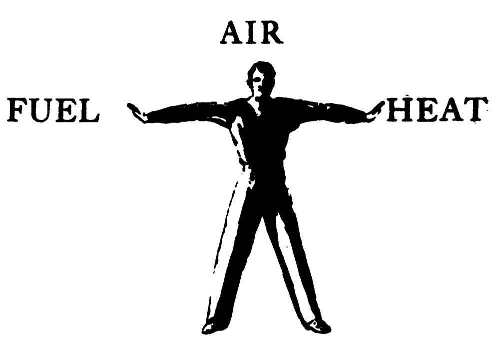
## CAN BE EXTINGUISHED . . .

By removing any one of these factors from the other two.

AIR may be removed by *smothering*. Cover burning containers with covers, lids, blankets or other means. Use DuGas, $CO_2$, or foam to eliminate air. Carbon tetrachloride may also be used.

HEAT may be removed by *quenching*. Use water from hose, soda-acid extinguishers, or as water fog.

FUEL may be removed by shutting valves, plugging lines, etc.




*REMEMBER . . . KEEP THESE APART*

UNIVERSITY EXTENSION--UNIVERSITY OF CALIFORNIA
Department of Institutes
Berkeley

INSTITUTE ON INDUSTRIAL ACCIDENT PREVENTION
February 4-6, 1948

# INDUSTRIAL HEALTH AND HYGIENE IN RELATION TO ACCIDENT PREVENTION

Speech
by

Leon Lewis, M.D., Associate Professor of Industrial Health,
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The personnel expert, the safety engineer, the industrial hygienist, the industrial nurse and the industrial physician constitute a professional group with closely integrated functions. Although they may have to act independently under many circumstances, they accomplish their fundamental purpose to best advantage when they work together as a team. This purpose may be broadly stated as follows: to maintain good health and good morale among our productive citizens; to train working men and women to work safely under safe working conditions; to assure clean, well-ventilated, well-illuminated, wholesome and sanitary environments in which to work; to supply medical care for industrial injuries and occupational disorders which have occurred despite preventive safeguards, and to give consultation and guidance for all health problems; to educate continuously for safety and health; and to cooperate with other departments in industry and with labor organizations in the proper selection and placement of employees to the best advantage of all concerned.

Within this field the industrial physician and the industrial hygienist have a wide enough domain in their own rights, but necessarily they are also concerned with safety. The question which I wish to explore in connection with this institute is the extent to which health and hygiene may contribute to the goal of industrial accident prevention.

All of us are well acquainted with the chain of circumstances which ordinarily lead to an accident and, under certain conditions, to accidental injury. We appreciate the importance of unsafe conditions, agencies, and agency parts, and we strive properly toward perfection of safeguards and sound technical methods. But we have become increasingly aware of the fact that the great preponderance of accidents are the result of "man failure" -- of some "unsafe act" or some "personal fault" of some individual.

You are familiar with Heinrich's analysis of 75,000 accident reports which led him to conclude that 88% "of all industrial accidents....are caused primarily by the unsafe acts of persons." Analysis by the National Safety Council gave similar estimates but also indicated mechanical causes in 78%. The differences in estimates are due to methods of analysis, since Heinrich considered "only the cause of major importance" while the Safety Council was concerned with both personal and mechanical causes of the same accident.

According to the November 1947 report of the Division of Labor Statistics and Research of the California Department of Industrial Relations, "unsafe acts" were involved in 9,724 of the 11,174 disabling injuries which occurred during that month.

Unsafe mechanical conditions were reported in only 4,469 of the same 11,174 accidents. In other words, some form of "man failure" was involved in 87% of the cases (a figure almost exactly matching that of Heinrich) while "machine failure" was involved in only about 40%. Even allowing for possible error and probably prejudice of the reporting supervisor or employer, it is obvious that some unsafe or unwise act is involved in most accidental injuries.

Unsafe acts by human beings may be classified in various ways. Heinrich listed as follows the "reasons that permit or occasion the unsafe acts of persons":

A. Improper attitude

1. Willful disregard of instructions
2. Recklessness
3. Violent temper
4. Absent-mindedness
5. Willful intent to injure
6. Nervousness, excitability
7. Failure to understand instructions

B. Lack of knowledge or skill

8. Unawareness of safe practice
9. No convictions that practice is unsafe
10. Unpracticed or unskilled

C. Bodily defect

11. Defective eyesight
12. Defective hearing
13. Muscular weakness
14. Fatigue
15. Existing hernia
16. Crippling defect
17. Existing heart or other organic weakness
18. Intoxication

D. Safe practice difficult or impossible

19. Circumstances preventing safe action
20. Circumstances making safe action awkward or difficult

All of these factors with the exception of the last two which are strictly environmental and those representing lack of knowledge or training may be classified as either personality defects or physical abnormalities. Many of them imply a volitional element and involve the concept of willful intent. There is no doubt that a more appropriate psychological analysis could be made, but this list serves the purpose of illustrating that two aspects of health -- namely mental health and physical health -- are frequently involved in accident susceptibility.

This does not necessarily imply that there is a close correlation between what we ordinarily understand as health or physical fitness and freedom from accident. As a matter of fact, there is ample evidence that physical impairment or defect per se does not increase the probability of industrial accidents providing selective employee placement is practiced. In a recent study the Bureau of Labor Statistics of the U.S. Department of Labor (See Accident Facts, 1947, p. 32) found identical nondisabling injury frequency rates for nearly 11,000 impaired workers as compared with 18,200 unimpaired workers doing the same work in the same departments of the same plant. The frequency rate for disabling injuries was even somewhat lower for the impaired workers.

There is some reason to suspect that the impaired workman is at times more circumspect and cautious because of his impairment. He is not, according to the evidence unusually accident prone when properly placed in industry. However, it is obvious that certain kinds of defects, including most of the physical disabilities in Heinrich's list, may render a worker "injury prone" although not necessarily "accident prone." The workman with an already weakened abdomen and relaxed inguinal ring is not necessarily a risk so far as accident liability is concerned, but in the event of a lifting strain, he is more vulnerable to injury. The same applies to the workman with high blood pressure or cardiac disease.

Physical impairment may cause increased "accident proneness" as well as "injury proneness." In the case of disorders of the nervous system and defects of vision, physical impairment may be of paramount importance. Dr. Stump of the Revere Copper and Brass Corporation (quoted by Kuhn, H., "Indust. Ophthalmology as of 1946," J.A.M.A., 132: 774, 11-30-46) demonstrated the relationship of deviation from normal vision to accident frequency. Employees with extreme deviation from standard vision showed a 75% greater accumulation of accidents that those with negligible deviation in the course of a 38-day observation period. Similarly, at the Purdue Industrial Visual Institute (op. cit., p. 775) a high degree of correlation was demonstrated between convergence difficulty and number of serious accidents. These examples in a field where quantitative measurement of defect is possible serve to indicate that physical impairment may increase "accident proneness." It is hardly necessary to invoke statistical proof that a structural iron worker with locomotor ataxia or a hod-carrier with a disorganized painless syphilitic knee, the so-called Charcot joint, is more likely to suffer an accidental injury than a robust fellow worker who stands firmly on two good legs. Obviously, under uncontrolled or random placement, the person with an organic defect may be a very bad risk from every point of view.

When we consider the matter of health from the point of view of illness rather than somatic defect, there is some evidence that accident frequency tends to parallel the frequency of sick reporting. Newbold (Newbold, E. M., Report #34 of Indust. Fatigue Res. Bd.) reported in 1926 on a study of men working in the metal departments of an automobile factory. He found a correlation existed between the frequency of reports to the dispensary for illness and the frequency of accidents in the observed group. This type of research can be expanded with modern techniques to give a great deal of urgently needed information. If a large group of workers can be physically appraised and subjected also to personality studies by a technique of the type used in screening selectees for the armed services -- the Cornell Index, for example -- and accurate health and accident data are collected, the resulting correlations may prove very significant.

In any such study it is important to eliminate every possible source of error. Caution must be exercised when accidents are ascribed to particular individuals. For example, to whom is the accident charged in the following case: A workman is riding in the body of a truck which is hauling four fifty-gallon water drums to a quarry operation accessible only over very rough roads. The truck driver is an exuberant fellow, known to disregard reasonable limits of speed. Despite warning by the rider in the truck he carelessly hits a rut, the water drums are tipped, the passenger in the rear attempts to right one of them, is thrown from the truck and a drum lands on him, fracturing his thigh. Regardless of the fact that both workmen may have been at fault for failure to secure the load, it seems to me that the accident should be charged against the driver rather than the victim around whom the accident is usually described.

This matter brings us quite directly to the problem of a type of "accident proneness" which has no direct relation to physical impairment. Investigations of accident statistics between 1919 and 1926 by the British Industrial Health Research Board (then known as the Industrial Fatigue Research Board) first demonstrated "that workers placed under similar conditions of environment and risk were unequal in their liability to sustain accidents, the bulk of accidents happening to a comparatively small number of individuals."

Thus, science demonstrated what every foreman in industry had known for years, namely that some workmen were dexterous and careful while others were "all thumbs." The British pursued this question of accident-proneness and attempted to develop tests which would select the bad risks before their presence was demonstrated by unfavorable accident statistics. Farmer and Chambers (Indust. Health Research Board Report #84) in "A Study of Accident Proneness among Motor Drivers" (1939) examined the records of several groups of London bus drivers and concluded that "accident proneness" was an important factor in the causation of accidents. They also found that by the use of certain psychological tests they could segregate to some extent those most likely to have poor accident records. These workers developed various hand-eye coordination tests which they considered useful among certain groups of skilled workers, and during the past twenty years there have been developed many tests of aptitutde, coordination, and function which are undoubtedly potentially helpful in connection with specific types of employment.

Ghiselli, Brown and Minium, of the Department of Psychology of the University of California, investigated this question of accident proneness among streetcar motormen of a local community. They confirmed the fact that certain individuals, as shown by their accident records, had accidents more frequently than could be accounted for on the basis of chance alone. Studying these men by means of selected tests, they were able to demonstrate that certain techniques were reliable in predicting the accidents of motormen. However, in all such studies it is found that predictive techniques are limited since even on the best basis, namely statistics on the same subjects over periods of employment, only about two-thirds of the accident-prone can be selected. Commenting upon their series of tests these workers point out: "While it is true that savings undoubtedly would result from the use of the test battery in the selection of new men, it is also true that a number of potentially good men would be eliminated by such use, and a number of accident makers would be retained."

Recently the problem of "accident-proneness" has been explored by the psychoanalysts and the apostles of psychosomatic medicine. On the basis of investigations on a case-history basis, Flanders Dunbar (of Cornell Medical School) and many others have shown that defects of mental and emotional health may play a greater role than physical impairment in the fundamental origin of many accidental injuries. To some of us the explanations involving frustrations in infancy or maternal fixations may seem far-fetched, but it seems to me that the psychiatrists as well as the psychologists should be encouraged to explore personality factors from every possible approach. It would be remarkable indeed if psychological abnormality did not play a very great role in accident causation, since drives arising out of hostility, egocentricity, masochism and other latent personality traits determine so much of human activity. The extent of psychopathy in industry has not been measured but we can gain some idea of its magnitude from the fact that at least one-third of the men between 18-35 years of age who were rated 4-F by examining boards for the Selective Service were excluded on neuropsychiatric grounds. These exclusions were based on very brief interviews and the number who slipped through the screening procedure bear testimony to the inadequacy of the tests and the conservative nature of the estimated amount of abnormality. There is no doubt that many individuals express resentments and achieve some form of self-expression, without conscious intent, by the occurrence of accidents. In my own experience in industrial medicine, I have seen obvious examples of unstable and neurotic persons who have behaved as though an injury were a purposive device for obtaining attention and sympathy. In only two instances, however, have I encountered self-inflicted injury among several thousand medical examinations in industry. While the obvious neurotic personality is often very impressive to the medical examiner, I suspect that a great many accidents traceable to personal causes may be explained by such temporary psychological aberrations as worry, distraction, fatigue and resulting carelessness. These are all states of mind which may have much deeper significance than is immediately apparent. Unfortunately, this whole realm is extremely difficult to analyze and each individual requires more attention than is available in the best industrial medical department.

The subject of fatigue was mentioned and I am sure that anyone speaking on health in relation to accident prevention is expected to say something about fatigue. However, this is a subject about which much that has been written is confused because of a lack of definition of terms. The word "fatigue" has many connotations. As a state of being recognizable by all of us it has meaning but cannot be measured. As soon as something is measured which the physiologist or the production man calls "fatigue," the meaning is confused. When the discussion is limited to something concrete such as excessive hours of work it can be shown that accident frequency is sharply increased, and this increase is charged to fatigue. Vernon reported accidents to women workers in munition plants in World War I 2.73 times as frequent while working 12 hours daily as compared to 10 hours daily, and a similar increase of 1.14 times for men. Similar findings were reported by the U.S. Department of Labor during the last war. These were referred to by Mr. Shelley, at yesterday's meeting.

In this connection, we must recognize the important role of social factors such as economic insecurity, poor housing, family illness, and scores of other causes of anxiety which manifest themselves in different ways, depending upon the stability and resilience of the personality under strain. Perhaps the industrial psychiatrist will be able to help us detect all these influences upon the potential victim of an accident in time to prevent its occurrence. I, for one, am willing to give him the opportunity. At any rate, I believe there is good reason to believe that the psychologist and the physician, through efforts directed toward maintaining every workman as a "mens sana in corpore sano -- a sound mind in a sound body," have much to contribute toward industrial safety in a very fundamental respect.

An equally important contribution can be offered by the industrial hygienist. It has been demonstrated repeatedly that accidents can be almost completely eliminated even in the most hazardous occupations by the skillful collaboration of the engineering and the medical staff. It is hardly necessary to elaborate upon the importance of good hygiene -- of sound sanitary and housekeeping practices, of good ventilation, heating or heat control and illumination, of fume and dust and noise control -- before this audience. (You have already heard Dr. Craig Taylor discuss the physiological factors of the environment.) Good accident records and good industrial hygiene are usually found in the same plant, while shabby practices in all phases of industrial management are likewise commonly found under a single roof. I am not going to submit statistical evidence that a wholesome industrial environment contributes toward accident prevention, but there is no sharp boundary between good safety practice and good hygiene. Good illumination is as important for safe practice as it is for physiologic performance. Similar analogies apply to all aspects of industrial hygiene. I believe it is well recognized by all of us who are interested in the closely allied fields of industrial health and safety that when we are permitted to pool our techniques we can achieve results. We are convinced that our function in maintenance of health, in environmental control, job analysis, personnel placement, and accident prevention pays dividends not only in the economic sense but also in terms of salvaged human beings. Our major problem is the broad application of our skills to the whole of our productive population. Large industries, to a very considerable extent, have recognized the value of these skills. Having the resources for utilizing such skills they may be expected to incorporate them in their operations. Small enterprises and industries with widely scattered personnel have not had the type of expert guidance which must become available if industrial morbidity is to be controlled.

I do not wish to appear to underestimate the difficulties which are involved. A serious economic depression can result in curtailment of research and serious interference with progress. In spite of all the handicaps, real and potential, there are hopeful signs on the horizon which suggest that the information accumulated in the first half of the twentieth century will be vastly expanded and widely applied before the end of the second half. These signs are:

1. The active stimulation of governmental agencies and voluntary groups -- the National Safety Council, National Association of Manufacturers, Chambers of Commerce, etc.

2. The growing interest of organized labor in matters of health, welfare and safety.

3. The recent concern of our universities and medical schools with problems relating to the working man and his environment.

4. The rapid development of the field of personnel placement and job analysis.

5. The growth of rehabilitation techniques and facilities; and, finally,

6. The slow but definitely recognizable trend toward wholesome preventive practices throughout the fields of medicine and psychiatry.

UNIVERSITY EXTENSION--UNIVERSITY OF CALIFORNIA
Department of Institutes
Berkeley

INSTITUTE ON INDUSTRIAL ACCIDENT PREVENTION
February 4-6, 1948

(Outline)

# Professional Development of the Safety Engineer

A. Milton Green, Industrial Relations Director, Oliver Tire & Rubber Company, and Chairman, San Francisco Chapter, American Society of Safety Engineers.

1. Why Give the Safety Engineer Professional Status
2. Brief History of American Society of Safety Engineers
3. American Society of Safety Engineers Activities
4. Ambitions of the Local Chapter
5. The Safety Engineer's Chances of Professional Status

2-6-48