



1955 TRANSACTIONS

VOLUME 13

Current Topics in

Industrial Safety

*as presented in the Subject Sessions
at the 43rd National Safety Congress*

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An Old Concept . . .

Each edition of the Transactions is a collection of the latest ideas and experiences of the top men in the accident prevention field. Then what's this about an old concept?

In this atomic age, progress has made obsolete the barriers of time and distance, and has drawn the people of the world physically closer together. It follows, then, that for peace and survival there eventually must emerge a spiritual closeness—a realization that each has a moral responsibility to respect and protect his neighbor.

A new concept? No, one of the oldest, "Be Your Brother's Keeper." In safety, as in other of today's world problems, a rebirth of this basic rule of life can hold great and optimistic hope for the future.

The National Safety Congress Transactions are published in volumes, each covering a phase of the safety picture, along with a General Sessions and Detailed Index to all volumes. The 30 volumes of the 1955 Congress Transactions are listed on the last page of this volume. In preparing these Transactions, the proceedings of the Congress have been condensed and edited for reference purposes. Complete original manuscripts, with any charts or illustrations which were used, are available in National Safety Council files. Views expressed at the Congress or in this record are those of the Congress participants and are not necessarily those of the National Safety Council.

ASSE SUBJECT SESSIONS

This volume is a record of the subject sessions sponsored by the American Society of Safety Engineers at the 1955 National Safety Congress. The conduct of these Congress sessions each year is only one of the many cooperative activities which the ASSE carries on in behalf of its members, and for the benefit of accident prevention work in industry generally.

Accident Control—Phase One, Administration

Organization—the Key

By FRANCIS T. McGOWAN

Safety Dir., The Borden Company, New York, N. Y.

Organization—the key to improved safety performance.

I wish I could announce to you that my company—Borden's—has found the perfect solution to the accident problem. Like other companies, we, too, have been searching for the magic formulae, that combination of activities which would provide a controlled accident frequency.

I can report, however, that the *organization type* of approach we have been using has given us many benefits—for example, *lower accident frequency rates* and an *improved cost experience*. We're confident we are on the right track. We intend to move ahead, adjusting our program as we move to meet changing conditions.

Everyone agrees that best results in safety work come when accident prevention efforts are built into or blended with normal operating procedures and executive decisions. Our fleet safety program now closely approaches this objective. Our industrial program is in the final development stage. So you may better understand why we selected the organization type of approach, let me briefly explain our activities and structure.

1. The Borden Company's assets make it one of the 100 largest manufacturing corporations in the country.

2. In sales, Borden's is the fourth largest food company. It is the nation's largest fluid milk distributor and the second largest ice cream manufacturer. Borden's is a major figure in the cheese and evaporated milk industries and in the production of various food products, including instant coffee. We are also active in chemicals, plastics and animal and poultry feed supplements.

3. We have more than 32,000 employees in 750 locations in both the United States

and Canada. We operate 10,000 vehicles in excess of 135 million miles per year.

4. It has been estimated that our total exposure to accidents and claims is comparable to that of a small insurance company. We are principally self-insured.

In a large, diversified and completely decentralized company such as ours, unusual problems and difficulties arise. Diversification requires radically different types of administrative, production, and sales organizations within the company. Decentralization complicates the problem even more, because of the several hundreds of operations, large and small, from coast to coast. Geographical differences, added to the difficulties of communication and interpretation of safety policies and procedures, prevent us from having anything but the most flexible type of safety program. Our program has been so designed that it compensates for these particular problems by recommending policies and procedures, mechanics and techniques in such a manner that they can be built into normal organization procedures in any operation, anywhere in the company.

Company safety policies are determined by a committee of vice-presidents at top level. Interpretations of such policies and the procedures by which they can be put into effect, at district and division level, are determined by a committee of top operating executives at that level. Determinations by this group constitute district and division policy, which is passed on to each plant or branch manager for application.

Of importance in this type of organization structure are the two-way lines of communication that have been developed. Not only does safety information, statistics and know-how pass from top level straight down through organization channels to each

local manager or superintendent; monthly reports on activities, problems or successes move right back to the top. Each district or division safety man, or we in New York, are always in the position to make a safety performance measurement of any operation, anywhere in the company at any time.

What I have given you is a skeleton outline of the safety organization structure in The Borden Company. Let me briefly explain how it operates. Let us take pre-employment physical examinations as an example. Giving pre-employment physical examinations has been a policy in our company for more than 20 years.

When it was determined that there was a need for a company-wide policy on this subject, the matter was first discussed with the medical director. The mechanics of a proposed plan and all related facts were collected and presented to our accident prevention committee in New York, comprising all the vice-presidents in charge of the company's activities. When agreement was reached and the area of activity defined, the procedures by which this policy could be put into effect were outlined.

The entire story was then passed on to the top executives at district and division level. With the help of their own top-level accident prevention committee, of which their safety man is secretary, the subject is studied, plans and outline reviewed. At this point, they determine what modifications, if any, are necessary to put the plan into effect in their area. Local managers are then advised of the new policy and informed when and how it is to be put into effect. As conditions require, the district or division safety man visits local operations to interpret, advise and assist in its application. Actually, this procedure is identical with that normally used in all other departments of the company's activities.

Coordination is of vital importance in the organization type of approach to accident control. Over-all coordination in our total safety effort is obtained principally through an annual, three-day Borden Safety Round Table Meeting.

At these meetings, we review our accident experience trends and costs, evaluate the effectiveness of our existing activities, reaffirm our objectives and, in general, agree on a course of action that is to be followed.

More than 40 key operating men with safety responsibilities at district and division level attend these annual meetings, plus representatives from all the service departments of the company. In all, 27 work or operating classifications are represented. Every district, division or major segment of the company sends a delegate. You can see, we have a true cross-section of our company, reviewing and discussing the company's safety problems, policies and control measures.

We are most fortunate in having keen executive and top operating management interest and support in our accident prevention efforts. Aside from the humanitarian aspects (and we consider our employees the most important asset we have), there is the full realization of the impact accident costs have on operating expense and profits.

For example, the cost of an average accident takes the profit from 87,000 quarts of milk. Putting it another way, it takes the profit of 87,000 quarts of delivered milk or six months' profit from an average route to pay the expenses of an average accident. This is not because accident costs are unusually high, but because the profit margin on a quart of milk is very low.

Is there any wonder, then, that safety performance and accident costs are on the agenda of every meeting of our top executives, at every board of officers' meeting, at district and division level and at production and sales managers' meetings at local level? Safety is even discussed at meetings of plant engineers.

At this point, I would like to give substance to the organization type of approach we are using in safety work. Perhaps I can lay the basis for it by explaining how it came about.

Some time ago, we were asked to attend a meeting of executives and department heads. As is usually the case before such a meeting gets under way, there was some good-natured bantering going on—first one, then another was placed under the spotlight. At one point, the head of our real estate department was on the spot because of some property acquired in one of our southern states. Convinced that he had made a sound decision, he brought the joking to an abrupt halt with this observation: "Gentlemen, there are only three

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things to consider when buying property—the first is location; the second is location, and the third is location.”

This reminded another that when he was studying engineering at the university, the instructor kept repeating, over and over again, “When building a road, there are three important things to remember. The first is drainage; the second is drainage, and the third is drainage.”

These two stories started us wondering what the three most important factors in safety work were. Such segments as management support, supervisory participation and employee cooperation occurred to us as being of extreme importance. Were these items, then, more important and of more value than planning, know-how or a concrete plan of prevention and control?

After playing with this apparently unimportant problem for some time, it occurred to us that the three most important factors in successful safety work were—first, *organization*, second, *organization*, and third, *organization*. It seemed obvious that any one or all of the factors we employ, regardless of their individual importance, are, in substance, component parts of the whole. Standing alone or in groups of three, they would accomplish nothing; but, combined and placed in proper sequence, they would accomplish the desired objective. Without organized effort, individuals and functions would be free to move in opposite directions. With organization, individual and group effort, functions and activities would all move in the same direction toward a common goal.

In selling this approach to our people, we stress the fact that building an organization for safety is comparable to building an organization to produce a product or provide a service. The purpose of both is to enable groups of people to work together as a team as effectively as they work alone. To establish this relationship between building an organization for production and one for safety, we point out that such planning involves the same facilities, the same processes, the same employees, the same supervision and the same management direction. They know that the management function in production is, expressed in simple terms, getting things done through the efforts of other people. We are selling the organization approach on the

basis that the management function in safety is just the same—*getting control of accident-producing conditions through the efforts of other people.*

We have no trouble obtaining agreement that the management function can be divided into three parts: planning, control and supervision. Planning for production means deciding what people are to accomplish and, to do this, they have to make an evaluation of needs, establish objectives, develop the procedures to accomplish these objectives and finally assign the responsibility to individuals or groups of individuals to see that the work is performed.

With respect to planning a safety program, all we are asking is that management do the same things that induce and stimulate people to work together in accordance with a production or sales program, to work together in accordance with a safety program. Just as in production, they have to make an evaluation of their safety needs. They have to make a determination of how extensive an organization will be needed. They will have to establish safety objectives and, finally, they must assign the responsibility for application and development to members of their management team. What we hope to have eventually is a miniature of an operation's over-all safety program in each department of that operation, a safety program accepted by supervisors and employees as a normal part of their operating procedures.

Much of our present program is the result of a study made several years ago. In that study, we learned that some operations, for some reason or other, never seemed to get their accident problem under control. The managers of these operations didn't openly refuse to cooperate, but neither did they extend themselves to any extent to improve their record. We drew the conclusion that, in these operations, management had not given serious consideration to their accident problem. They knew they were having a few accidents, but this was a matter for the safety committee. It was apparent that such managers had about convinced themselves that they were doing everything possible to control accidents.

In the normal course of events, we knew that, under such conditions, we would find only a minimum of safety activities, a minimum of safety supervision, a safety com-

mittee that limited itself to the correction phase of safety, operating without any plans or program, and, finally, we knew that the activities being carried on were not coordinated.

When all the facts were collected and analyzed, here's what we found to be the trouble. What appeared to be lack of cooperation and a lack of effort to do something constructive about the prevention and control of accidents was, in reality, a lack of understanding about the seriousness of the problem and a lack of knowledge of what to do about it.

We learned a few other things, too. For example, we found that safety work in Borden's followed a set pattern.

In plants where the accident frequency rate was favorable and costs under control, safety work was found to be functioning smoothly. There was good management interest, support and direction. The result was that managers, supervisors, safety committees and employees knew their problems and were working together, *doing something constructive about it.*

In operations where the frequency rate was average and in line with the district or Borden Company rate, there was some management, some supervisory and some employee interest, but not enough. On the whole, one would get the impression that, while preventing accidents was important, other matters, such as production or sales, were of more importance. The end result was that their frequency and cost experience clearly reflected the extent of their effort.

And then there was that small group where little or no safety work was being carried on, as previously explained; frequency rates were high, interest in safety low.

These three types of situations indicated that accident occurrences had a different meaning to different people at management level. Some sit tight, not realizing a problem exists, doing nothing. Others do a little tinkering. Having a vague idea that something is wrong, they proceed on a hit-or-miss basis, with only half-hearted effort, and they obtain half-hearted results. Finally, there is that group which realizes they have an accident problem; they collect and study the facts, compare their record with that of previous years and, by evaluating the effectiveness of each

phase of their program, are able to work out a satisfactory solution.

From an awareness of these three types of situation, when added to the other facts collected by our study, we drew this firm conclusion. First, *the extent of accident prevention work carried on in any of our operations depends almost entirely on the attitude of the manager toward safety and the amount of knowledge he has of accident prevention methods and techniques.* Second, *where management was familiar with safety policies and procedures and determined to control accidents, he was successful in stimulating this activity among his foremen and supervisors and, through them, to his employees.*

If this was a correct conclusion—and we had every reason to believe it was—it was obvious that we had to redesign the application phase of our program. What we had to do was this—place in the hands of local management the necessary knowledge in the form of safety know-how, plus the tools and equipment that would permit them to apply and carry on effective safety work in their operation. We were confident such an approach would overcome what was then an impossible situation—a situation where we were asking our operating people to do something they didn't know how to do. If we were successful, we could be assured of improved safety performance all along the line.

Our first step in redesigning our program was to establish the specific areas of activity in the safety program among four groups: management, supervisors, the safety committee and the employees. The focal point, of course, was the manager. Each other group had areas of responsibility and accountability for the results obtained. We have found that, by outlining for management the several things they should do to develop and promote safety in their operation, they would give us their cooperation and support. The first thing we suggested was that they adopt and enforce a safety policy for their operation, somewhat along the following lines:

1. That accidents are a by-product of production and of distribution and, therefore, an operating problem under the control and the responsibility of management.
2. That accident prevention work takes up no more and no less time of the manage-

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ment team than do other operating problems of equal importance.

3. That supervisors should consider the promotion of safety education and safe practice in their departments as a normal function and a part of their daily work.

4. That supervisors will be held responsible and accountable for conditions that result in accidents to employees under their supervision.

In the application of such a policy, we encourage managers to provide executive leadership and direction in safety work to the same degree and in the same manner that they provide leadership and direction in production and sales matters.

Next, we ask our managers to clarify the functions of the supervisor in the safety program. We point out that if employees are to work safely and be able to recognize and avoid accident hazards, the training, instruction and guidance that will encourage them to do this can only come to them through the supervisor. In order for the supervisor to include safety in his job function, it is expected that the manager acquaint the supervisor with his safety responsibilities along the following lines:

1. The manager should tell all supervisors his attitude on the importance of accident prevention work and the need for improved safety performance in his department.

2. He should instruct them in what they are to do, why it is necessary, how they are to do it and when they are to do it.

3. He should require a report of investigation on each accident.

4. He should insist that adequate safety training be included in the new employees' induction training program.

5. Management should insist that supervisors follow through on selective enforcement. Here is an area where the supervisor should know just how far he can go in the application of discipline for repeated violations of safe practice rules.

'We made a strong point of the fact that if the mere issuance of policies, instructions and procedures would induce people to do as they are supposed to do, supervision would not be necessary; that the function of supervision in safety was the same as the function of the supervisor in production—to close the gap between desired performance and actual performance.

One of the main reasons why many of our safety programs failed to produce results in the early days was that management had placed full responsibility for the prevention and control of accidents squarely on the shoulders of the supervisors, without giving them adequate tools or instructions on getting the job done.

We have taken the position that adequate safety training of employees and the application of a safety program at department level hinges on the recognition by management of the fact that safety work is only one of a supervisor's many duties; that there are certain necessary things he cannot do unless local company policy encourages him to do them and that he definitely requires help from above. As to job conditions, management should encourage supervisors to eliminate and control job hazards and provide them with the necessary safeguards, proper equipment and clear-cut instructions to get the job done.

Regarding all other phases of the safety program at department level, supervision should only be expected to execute a safety program planned by others and so designed that it ties in with the operation's over-all effort. Only after these steps have been taken, should management hold supervisors responsible and accountable for the accidents and safety performance record of their departments.

Another part of our organization type approach are our safety committees. These safety committees are looked upon as the heart of local accident prevention activities and one of the keystones of our whole program. When they function correctly as an advisory function to management on all phases of the accident problem, they are the watch-dog on accident trends; the guiding force in building safety programs and in recommending ways and means in which safety can be incorporated into existing induction and job training procedures. The last time we measured, approximately 3,000 Bordenites were taking active part in local safety committee activities.

Our entire accident prevention effort, the organization type of approach, has only one purpose—to reach down through all levels of the company to the individual employee who is exposed to accident and injury. What we are trying to do is to develop safe thinking and safe work habits

among our people. We want them to be able to recognize and avoid accident hazards. What we are trying to accomplish through education, instruction and supervision is recognition by each individual that safety is a personal responsibility. Our management wants its employees to look upon their plants' safety activities as a friendly medium that encourages and permits each individual employee to work *with* the company in promoting his own safety and that of his fellow workers.

I wish time would permit me to give you the story in greater detail—the successes we have had, the problems we have overcome by using management's own positive type of approach for getting results. We're not out of the woods by a long shot, but we can now see daylight.

What we have been doing, with some measure of success, is building or blending accident prevention thinking and accident prevention effort into normal operating procedures and decisions at executive and operating level. We have been placing in the hands of the people to whom we look for results, information and know-how on accident prevention methods and techniques. We have established lines of coordination, cooperation and communication at all levels. We have been as successful in selling our program upward to top level as we have been downward to employee level.

We believe in the organization type of approach. It has produced results for us—it will for you. Just as organization is the key to improved performance, here are necessary keys to organization:

1. Top level control and direction.
2. Clear-cut outline of policies and procedures.
3. Placing of responsibility on line organization.
4. Accountability for results on management team.
5. Providing factual information and statistics.
6. Indoctrination of program at all levels.
7. Direction and application.
8. Employee participation.
9. Discipline.
10. Awards.

In closing, let me point out four major things that the organization type of approach has done for us:

1. Since we have adopted this approach, our company-wide accident frequency rates dropped 35 per cent—from an all-time high to an all-time low. Each year since 1949 we have had consistent improvement in both vehicle and employee injury accident frequency rates.

2. Accident costs, too, have shown substantial improvement. At the close of the 1954 year, our insurance department declared an additional 20 per cent dividend which was returned to every district and division in the form of adjusted accruals (lower self-insured premiums).

3. Two of our operations, each employing close to 100 men, completed a million man-hours without a lost-time accident. It took them five years to accomplish this record. Both received the National Safety Council's Award of Honor and our President's Award for Outstanding Safety Performance—one in 1953, the other in 1954. While on the subject, I want to point out that our East Detroit branch, which won one of these awards, was the first fluid milk operation in history ever to complete one million man-hours with a lost-time accident.

4. Of greatest satisfaction to us is the realization that our executives and operating people, as never before, appreciate the valuable contribution a good safety program makes to production and sales performance, and that accident control is an important factor in controlling production and delivery expense.

The level of importance of safety work in The Borden Company, in relation to production or sales or other Company activity, was established some time ago in a talk by our president, Theodore G. Montague. The following statement, taken from that talk, supports the organization type of approach to accident control, and is printed on the bottom of all safety department letterheads. It reads: "Good safety performance, like good production or good sales performance, is an essential part of good management."

I hope you will agree that the organization type of approach is really the key to improved safety performance and worthy of your consideration. We are confident it will continue to produce results for us as we continue to perfect organization.

Accident Control—Phase Two, Cost

Getting the Cost Data—and Using It

By LEE B. JOHNSON

Chief Safety Eng., Northrop Aircraft, Inc., Hawthorne, Calif.

this approach, recovery rates are high as far since 1949 movement in both accident fre-

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each employ- eted a million time accident. accomplish this ational Safety nd our Presi- g Safety Per- other in 1954. t to point out h, which won the first fluid r to complete a a lost-time

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Industry today is placing emphasis on "cost reduction" in manufacturing operations. Thus the use of accident control cost reports in safety engineering is a "must."

This does not mean that the board of directors has had a change in attitude toward the well-being of their subordinates—they remain humanitarian, but, in addition, they desire a lean, hard-hitting accident cost reduction program from their safety engineering department.

The board of directors is primarily interested in maintaining a favorable financial report through an efficient operating industrial management. The safety engineering department is in an excellent position to place a larger figure under the *assets* column of the annual financial report rather than in the liabilities column. Knowing that our busy plant executives today use the financial report as their first line of communication, why shouldn't the safety engineer add his safety record, interpreted in dollars and cents, as a supplementary part of the assets column in the financial report?

There are various methods for obtaining accident cost data, and unlimited ways in presenting your findings to management. Let us elaborate on just one method, which appears to be a workable plan for industry.

This paper will be presented in two parts:

1. Getting the Cost Data.
2. Using Cost Data to the Best Advantage.

Part One Getting the Cost Data

In obtaining cost data, first we must standardize what kind of accidents are to be charged. *All* industrial accidents resulting in injury must be charged, including first-aid, doctor-treated and lost-time cases, as

well as all retreatments or redressings. All man hours which are lost through industrial injuries are charged directly to the individual department involved.

Historically speaking, too many sins can be committed when intangible cost figures are added to the direct cost loss of accidents. Avoid charging the supervisor's time, etc., which is involved in the investigation of the accident. This is "intangible cost," and it is difficult to get department heads and top management to accept same.

You may be asking yourself: why charge minor first-aid cases and redressings? It has been proven in many plants that in order to present a true cost picture of accidents to management, time lost due to first-aid treatments is essential.

This type of cost analysis is not reflected in the Workmen's Compensation Insurance data on the monthly report. It is a true picture of what all industrial injuries cost the company in dollars, cents and man hours lost.

In obtaining cost data for reporting purposes, every effort should be made to obtain *actual* rather than the estimated costs.

At present, many such reports fail to include travel time in estimating accident costs. The amount of man hours expended due to travel time to and from the hospital is staggering.

For example, if you had 1,000 first-aid cases treated last month, at an average of 10 minutes travel time to and from the hospital, a total of 166 hours would have been consumed. If each accident required an average of one and one-half treatments, or 250 man hours, the total man hours lost through travel time would be 416. This should prove how important it is to include travel time when computing cost data.

Computation

1,000 injuries	
10 minutes travel time—	
10,000 minutes	each case
10,000 minutes	= 166 hours
60 minutes	
1½ treatments = 15,000 minutes	= 250 hours
60 minutes	
166 hours	
250 hours	
Total	416 hours expended

Travel time can be accurate or estimated, but, for the best results, accurate time should be obtained. There are four ways that this can be accomplished for inter-plant reporting.

1. Use of "Employee Pass" to be issued by the department clerk or members of supervision, noting time out and in. The hospital to record on the slip time-in and out of the hospital. Forms should be made out in triplicate—copies for department foreman, hospital and safety department.
2. Issuance of necessary pass by timekeeping department, said pass to include the same information as outlined in Item One. (These two methods will cost the company more time in keeping records than the following methods Three and Four.)
3. Travel time to be set up by the safety department by estimating the time expended from the department to the hospital. *Note:* The use of estimating the time should be discouraged, unless time studies of travel time can be kept up to date.
4. Setting up a standard time charge for all travel time to and from the hospital. This is a flat time charge, regardless of the location of personnel from hospital or first-aid stations.

(The last two methods will require less time and cost, but again they are estimated and not actual cost figures.)

Travel time for outside medical treatment is controlled by use of the hospital out-pass.

All industrial injuries should be reported to the safety engineering office by the following methods:

- (1) Daily injury and illness hospital reports made out on all first-time injuries.

- (2) Daily redressing reports by the hospital.
- (3) Weekly first-aid box treatments reports forwarded by the departments. *Note:* In remote areas, where there are less than 100 employees, the recording of all first-aid treatments is the responsibility of the operating supervisor.

When starting a cost-collecting data program, the forms now in use will serve the purpose by the employment of a rubber stamp over the face of the form. The rubber stamp we use says:

Cost of Accident

1. Machine Damage Cost \$_____
2. Material & Tool Damage Cost \$_____
3. Lost time (in man hours) of employee to date _____

At this point, the travel time slips and hospital reports are sent to the tabulating department, from which information that department makes up a tab run and forwards the run to the safety department. The tab run sets forth:

- (a) Number identification of each department.
- (b) Number of injuries per department.
- (c) Number of redressings per department.
- (d) Time spent in hospital.
- (e) Travel time.

The cost factor is now computed for all injuries. We must use the average shop rate and supervisory rates to determine travel time and lost time injuries, and this information is obtained from the monthly current rates forwarded to the safety department by Wage and Salary Administration.

In the following example, we shall use hypothetical costs to outline the entire scope of cost data:

Mary Jones, a shop employee, (average \$2.00 per hour), was injured, and the injury required three retreatments. Travel time, hospital costs and time spent in hospital will have to be included in the computation:

1. Travel time (four trips)
—10 minutes per trip, or
40 minutes\$1.33
2. Initial time in hospital—
12 minutes40

by the hospital.
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3. Three retreatments at five minutes 50
Travel time\$ 2.23
4. Hospital costs—four calls at \$3.50 each..... 14.00
Total costs\$16.23

The result—for just the time factor involved—a total of one hour and seven minutes or \$2.23 expended for one minor injury.

The above sample case, costing \$16.23 for four trips to the hospital, includes the initial treatment cost of \$4.05 per trip. This \$4.05 cost per trip for first-aid treatment can be used as a start toward formulating an average cost index figure for each visit to the first-aid dispensary. However, many cases would have to be studied each year in order to obtain an accurate annual cost index figure to be applied for obtaining total cost of all first-aid cases.

Charges for first-aid treatment and dressings are furnished by the cost accounting department. These are average costs and are applied to the noted sample case in order to arrive at actual costs.

The insurance carrier, or, in the case of a self-insured company, the safety engineering department, provides a monthly breakdown on outside medical costs after the actual costs on the reserve cases have been closed. Compensation and medical costs on reserves are not included in the monthly analysis report, but are withheld for the annual cost analysis report sent to top management.

First-aid box injuries are estimated by the safety engineering department as to travel time and treatment time by use of an established index.

The medical costs should be furnished by the finance division and shall include bandages, medications, and so forth. When computing operational cost of first-aid stations or hospitals, one should only consider cost used for treating industrial injuries. Today, many large industrial plants show that the non-industrial type of treatments or calls to the company hospitals account for better than 50 per cent of the total hospital visits. Therefore, apply only that portion of the hospital cost of bandages, drugs, nurses and

doctors' salaries that are used for treating industrial cases.

A fairly accurate annual hospital cost index figure per case can be established if the hospital operating cost is figured for a 12-month operating period. The established annual hospital cost index figure per treatment will save untold expenses in keeping cost accounting records on first-aid cases.

Part Two Using Cost Data

To portray a complete picture, the above outlined "cost data" must be used to the best advantage, for if we fail to use this data effectively, to see the report, we have accomplished nothing.

There are unlimited ways of issuing this information of accident costs. An effective way to sell a cost data program is to channel the information to every person in an organization. This is accomplished by using the basic information in tailoring a report for a three-level approach—(1) management report, (2) foremen and supervisors report, (3) shop and office personnel report.

It is essential to emphasize four major points: (1) lost man hours due to injuries, (2) current cost of industrial injuries, (3) methods used to reduce the above mentioned points, and (4) actual machine, tool or parts damage.

A. Management Report: This is a short, concise report, outlining the actual costs of industrial accidents.

Financial

Number of industrial injuries...1,000
retreatments.2,500
Total injuries and retreatments.3,500
Travel time (10 minutes each trip)—
 $3,500 \times 10 = \frac{35,000}{60} \text{ minutes} = 583 \text{ hours}$
583 hours at \$2.00 per hour =....\$ 1,166
Initial hospital time at 12 minutes
per case:
 $1,000 \times 12 = \frac{12,000}{60} \text{ minutes} = 200 \text{ hours}$
200 hours at \$2.00 per hour =.... 400
Retreatments at five minutes per case
 $2,500 \times 5 = \frac{12,500}{60} \text{ minutes} = 208 \text{ hours}$
208 hours at \$2.00 per hour =.... 416
Hospital costs at \$3.50 per case
 $3,500 \times \$3.50 = \dots\dots\dots 12,250$
Inter-plant industrial injury costs—
3,500 treated cases.....\$14,232

Per Capita Cost of Industrial Injuries (Industrial plant of 20,000 employees)

*1955 current month's company per capita cost.....	\$.71
1954 average monthly company per capita cost.....	.85
*Method for computing formula:	
Time period—one month	
Total accident costs for above period—\$14,232	
Current month personnel strength—20,000	
Formula: $\$14,232 \times 1 = \$.71$	
	20,000

This monthly report can be projected for use as a forecast as to what the total industrial injury cost will be for a full year, if the injuries continue to occur monthly in the same number.

B. *Foremen and Supervisors Report*: This report shows the lost man hours and costs for his department. It should also set forth a safety-educational program for shop and office personnel.

Department 5503	May 1955
Industrial injuries reported.....	100
retreatments.....	150
Total injuries and retreatments....	250
Travel time (10 minutes each trip)	
$250 \times 10 = 2,500$ minutes	
$\frac{60}{60}$ minutes = 41 hours	
41 hours at \$2.00 per hour =.....	\$ 82
Initial hospital time at 12 minutes per case:	
$100 \times 12 = 1,200$ minutes	
$\frac{60}{60}$ minutes = 20 hours	
20 hours at \$2.00 per hour =.....	40
Retreatments at five minutes per case	
$150 \times 5 = 750$ minutes	
$\frac{60}{60}$ minutes = 13 hours	
13 hours at \$2.00 per hour =.....	26
Hospital costs at \$3.50 per case	
$250 \times \$3.50 =$	\$75
Total cost for industrial injuries.....	\$1,025

Per Capita

*1955 current month's department per capita cost.....	\$1.71
*Method for computing formula:	
Time period—1 month	
Total accident costs for above period—\$1,023	
Current month personnel strength—600	
Formula: $\frac{\$1,023 \times 1}{600} = \1.71	
1955 current month's company per capita	\$.71
1955 current month's department per capita	1.71

This monthly report can be projected for use as a forecast as to what the total industrial injury cost will be for a full year, if the injuries continue to occur monthly in the same number.

C. *Shop and Office Personnel Report*: This could be the most important of the three if used correctly. The positive approach can be beneficial in this type of report.

One method of giving recognition to the shop level personnel is by comparing your organization with other comparable industries, whose frequency rates are higher than yours, and show them tangible results such as: *A six months' savings in man hours through reduction of lost time accidents produced this airplane.*

The use of educational posters can be used to build employee's attitudes to assist in the reduction of operational cost in injury.

An employee is a credit to his community when he thinks, acts and works *safety*. If he doesn't, he becomes a liability to his community.

Summary

We might summarize this discussion by stating that the very foundation of a successful program for *Getting the Cost Data—and Using It* lies in a well-planned and well-conceived practical reporting procedure. If such a program is so conceived and is operated intelligently, results must follow.

Accident control through cost control data reporting is the affirmative side of safety. That is the businessmen's approach. The time, money and effort we expend in applying this approach is an investment which pays dividends—by getting executive determination to stop accidents.

American Society of Safety Engineers: Annual Meeting

What Is Ahead for Engineering?

By JOHN T. RETTALIATA

Pres., Illinois Institute of Technology, Chicago, Ill.

The rapid advancement of scientific and technological knowledge has enlarged the potentialities so greatly as to almost stagger the imagination, for in modern science and engineering we have the means of turning into reality practically whatever the mind is capable of conceiving.

For more than a half-century, the Illinois Institute of Technology has been concerned with safety and the prevention of disaster. In 1903, officials of the Armour Institute of Technology, a predecessor of Illinois Tech, in response to a need for qualified personnel in the insurance business, established what is now known as the Department of Fire Protection and Safety Engineering. It offers the nation's only degree-granting fire protection and safety engineering program and the Midwest's only complete property insurance educational program. Hundreds of graduates of the department have taken major places in the insurance business and in industrial safety work.

A tremendous job has been done in all types of safety. Our great cities stand as a tribute to the progress which has been made in controlling the destructive power of fire, and the advancement of industrial safety is reflected in the decline in the number of deaths resulting from work accidents, and improvement in the injury frequency rates over many years.

Unfortunately, the slaughter on the highway continues, despite the best efforts of engineers, the automotive industry and the many agencies engaged in safety educational work. National Safety Council records show that last year approximately 36,000 persons were killed in traffic accidents in the United States. There is some measure of consolation in the fact that this total was some 2,300 fewer than in 1953.

America's engineers and scientists have made this nation the greatest power on earth. Our technology has given us the highest standard of living ever known, lightened our physical burdens while reducing our hours of labor, sustained the defense of the nation against its foes and made the United States a bulwark of strength of the free peoples of the world.

With little more than six per cent of the earth's population and land area, we enjoy an abundance greater perhaps than all the rest of the world combined. And in creating this material abundance, we have not neglected the other things which make for a better and fuller life.

More young men and women are attending colleges and universities in the United States than in any other nation; we have more charitable institutions, more libraries, more hospitals than any other country. We ever have been ready to share our plenty with the less fortunate of the earth. America stands before the world as an example of what men can accomplish under a free enterprise system which encourages them to pursue ideals and ideas.

Engineering is entering an era of achievement that will dwarf prior accomplishments, great though they have been. Our rapidly rising population, the exploitation of new areas of scientific development, and the continuous necessity to maintain the technological supremacy of our national defense will find useful work for all the engineering talent we can muster.

I cannot emphasize too strongly the importance of maintaining the superior technology that, more than any other factor, has been the deterrent to aggression by the enemies of freedom. Let us not be deluded or confused by the professed friendly attitude and seeming interest in promoting

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world peace emanating from the Kremlin these days. Let us stand ready to grasp the hand of friendship when offered in sincerity and backed by convincing action, but, meanwhile, we must not drop our guard.

There is evidence that the Soviet Union, despite these gestures, is still hard at work seeking supremacy over the United States in atomic weapons, guided missiles, long range bombers and other weapons. To that end Russia is directing every effort to overcome America's present advantage in technological manpower.

At present, the United States appears to have an advantage of some 100,000 engineers, but in the five years ending in 1954, Russian colleges turned out a reported 154,000 engineering graduates, compared with only about 118,000 in this country. For 1954, comparable figures were 54,000 and 22,000.

Our engineers and scientists constitute the hard core of the national defense. They will continue to carry this responsibility, ever devising more powerful and effective weapons, until the need finally shall have passed.

Consideration of the future domestic needs of the country leads to the conclusion that new technological advances will be more necessary than ever before. Population increases and rising incomes will swell the demand for goods and services, and the facilities of production, distribution, transportation and communications must be increased to meet these demands.

According to the Bureau of the Census, in 1965—just 10 years from now—there will be close to 190 million Americans. There are 165 million today.

There will be some 56 million households, nearly a fifth more than we have today. It is estimated that the disposable personal income will rise by more than \$400 a person, or nearly \$1,400 per household.

It is further estimated that in terms of current prices, durable goods expenditures—for such things as washing machines, automobiles, television sets, electrical appliances, and so forth—will be about 40 per cent higher per family in 1965. Clothing and non-durable goods expenditures are expected to be up about 30 per cent per capita, and spending for services, including education, is placed at almost 25 per cent higher per person.

These factors alone contain a challenge to the productive ingenuity of American industry. They promise a tremendous stimulant to economic activity which can be met only by continuous technological advances to increase the output per man-hour. Meeting this challenge will be the responsibility of the engineer and the scientist.

New families will need homes and everything that goes into them. Even now, housing is woefully inadequate and half of the houses are more than 30 years old. There is widespread need of redevelopment of great sections of the cities to eliminate slums and provide for more decent living for all of the people. Yet, there is a serious shortage of people qualified in urban and regional planning. There will be a need for more hospitals, stores, churches, schools, water, food, electricity and many other things necessary to sustain life and expand further the standard of living.

Our roads are overcrowded and unsafe, and we are confronted by the prospect of several million more automobiles and a 50 per cent increase in traffic over the next decade. It has been said that the highway program which was proposed by President Eisenhower would require the employment of some 32,000 engineers that are not now available.

Broadening technology in the fields of atomic energy, automation and electronics will create new demands for engineers and scientists, the extent of which is largely yet unknown. It is reported that the Atomic Energy Commission could use another 40,000 engineers and scientists, if they could be hired. No one has estimated the number of new technical jobs being created by the fast-spreading automation. Certainly, research in these fields will lead us to a higher professional plane and stimulate creative qualities to a far greater extent.

Almost every business will be influenced by nuclear energy. The Atomic Energy Act of 1954 removed many of the restraints on dissemination of technical information, and gave industry an opportunity to study the significance of nuclear energy on its operation.

At present, major attention is centered on the production of electric power using atomic energy as fuel. The incentive to use this kind of fuel derives from the fact that the energy in the country's reserves of

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uranium and thorium is 20 to 30 times that represented by the fossil fuels—coal, oil and gas.

It is expected that power plants employing fossil fuels will be with us for some time to come, however, as more development will be required before nuclear plants will be economically competitive. Even then, since the electric utilities plan to double their present capacity of 102,000,000 kilowatts within the next decade, there will be need for both kinds of plants.

So far the application of nuclear energy to electric power production has employed the fission process as used in the A-bomb. A much more difficult achievement, but one which would increase many times our energy reserve potential, would be the application of the fusion process, the kind found in the H-bomb. One of the major difficulties in the latter process is that it requires extremely high temperatures, many millions of degrees, to bring about the reaction. American technology—its engineering skill—will be intimately associated with the continuing effort to harness the hydrogen bomb to provide vast resources of cheap power.

And as the land resources diminish, the oceans become man's largest, last, and as yet largely untapped, resource. The vast sheets of water which cover so much of the globe hold great reserves of many kinds—oil, minerals, drugs, chemicals and foods—awaiting conversion to the use of mankind. Exploitation of these resources will be necessary if we are to support a population of approximately one-quarter of a billion American people predicted for the beginning of the 21st century.

In the skies, technology has enabled America to develop and produce the best aircraft in the world. Prior to 1950, it was conceded generally that the British led in jet engine developments. Since then, however, the United States has taken the leadership, particularly in the category of high thrust engines—10,000 pounds and above. Widespread commercial use of turbine-powered aircraft can be predicted for 1960.

The implications of government-announced plans to launch an artificial satellite sometime during the International Geophysical Year—July, 1957, to December, 1958—are tremendous. A successful satellite would mean that technology has conquered the

so-called space barrier, again reminding us that in the language of the scientist or engineer the word "barrier" has only temporary significance.

Until now, I have spoken largely of the opportunities that lie ahead for engineering and suggested areas in which the profession can utilize its talents to the benefit of the human race. But engineering, which has played so prominent a part in creating the complex civilization of today, is facing additional calls the world is making upon it.

The first of these, and perhaps the most important, is that of leadership, a role which I believe the engineer is pre-eminently fitted to fulfill.

The foundation of our abundant economy is, without question, science and technology. And at the center of things is the man who is a combination of both scientist and technologist—the engineer.

There have been changes not only in our processes and products, but in our organizational structures, in growing corporate complexity, in methods of financing and selling, in the relations of business with labor and government, in concepts of business ethics and in the laws under which business and industry operate.

The changes will affect everything the engineer does. Upon him, in increasing measure, business and industry will place greater reliance. He will move more and more into the broader spheres of management as a whole.

It is the engineer's knowledge and skills, his foresight, judgment and decisions that weigh heavily in the successful outcome of the primary aim of the industrial corporation, namely the earning of a profit. As management at the policy level grows more complex and difficult, the engineer in ever-growing numbers will be called upon to assume functions far beyond engineering itself.

From a fractional representation a few decades ago, a recent Columbia University survey showed that today 40 per cent of industrial management is engineer-trained. The engineer is replacing both the lawyer, the banker and the financier in the top industrial posts of the nation.

If the engineer is to be counted upon more and more to share the helm, to have a larger sphere of influence in keeping this high-paced, dynamic economy going, two things

must happen. (1) The ranks of the engineering profession must be continually reinforced and replenished. (2) The educational process for the engineer must encompass vastly more than the imparting of scientific knowledge and technical skills alone.

The task of making the engineer increasingly useful to society devolves primarily upon the engineering colleges. We who represent the engineering educational institutions know that the embryo engineer must be exposed to economics, history, psychology, political science, to law and literature.

The young engineer must be made aware of the cost factors in productivity, the labor factor and marketability. He must be made conscious of consumers, advertisers, suppliers and customers. And all this beyond a deep and solid grounding in the basic principles of his chosen engineering field. It is a tremendous responsibility, this preparation of the engineer for a world of new and vital comprehensions.

I think I may assure you that the problems of engineering education are keenly recognized by the leading technological colleges of the nation. Speaking for my own institution, we have steadily been effecting changes and extensions aimed at greatly broadening the base of engineering education and of building into the engineer the potentialities of widest usefulness in our industrial civilization.

The task of our technological institutions however, is not simply turning out a finer product. We must educate enough of them, the right ones, and educate them superlatively well. It is a task which educational institutions alone cannot achieve. They must have help.

And it is here that you, your American Society of Safety Engineers and other professional organizations of engineers, can play a vital part. One of the new calls upon you is to help us in the task of education.

If the demand for more and finer engineers is to be met, there is an urgent need for a greater effort to reach into the high schools and bring engineering as a splendid career strongly to the attention of American youth.

The shortage of engineers, as you know, is acute in all fields. The challenge before you is to intensify the effort greatly to in-

terest more young men and young women in the profession, to give them compelling motivations for entering the field.

You can help in discovering and encouraging high school students with natural abilities for engineering careers to pursue such studies at the higher level. I would call to your attention the striking fact that only six out of every ten of the top five per cent of high school graduates go on to college. There is a tremendous loss there, to engineering, and other fields, of America's brightest youth. It merits the considered thought of your society.

In attracting to engineering those youths with the greatest potentialities for it, the provision of financial inducements, in the form of scholarships, would help enormously. I hope that we, in the field of engineering education, can count upon you, as individuals, upon the corporate and industrial enterprises with which you are associated, and upon your society, to help the educational institutions build up the nation's resources of engineers—men who are technologists of the finest kind, to be sure, but who will be able to meet, as they progress and rise in their careers, the growing demand upon them for broadened perception and high potentialities of leadership.

Let me touch briefly upon two other calls upon the engineering profession for the benefit of posterity. First, we are, as a nation, a fair island in a world sea of privation and want. We have sought, for humanitarian reasons and for mutual security and safety, to come to the aid of the peoples of the less-developed areas of the earth. We have poured out our wealth, in prodigious amounts, in efforts to bolster and assist. Perhaps that has all been wise as well as necessary, in the initial stages, due to calls by weaker nations upon our strength.

But temporary and emergency measures must finally be replaced by more fruitful, long-term forms of assistance. The less happy regions of earth must become their own sources of abundance and reliance. In that important process, it is American skills that can contribute most to the remedying of their ills.

Our government is increasingly recognizing its responsibility in this quarter. But it is an effort that cannot be left to officialdom alone. Joined with it must be the private

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tions, of corporations, and of organizations
such as your own, in the full knowledge that
such service represents the highest kind of
contribution to the welfare of all mankind.

Finally, there is the call to conserve.

It is hard for Americans, long accustomed
to ideas of boundless American resources, to
think of ourselves as a nation whose re-
sources are running out. Yet in ever-sharper
measure our attention is being called to the
growing problem of shrinking stores of
natural national wealth. The time has come
when we must be truly scientific about the
utilization of our resources.

Our hope for the future in this respect
lies with the engineer and scientist, not only
to husband our resources, but to prevent in
every way, as your society does, the need-
less destruction of our national wealth, and
the useless loss of life among our people,
who are our most precious resource.

I have sought to suggest a few aspects
of what is ahead for engineering—its oppor-
tunities for service and the responsibilities it
must recognize and accept. I am confident
the continued prosperity of our nation and
its security are in the hands of our most
capable people.

Are Your Employees Falling Down On the Job?

Falls from Portable Surfaces (Ladders and Other Portable Surfaces)

By R. L. POTTER

Supvr., Industrial Safety, American Airlines, Inc., Tulsa, Okla.

There is probably little question in your minds as to what constitutes a safe ladder or portable workstand for any given job in your industry. We usually know exactly the type of equipment that is needed for our operations. We provide such equipment. I am sure there are few management groups that fail to provide what they consider to be safe equipment.

At this point, I would like to say that such organizations as the American Standards Association, Metal Ladder Manufacturers Association, the Association of Casualty and Surety Companies, National Safety Council, and others, have done a wonderful job of providing ladder standards. Their specifications are good. Manufacturers of ladders are cognizant of our problems and are building safety into their products as prime selling points. In other words, it isn't too difficult to buy a good ladder that is suitable for most jobs.

If you have a specialized problem where ladders are not the answer, portable workstands which comply with recognized standards are used. But regardless of how much care is used in the selection of ladders and portable workstands, we will continue to have accidents if:

1. They are not used for their intended purpose.
2. They are used improperly.
3. They are not properly maintained.

We have closely analyzed several hundred fall incidents where portable workstands and ladders were involved and failed to find a single instance where good, properly used, properly maintained equipment was the cause.

The term "portable workstands" can cover a multitude of neck breakers. If a man has

a quick job to do that is just out of reach from floor level, he is likely to use the nearest and handiest object that will provide the desired elevation. Those of you who are in the construction industry will readily think of nail kegs and dynamite boxes in this regard. Those two demons, particularly the former, caused me endless worry during the ten years I spent in construction safety.

There was one incident I will never forget. It was during the war, on one of the large government contracts. We had an iron-clad rule that nail kegs were to be demolished when empty of their original contents. But, like so many other such rules, there was the occasional slip in its enforcement and eventually (usually sooner) a fall resulted.

I was driving down a road one morning and saw a carpenter standing on a nail keg while nailing a scaffold member to the side of a building. Immediate corrective action was in order, but I was in a hurry and did not stop. A few minutes later that carpenter was on his way to the hospital with a broken pelvis.

He later told me that he hadn't wanted to waste the time getting a ladder to do a job which would only take a minute. I think the man was conscientiously trying to save time. He had not, however, been properly educated in safe practices. And there is something you might say about his supervision. I had my say at the time.

Now that I have drifted into the supervisory aspects of accidents, I would like to say that if we are to prevent falls or any other type of accident, we can do so only with intelligent first line supervision. Getting these people interested in accident prevention is one thing, educating them to

the point where they can prevent accidents is another. Here is an example:

Several years ago on a construction job, we had a very reckless individual employed as a carpenter foreman. He was an excellent mechanic but lacked supervisory experience. The result was sub-marginal work, and accidents involving members of his crew were frequent.

I spent a lot of time with this fellow, and, in time, he became enthusiastically persistent in his efforts to prevent accidents. He insisted upon the use of personal protective equipment; he urged his men to purchase safety shoes. These were the superficial aspects of the safety program that were within the scope of his capabilities.

One morning I got a call from the dispensary and was advised that one of his men had suffered a broken leg. Immediate investigation of the incident disclosed a perfect example where a supervisor's enthusiasm to do the correct thing, minus technical knowledge, equals disaster.

The injured man had been descending a ladder into a 12-foot pit in which concrete forms were being placed. The ladder, complete with hand rails, was set at a 45° angle. The foreman was very proud of the ladder, pointing out to me the added safety of the hand rail. The results, of course, were obvious. Everyone used the ladder as they would normally use stairs. It was in use less than two hours when the accident occurred.

This was a case of a man who had a "smattering of ignorance" about accident prevention. He was sincere in his determination. He had heard a talk at a safety meeting on requirements for handrails on scaffolds, stairs and platforms. Why not put hand rails on the ladder, he thought. Wouldn't that make it safer? No one had taken time to teach him the basic difference between stairs and ladders, or the critical angles of each.

Similar incidents were commonplace during the wartime building emergency when good supervisory talent is spread too thin. Those of us in rapidly expanding industries today are facing similar problems. Promotions into the supervisory ranks are faster than men can be trained to assume the responsibilities.

Our foremen training must be intensified and it is our job—yours and mine—to see to it that accident prevention is a part of such a program.

It is not my intention to change the subject of this discussion from ladders and workstands to supervisory training. I am merely attempting to point out the fact that, in my opinion, falls or any other accident situation cannot be effectively prevented except through the efforts of first line supervision. It is our firm conviction that situations which cause accidents should be corrected immediately.

If the foreman observes improper use of any type of equipment, he should tell the offender as quickly as possible. If he sees or is told that a piece of equipment is in need of repair, he should remove it from service at once and have it repaired. Those are cardinal points in our program, and the foremen who practice them spend little time writing accident reports.

In aircraft maintenance and operation, we have multitudes of ladder and workstand problems involving a great variety of specialized equipment.

A tremendous amount of our maintenance work is done from portable stands and ladders and it takes a variety of such equipment to service a four-engine aircraft which requires service checks from floor level to the top of the vertical stabilizer—30 feet up. The presence of various types and sizes of stands presents problems. It leads to misuse. In other words, stands of insufficient height are sometimes used when it seems inconvenient to walk a short distance to get the proper size. (Remember the nail keg incident?)

Even with our high exposure to the hazards, only two per cent of our reportable injuries during the past two years were due to slips and falls from portable stands and ladders. We feel that this is a fine record, although we know that just a little extra effort would have made it near perfect. I say "near perfect" because I do not think it is possible to win the battle against falls completely. My reasons are:

1. *Gravity*—Falling is simple because it is given a big assist by one of nature's constant laws. Gravity is a strong thing. It is constant. Most other types of accident situations require greater con-

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tributions from the participants than shifting one's center of gravity a fraction of an inch too far in the critical direction.

2. *Physiological Factor*—Some individuals have near-perfect equilibrium. Others lack it to the extent that they experience difficulty in walking a straight line, even without benefit of stimulants which normally produce such action. Athletic coaches will tell you that good balance is a prime requisite for superior athletic ability. This is also true of aircraft pilots. There is little question that the same rule would hold true in any activity which requires muscular coordination. Certainly, working at heights on ladders and stands requires excellent balance.

We can do nothing about gravity, but we can certainly keep an eye out for the fellow whose balance is poor and keep him on the floor.

Perhaps the reason that we have had no general sessions on falls since 1938, is that it is difficult to develop a fresh approach to the subject. Nothing that I have told you is new. As a matter of fact, we can use the time worn *Rules for Tools* and convert them to ladders and stands:

1. Use the right tool (ladder).
2. Be sure it's in good condition.
3. Use it properly.

Here is a poem, published last spring, in one of the National Safety Council's *News Letters* and credited to E. Fred Shipman, Industrial Products Co., *Flash-O-Gram*.

"The Shortest Route"

Now, the shortest way to heaven
Is by climbing up a ladder
That isn't resting firmly on the floor.
If the ladder isn't level
You may visit with the devil
Who can always make room for just one
more.

You may go to see St. Peter
Who is still official greeter
If you climb a ladder which has lost a rung.
If you're careless in descending
You may have a sudden ending
To the tune of angel music sweetly sung.

If you don't watch how you're climbing
Church bells o'er you may be chiming
And it's up to you to see which way you'll
go.

If you're good you'll just climb higher
And if not they'll light your fire
For a hot time in that city far below.

If the ladder isn't steady
Both the places will be ready
So you'll forget the things you've left be-
hind.

You may go to meet your Maker
Or become a brimstone-breaker
If the ladder isn't properly inclined.

If you carelessly keep standing
On the ladder, you'll be landing
Very likely in a quiet family plot.

And since you have no selection
Of your ultimate direction
Play it safe and keep the only life you've
got.

Atomic Energy Is In Industry

New Uses for Isotopes, Reactors and Associated Developments

By BERNARD MANOWITZ

Project Eng., Fission Products Utilization Project, Brookhaven National Laboratory,
Upton, L. I., N. Y.

Necessity is the mother of invention. A need first exists, and a new industry is developed to meet that need.

Atypically, a new mode of power is being born, and uses for this power are being sought after. The power is that of the fissioning atom. Its power to destroy is awe- and fear-inspiring, and amply evident. Its power to benefit mankind is the challenge that faces mankind.

Prodigious efforts are being made to harness the atom for the production of conventional electrical power. Less attention has been paid to the radiation associated with the fission process. However, it is this very radiation that may pay off in new technology, new products, and new benefits to mankind.

Nuclear radiation is an insidious kind of power. You cannot see it, hear it, smell it, touch it, or feel it. But every time an atom of uranium is split, copious quantities of radiation are emitted, and their effects can be felt in many ways.

Radiation can kill men, but it can also kill insects and bacteria. Radiation can penetrate steel. Radiation can initiate chemical reactions. Radiation can cause fluorescence and ionize gases. Radiation can produce new strains of disease-resistant wheat and corn. With these many possibilities radiation may yet find its place in the industrial family. "But," the practical-minded industrialist asks, "just how much of this radiation is available? How much will it cost? How can we handle it? What will it do that I can't do with more conventional methods?"

The potential availability of radiation power is closely linked with the future po-

tential of atomic power. The principle on which atomic power is based is that every time an atom of fissionable material explodes, approximately 200 million electron volts of energy are released. When the 200 million electron volts of energy are converted to their heat equivalent, the argument is established that fissionable material (1 pound U-235 = 2.10⁹ pounds coal) is a highly concentrated fuel.

However, when the fission process occurs, not all of the 200 million electron volts are immediately converted to heat. Over five per cent of the energy of fission at equilibrium is dissipated in the form of penetrating beta and gamma rays. Even more than five per cent of the power of fission may be used for ionization purposes, but this figure is a fair one, I believe, for our first crude estimate of the availability of radiation power.

Thus a good deal of radiation power is being generated today in the Atomic Energy Commission's nuclear reactors, but it is all being wasted by being absorbed in the huge concrete shields that surround present-day reactors. Nuclear reactors of the future, however, can easily be designed to optimize the extraction of radiation power.

What then is the future for nuclear reactors? A great many people, including myself, are convinced that we are now entering the Atomic Age. America's power needs are expanding. Her supplies of fossil fuels are being depleted. The American government for its own defense and for the ultimate conservation of its resources has poured billions of dollars into the development of atomic energy. American industry, sensing the birth of a great new industry,

has made rapid strides in the advance of a new technology.

This country now has nearly 100 thousand megawatts of conventional electrical generating capability—about 40 per cent of the electrical power of the world. Do we not have enough confidence in ourselves to say that within our lifetime at least one per cent of our present capacity will be replaced by nuclear power? That is, after all, only 1,000 megawatts—the equivalent of the output of Grand Coulee dam, and surely within the integrated combined ability of American government and American industry.

But if we have 1,000 megawatts of nuclear electrical power, we must have generated even under favorable thermal efficiencies at least 3,000 megawatts of heat power, and therefore at least 150 megawatts of radiation power. 150 megawatts of radiation power is really quite a tremendous amount of this unique type of power. A one-watt bulb gives a barely perceptible amount of light. Yet, exposure to 1 watt of gamma rays would kill a man within less than one hour. Ten kilowatts of radiation power would be enough to pasteurize the average food requirements of an army division.

One megawatt of gamma power could polymerize as much styrene as is now being produced by other means throughout the entire country. For average applications, 10 kilowatts would be sufficient radiation power to equal typical production capacities. On the average, then, 15,000 factories or applications could be maintained by our projected national capacity of 150 megawatts.

I, for one, am convinced that the limiting factor to the successful industrialization of radiation power will not be a matter of supply, and will probably not be primarily a matter of cost either. Radiation power will always be a by-product or waste product of atomic power, and as such its cost will be adjusted to meet market demands.

If supply and cost are not the limiting factors, how about the problem of handling radiation power? This is indeed a problem, one certain to add to the cost of our project. That the problem can be surmounted is attested to by the considerable success the A.E.C. has had in operating and maintaining its facilities.

The main feature of the problem is that radiation and radioactive materials are biological hazards, and operating personnel and the public in general must be protected both from the penetrating radiation and from the remotest possibility of ingestion of radioactive material. Basically, we must learn to live with the atom while we use it, and keep it from harming us, just as we have learned to live with fire.

Industry is replete with examples of how hazardous materials have been handled before. Explosives, acids, high voltage; bactericidal agents, have been confined where they will do their work without harm to the user. Indeed, we are more fortunate than the organizers of earlier industries who used hazardous materials, in that a governmental agency has already set up a wise and far-sighted policy governing the handling of radioactive materials, and has already developed the technology for implementing that policy.

The question remains—what advantage does the use of radiation have over the use of more conventional methods? To gain a better insight into possible unique applications, we must first look a bit more deeply into the fundamentals of what radiation is and how it interacts with matter.

Radiation can initiate chemical reactions much in the same way that a catalyst can. Quite a few such chemical reactions have already been under investigation and are the basis for the growing science of radiation chemistry.

Although radiation can be used to effect simple chemical reactions, such as degradations, the yields are ordinarily so low as to make this application obviously uneconomical. For instance, the use of radiation as a brute force to rearrange molecules is not going to replace thermal cracking in the petroleum industry.

Most of the work in the field is being done on the use of radiation to trigger chemical chain reactions, where radiation has to supply only a small amount of initial energy to start the reaction, and chemical energy carries it the rest of the way.

Polymerizations are systems of this sort. Bretton at Yale and Martin at the University of Michigan have demonstrated that ethylene can be polymerized at potentially commercially significant rates and at low

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pressures. This may be a new way of manufacturing polyethylene—a very important polymer.

Some Brookhaven work has demonstrated that important physical properties of some polymers may be changed by radiation. Polyvinylpyrrolidone is a blood plasma substitute. The present commercial variety has the disadvantage that a high molecular weight fraction does not pass through the kidney wall and is not metabolized. Radiation can polymerize this material at higher than the present commercial rates and form a polymer of such molecular weight distribution that the plasma properties are retained, but the high molecular weight fraction is not formed.

Graft copolymers can be made by radiation techniques. This is a method of joining or grafting polymers together in such a way that some of the physical properties of the product are better than the individual properties of each polymer. For instance, vinyl acetate and acrylonitrile, two cheap plastics, can be grafted to form a copolymer that can resist boiling water. We may yet see hot water pipes made of this material.

The crosslinking of macro molecules deserves some further discussion. General Electric has marketed what seems to be the first practical application of intense fields of radiation. This is a material called irradi-thene or irradiated polyethylene. The company has claimed that crosslinkage by high speed electrons has produced a material that has more thermal stability and more mechanical strength than the unirradiated variety, and is offering the material as temperature stable electrical tape.

Possible use for crosslinked polymers range from plastic bottles that can withstand commercial sterilization temperatures to plastic blisters for jet aircraft that may maintain rigidity at ultra high speeds.

The chemist will recognize that only a bare beginning has been made in finding applications for this new mode of energy. Can we beneficially effect oxidations, sulfonations, halogenations, aminations, etc.? Can you depolymerize protein molecules? Can you degrade sugars? Can you supply free radicals for low temperature reactions in non-aqueous solvents? These and many more such questions have yet to be answered by enterprising experimenters.

Biological applications of radiation represent another phase of this fascinating new business.

The basic facts of radiation biology seem to be that the more complex the biological organism, the easier it is to destroy by radiation. Thus it takes a whole body dose of about 400 R to kill a man, about 25,000 R to kill insects, and about 2,000,000 R to kill bacteria. Behind this rough generalization lies a tremendous amount of not yet understood mechanism.

A large part of AEC effort in radiation biology is an attempt to evaluate the mechanism of the interaction of radiation with a seemingly endless variety of systems. There is also the blunt empirical approach on systems that apparently would have some practical value. For instance, the food technology groups at M.I.T., at the University of Michigan, at Columbia, and at other sites, have been trying for years to find if one can practically sterilize foods at low temperatures by the use of radiation.

What have they found out to date?

First, it is possible to sterilize any food by the use of radiation.

Second, the nutritive value of foods is affected only in a minor way by the amount of radiation necessary for sterilization.

Third, it appears that all food products undergo some degree of flavor change at the sterilization dose. Not all foods are as sensitive—milk is very sensitive; meat and fish moderately sensitive; cereal and bread are relatively insensitive to flavor change. However, today the major problem in the broad application of ionizing radiation to the treatment of foods, appears to lie in this flavor change. Many attempts are being made to minimize off-flavors, and of these, pasteurization rather than sterilization seems to be most successful.

Fourth, workers have observed that dosages of the order of 5 to 30 times that required to destroy bacteria by radiation are required to destroy enzymes. Limited studies have indicated that the enzymes in meats, although still chemically active, do not produce significant deterioration upon storage at room temperature as would be ordinarily expected. Generally speaking, however, food products treated will have to be enzymatically controlled in some other manner.

Fortunately, many of the problems of food sterilization do not exist in drugs. We do not expect drugs to taste good, for example. Many years of work at the Upjohn Co., the Schering Corp., and some recent work at Brookhaven have indicated that it is indeed feasible to sterilize heat-sensitive drugs with radiation. Whether or not it is practical depends primarily upon the availability and cost of suitable commercial equipment.

The use of light doses of radiation for useful biological reactions may find yet earlier application. Drs. Sparrow and Christensen at Brookhaven have found that doses of 10,000-20,000 R are effective in inhibiting the growth of sprouts on potatoes, thus greatly prolonging the storage life of the potatoes.

Drs. Hassett and Jenkins of the Army Chemical Center have reported on the use of radiation for insect control. They have found that doses of 65,000 R are quickly and completely lethal to a large variety of insect pests and thus would stop the damage of heavy infestation. Light infestations can be controlled by doses of lesser intensity which would stop reproduction.

This opens up the possibility of controlling insect infestation in food, clothing and wood products, a potentially valuable use indeed, since estimated yearly damage to stored products in the United States alone is over one billion dollars.

A reactor itself may be housed on a rail-

road box car. The reactor is non-critical in transit and must be shielded in transit only for the decayed fission products contained therein. The reactor consists of a one-foot sphere in a moderator through which a solution of enriched uranium is circulated. By rapidly removing the fission gases, about 1 per cent of the power of the reactor can be extracted as radiation power free from neutrons. The gases are circulated through the slab bisecting the rest of the car to provide a slab source of radiation.

In transit the slab would be surrounded by two movable lead walls. In use the car would be shuttled into a tunnel, the irradiator shield removed, the reactor brought up to criticality, and materials to be treated brought through a labyrinth entrance in and out of the radiation field on a monorail system.

If there really is to be a new radiation industry, a tremendous task still lies ahead. Basic research information on the interaction of radiation with chemical and biological systems is needed. Considerable development work will be required before commercial sources of nuclear radiation will be available.

Even then operating personnel must learn the intricacies of remote control and remote maintenance. I am confident, however, that these tasks will be accomplished and a place in America's industrial family will be found for these non-power applications of atomic energy.

What Are the Safety Problems in the Atomic Energy Business?

By D. F. HAYES

Chief, Safety and Fire Protection Branch, Atomic Energy Commission,
Washington, D. C.

The atomic energy business is replete with problems of many kinds—some never thought of before! Safety problems in this new industry are not the least.

I have selected some to discuss which would appear to me to be of interest to you.

Reporting Radiation Injuries. The first of these is a problem which has bothered

safety engineers in other fields. The addition of ionizing radiation as a new common industrial hazard emphasizes the existing inadequacy of a reporting system that will allow a measure of exposure, as distinguished from injury. This problem exists wherever injury is of a chronic nature rather than acute or traumatic.

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We do not have a very good index for measuring the slow accumulation of injury caused by an industrial contaminant. Our most widely accepted standard for measuring accident prevention effectiveness is the "American Standard Method of Recording and Measuring Work Injury Experience," ASA Z16.1. With it we record injuries to people to tell whether our accident prevention efforts are effective in actual experience.

The introduction of radiation which does not affect any of the human senses makes injury as now defined in Z16.1 useless. In addition to this, the hazard is cumulative above certain levels of energy, so that time is an added element.

Known, reported, and documented cases of actual injury having a causal relationship with exposure to radiation in atomic energy activities since 1945 are as follows:

One person died of radiation in an accident at Los Alamos on August 21, 1945.

One person died, one suffered serious burns, and another received slight burns in a similar accident at Los Alamos on May 21, 1946.

One person received a burn on the leg while handling containers which had not been thoroughly cleaned and were still wet. Some of the material soaked onto his trousers which he wore for the rest of the day, resulting in the burn to his leg.

Four persons received Beta burns to their hands as a result of handling filter papers without protection of gloves which had been provided but not worn, when samples of fission products were collected on filters from drone planes during a bomb test.

These were cases in which the injury was evidenced by observable physiological changes. Not included in this list are the injuries resulting from the bomb explosions at Hiroshima and Nagasaki which cannot be considered accidental, and are excluded from any consideration of atomic energy as an occupation. The accidents involving Japanese fishermen during the tests in 1953 are also not included.

Cases where there has been over-exposure but no observable injury are omitted also since the relation between exposure to given amounts of radiation has not been evaluated

to the same degree that other industrial contaminants or materials have been related.

Limits for both external and internal radiation exposure have been set, and care is exercised so that persons working with radioactive materials will not come into an environment sufficiently severe to cause injury. How this is accomplished involves the whole story of the preventive measures in active practice.

Over-exposure to radiation in the human body means that it has been subjected to quantities of alpha, beta, gamma, or neutron radiation above those which have been set for safe operation. The limits set for regular working conditions have in them considerable safety factors. Over-exposure, therefore, does not necessarily mean injury.

The basic daily safe working dose has been set at 3/10ths R per week. Immediate or even long-range physiological effects are not observable when the value is up to approximately 25 R. 25 R is the value discussed in the National Bureau of Standards Handbook 59, "Permissible Dose From External Sources of Ionizing Radiation," as the maximum safe emergency dose; if a dose this large is experienced, no further exposure is allowable. Therefore, even if a worker were exposed to 25 R or more, it cannot necessarily be assumed that he has been injured.

From the point of view of damage to the worker, over-exposure means only that the individual has been subjected to radiation which might, in some people, result in physiological changes. Some idea of the relationship between 3/10ths R, the working value, 25 R, the emergency value (which may create some observable effects in some people), and the actual exposure which produced fatal or serious accidents may be gained from a statement of the quantities of radiation which resulted in the deaths and injuries of the persons mentioned in the first two accidents.

The estimated doses of several radiation energies which produced fatalities and serious injuries in these cases were in the hundreds of gamma and X radiation to the whole body and in the tens of thousands to the hands.

(In one case, a combination of 480 roentgens equivalent 80 KV X-ray plus 110 roentgens Gamma ray, plus 20,000 to 40,000 roentgens

equivalent soft X-ray on hands; in another case, 1,930 roentgens equivalent 80 KV X ray, plus 114 roentgens Gamma ray, plus 15,000 to 30,000 roentgens equivalent soft X-ray on the hands; and, in the third case, 390 roentgens equivalent 80 KV X-ray, plus 26.4 roentgens Gamma ray, plus 400 to 600 roentgens equivalent soft X-ray on the hands.)

It probably has to be accepted that for a long time in industry, assuming that the same care is exercised as is presently exercised in respect to protection against over-exposure to radiation, there will not be a sufficient number of actually damaged human beings to determine just what differentiates any exposure from one resulting in injury.

This demonstrates the paucity of injury data and why exposure data is relatively inadequate at present. Complete records of exposure are kept on each worker by means of controls inherent in the prevention effort. It has been necessary to give the operating personnel and those interested in the safety of the worker some starting point on which to predicate the protective measures. The present experience with exposure with injury is admittedly incomplete because the operating levels have been kept low.

Section 5.13 "Hospitalization for Observation," in the ASA Standard Z16.1, is the only nearly applicable rule. The AEC has, for want of something better, adopted the following rule: "Nuclear radiation of personnel . . . resulting in over-exposure sufficiently serious to warrant hospitalization for observation or treatment . . ." Since this definition was adopted in September, 1954, where such hospitalization for observation has been required, the records show no cases of discernible permanent effects and no injury.

One cannot say that the individual has not been injured but neither can one say that he has, until some more years of experience have been accumulated. One can only say that he has been exposed to an amount of radiation which is above an arbitrary safe limit.

Nothing which has been said here can be without reference to a much more complete set of criteria published in NBS Handbook

59. Until this definition of reportability has been tested by use and medical experience, the practicability of recording radiation work injury will be a problem.

Safety Education. A second important problem will be to educate people in practical work with radiation hazards so that the business can proceed without hindrance due to fear, misunderstanding, and lack of skill.

There are two parts to this objective; first, to tell what the hazards are, and second, what they are not. From the day the first newspaper headlines announced that the equivalent of 20,000 tons of TNT had been dropped on Japan, fear, both justifiable and unjustifiable, has accompanied this business.

Many of the peculiar ideas and misconceptions originating from that day continue with obstinate persistence. Many of the concepts are new and hard to understand. People have a tendency to resist change, and the security requirements which have hedged the business have frequently given them something to hide behind, when at least partly subconsciously they are backing away from the mental effort required to comprehend new ideas.

Recently, in a state legislature, a proposal was actually introduced which would give certain local authorities the same powers to incarcerate a person who had become contaminated with radiation as they have to confine one who is mentally deranged (and presumably a menace to the public).

It will take a lot of effective training and education to dispel the notion borne of fear or ignorance that this is not a reasonable precaution to take. The proposal sounds ridiculous to those who know that, if a person's body were exposed to sufficient radiation to make him radioactive, he would be dead before a Justice of the Peace could write up the order of incarceration (and, if the person became so irradiated from a bomb during a war, the Justice of the Peace would probably be dead too, or contaminated himself).

To familiarize workers with the fact that radiation is hazardous like gasoline or electricity but can also be handled safely, will take time and effort and the expenditure of that time and effort is a proper problem for safety engineers. The safety engineer himself will have to learn the proper perspec-

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tive in which to place the radiation hazard
before he can help the technicians, physi-
cians, and health physicists to do their jobs.

Closely allied to this will be to work out
appropriate procedures for the crafts who
will be required to maintain facilities where
the hazard exists. This is particularly true
where alterations construction work is to be
carried on.

Reactors. Another problem of safety in
the atomic energy industry will be to make
safe reactors and fission product separa-
tions plants. The safety aspects in the first
of these—reactors—is largely in their design
and their design is in the hands of highly
trained technical people (of whom, inci-
dentally, there are not enough).

The AEC has set up rigid requirements
to assure that a reactor will not be involved
in an accident which might have serious
consequences. Before one is approved, a
complete study of every conceivable fault
leading to possible damage is made. This is
submitted to a committee of the best ex-
perts available who review the protective
measures devised. If they are not satisfied
that all precautions have been taken, they
will not approve until they are satisfied.

There are other precautions. A license
is required by the operator. Certain restric-
tions may be placed. Up to now, no two
reactors have been alike, and so each one is
separately evaluated.

It will probably be a long time before
safety engineers will actually have a direct
part in the reactor safety field. But there
are incidental aspects which he will be able
to influence. The general safety conscious-
ness of all, the electrical systems affecting
the reactor and its related equipment, the
material handling, shipment safety, and all
of the hazard-producing situations found in
normal activity which must be reduced be-
cause of their effect on the reactor.

It is not probable that the fission product
safety problem will be general in the near
future. The AEC will probably continue
this part of the operations until the problem
of waste disposal is solved.

New Materials. There are a large num-
ber of new materials closely allied with the
atomic energy industry, particularly where
high energies will have a relationship with
those materials. Sodium, NaK (sodium
potassium), zirconium, uranium, thorium,

hydrogen, boron, hafnium, fluorine, and
beryllium are examples. Some of these have
dangerous inherent characteristics, such as
zirconium and uranium, which are pyro-
phoric in their normal state, and others will
be particularly dangerous because of their
application.

Liquid metals are being used as heat
transfer agents. They, in themselves, are
dangerous in their normal state with an
added hazard when radiation is involved.

There are also the normal mechanical
hazards which accompany higher tempera-
tures and higher pressures which will be
made possible by the great energy available.
The simple storage and handling problems
are magnified because uranium, the princi-
pal fuel, is the heaviest element known to
man, and accidents because of the unex-
pected weight have already occurred in
AEC contractor operations.

Accidental Nuclear Fission. Fission is the
nuclear phenomenon which is atomic energy.
When a sufficient quantity of fissionable
material is brought together under the
proper conditions, the atoms break up with
the emission of heat and radiation.

As a result of the ever-increasing use of
fissionable materials, the responsibility for
avoiding nuclear accidents no longer re-
mains with a few individuals. The factors
which influence nuclear safety are accord-
ingly of increasing interest.

In operations with fissionable materials,
such as processing, transporting and stor-
age, it is necessary to ensure that the mate-
rials shall not reach a critical configuration.
A just-critical configuration is attained in
a nuclear reactor operating in a steady-state
where the rate of neutron-linked fissions is
held constant by sensitive controls. With
only a small increase in reactivity over the
just-critical state, the system becomes essen-
tially uncontrollable, and a nuclear accident
will occur.

The mass of active (fissionable) material,
in a particular configuration and set of cir-
cumstances which is critical is referred to
as a critical mass for that particular system.
Obviously, the margin of safety in any op-
eration with fissionable material is estimated
by comparing the actual mass with the esti-
mated critical mass under the most unfavor-
able conditions that might conceivably exist,
as for example, from an operating accident.

The most difficult step in establishing a realistic nuclear safety margin is anticipating the extreme unfavorable conditions which might occur. The following questions illustrate conditions which may have a profound influence upon critical mass. Can a piece of Uranium-235 metal be flooded if a water line breaks? Are manipulations such that a batch of plutonium salt can be dropped into water? Can a thin column of Uranium-233 solution change to a more compact shape as the result of vessel breakage? Furthermore, how well can one establish the upper limit to the mass of material involved in an accident?

Probabilities of double-batching, analytical error, and accidental grouping of units (as in a transportation accident) must be evaluated in answering this question. In establishing nuclear safety restrictions, it must be borne in mind that the easy way

out, to allow over-generous margins of safety, can add enormously to the expense of operations.

The specific factors which are most likely to influence nuclear safety are now rather well known, but not widely known to other than the specialists.

The effects of a critical mass accident are often speculated upon, and many have heard some rather wild guesses. But it appears, essentially, that such an untoward incident would be a "local mess." Nearby property, within a few feet, might be damaged. The immediate environs, many yards, might be heavily contaminated. More distant effects would be air borne contamination by fission products or dissipated fissionable material. The arrival of such contamination would take time, depending on wind, and permit evacuation of exposed personnel.

What Are the Health Problems?

By DR. JOSEPH QUIGLEY

Medical Dir., National Lead Co. of Ohio, Cincinnati, Ohio

The atomic age, which had its beginning here in Chicago 13 years ago, has been unique in many respects. Time will not permit us to make a complete comparison of its introduction and development with that of steam power, electricity, the automobile or any of the other major developments of recent times.

From the point of view of safety and health, however, a brief comparison is warranted. An understanding of the safety and health problems introduced by steam power, electricity, and so forth, developed slowly with the development of these new forces. Adequate protective measures were developed even more slowly, and their acceptance met considerable opposition.

The Corps of Engineers of the Army, who, through its Manhattan Project and its contractors, introduced the atomic age on the large scale, placed paramount importance on the health and safety of their employees. Safety was considered in the earliest phase of planning, and protective measures were introduced from the outset. This was accomplished by consulting the foremost radi-

ologists in the country on matters of radiation protection and the foremost safety engineers on both construction and operation phases.

The Atomic Energy Commission and its contractors have continued this policy. As a result, the safety record of this comparatively new industry is one of the best in the nation.

Ten years have gone by since atomic energy was first put to use to stop a major war. It has continued to be a great deterrent to war since that time. Progress towards constructive, peaceful uses of this new force has been tremendous during this ten years.

During this period, the lay press has featured many stories on the destructive force of atomic energy, and, as they would have us believe, the almost insurmountable hazards associated with any work with radioactive materials. Scientific publications have also featured this type of story. Possibly, the security restrictions placed on much of the work have contributed to this attitude through fear of the unknown.

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I believe that this general attitude is wrong! It is certainly not the one that prevails at our plant.

Handling high-voltage electricity most certainly presents serious hazards. At our plant, electricians replace fluorescent bulbs every day. They also work in electrical substations handling 13,200 volts with no fanfare. I am sure that you all feel that this is all right. It is possible, however, only because the hazards of both 110-volt and 13,200-volt electrical circuits are understood and adequate protective measures are taken in both instances.

There is no question that large doses of external radiation can cause serious injury or death. With the proper understanding of the hazards involved and the utilization of adequate protective measures, there is no need for anyone to be more fearful of handling radioactive materials than working on electrical circuits. It is important to remember that since the use of the atomic bomb in Japan, radiation has caused only two accidental deaths in the United States. This becomes even more significant when we consider that the contractors of the Atomic Energy Commission presently employ over 82,000 people in development, research and production operations.

Our discussion this morning is based to some extent on our experience at the University of Chicago, Hanford, and the AEC, but to a large degree on our experience at the Fernald plant of the Atomic Energy Commission. This is a feed materials production center, which is operated for the Commission by my employer, the National Lead Company of Ohio.

There are seven main production plants plus other associated units, such as maintenance, power house, substations, and so forth, at Fernald. The primary function of the plant is to convert uranium-bearing ores to fuel elements for nuclear reactor piles. Ore concentrates, to a lesser degree radium-bearing ores, are crushed and pulverized in the sampling plant to provide refinery feed. In the refinery, the ores are digested with nitric acid and the uranium extracted in a TBP-kerosene solution as uranyl nitrate. This is then converted to uranium oxide (UO_2).

In the Green Salt plant, the uranium oxide is converted to uranium tetrafluoride in a process involving the use of hydrogen

and anhydrous HF. The product of this plant is then converted to uranium metal in the metals production plant, and the raw metal is then converted to ingots in vacuum furnaces. In the metals fabrication plant these ingots are rolled into billets and next into rods, which are eventually converted to fuel elements by the use of automatic screw machines and centerless grinders.

In addition to the above process, there is a hexafluoride reduction plant which converts uranium hexafluoride into green salt and a scrap plant which converts various types of uranium scrap into feed for the refinery.

To summarize briefly the hazards which exist at Fernald: handling of large quantities of nitric acid, tributyl phosphate (which causes severe dermatitis), hydrogen, anhydrous HF, and reduction and induction furnaces using a large amount of electrical power; the hazards associated with a rolling mill and the automatic screw machine; the handling of quantities of uranium hexafluoride, which is a very soluble uranium-bearing material.

We have extensive materials handling problems which are more serious than those of the average chemical or metals plant because of the high specific gravity of the material involved. In addition to the hazards inherent in the process, many radiation sources are used in densitrons as fluid level gauges.

In summary, we have the usual hazards encountered in chemical plants and in metals plants, plus the special hazards induced because much of the material is radioactive. All of these problems warrant special consideration because of the quantities of materials involved.

Our discussion this morning is to deal specifically with the health problems. As I see it, these are four in number: (1) external radiation, (2) internal radiation, (3) chemical problems, and (4) all other problems. Problems (1) and (2) are possibly new to many of you, but problems (3) and (4) may deal with subjects with which you are already familiar.

External Radiation

For practical purposes, we can divide external radiation into two types: (a) penetrating radiation, as for example, gamma, neutrons and high-voltage x-rays, which

penetrate deep into or through the body; and (b) soft or relatively non-penetrating radiation, as for example, alpha, most beta, and some x-rays, which can penetrate only the superficial layers of the body. We shall dispense with definitions of alpha, beta, gamma, and so forth, since many of you are already familiar with them. In any case, we are more interested here with their effect on humans.

Effect: To understand the action of external radiation, we can best compare it with light or possibly with ultraviolet light. The source may be at varying distances from the body. Its effect on the body will depend upon the distance and upon the intensity of the radiation.

The effect which external radiation has on the body depends upon its property of producing ionization in or near the individual cells of the body. If only a small amount of ionization results from the passage of radiation through a cell, there may be no harmful effect or only slight damage. The damage may be very slight and recovery may occur; on the other hand, the damage may be permanent or a cell may even be killed outright. The ability of ionizing radiation to produce cancer possibly depends upon its ability to cause permanent change within a cell without affecting the cell's power to divide and reproduce itself.

In the case of *penetrating radiation*, the effect may be exerted on the blood-forming organs which are concentrated to quite a degree in the flat bones, such as the ribs, sternum, vertebrae, and so forth. This may lead to the production of anemia, leukemia or other blood dyscrasias, such as some of the hemorrhagic diseases. It may also affect the reproductive organs, causing sterility. A great deal has been written about the ability of ionizing radiation to adversely affect coming generations.

I think it is important to point out, however, that most of the harmful changes which can occur to reproductive cells are so-called "lethals," that is, they tend to cause the death of the individual cell so that the tendency to produce monsters is controlled to some degree by nature itself. Ionizing radiation can also affect any of the other cells of the body, such as the liver, spleen and intestine, and the symptoms and findings will depend upon the tissue most seriously damaged.

It is important to remember that each organ of the body is made up of a very large number of cells so that considerable doses of radiation can be withstood without serious effect. The dose estimated to produce death in 50 per cent of an exposed group—the so-called LD-50—is from 400 to 450 R for humans. It is probably impossible to detect any changes in the body from a whole-body dose of less than 25 R. In fact, whole-body exposures of 100 R will produce radiation sickness in only about 10 per cent of the individuals. The symptoms of radiation sickness—nausea, vomiting, bleeding from the mucous membrane, anemia, leukemia, and so forth, will therefore be seen only after exposures to very large doses of radiation.

When one considers that the maximum permissible dose for penetrating radiation is 3 R per week, it is readily seen that subjective symptoms or even clinical findings could only occur following some unusual incident. It is for this reason that routine blood counts have been dispensed with as a part of the health control of exposed individuals.

Soft or non-penetrating radiation: Its effect is exerted primarily on the skin since most of this type of radiation is stopped by a few millimeters of tissue. Its effect can, therefore, be compared with that of sunlight or ultraviolet light. In large doses it can cause severe burns; in smaller doses a mild reddening of the skin; and in still smaller doses no visible effect.

Maximum Permissible Doses: Maximum permissible doses have been established for each type of radiation, depending upon the specific ionization which it can induce in tissue. These doses are presently established in the United States by the National Committee on Radiation Protection and appear in *Handbook 59* of the National Bureau of Standards. The National Committee on Radiation Protection is made up of foremost radiation experts in the United States. Many of the standards presently recommended in *Handbook 59* have been in use for a number of years, and experience to date indicates that these maximum permissible doses have been established at safe levels. I believe that all of you should feel that they can be accepted without question, just as you would accept maximum allowable concentrations for toxic gases in air. It is important, however, to point out

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that these doses are maximum. Every ef- fort should be made to keep all exposure to both penetrating and non-penetrating ra- diation at the lowest levels possible.

Protective Measures: To maintain indus- trial employees at or below the maximum permissible dose for external radiation, cer- tain protective measures must be under- stood and followed. The intensity of light diminishes as we get further from its source. The radiation dose likewise dimin- ishes as we get further from the source of radiation. Distance or space from a radia- tion source is, therefore, our "number one" protective measure.

The density of air is quite low. By inter- posing any material of greater density be- tween the source of radiation and the hu- man body, the distance may be reduced. The greater the density of the interposing material, the greater may be the reduction in the safe distance from the source. As you all know, lead is ideal shielding mat- erial. Uranium, because of its higher den- sity, produces an even better barrier. Wood, steel, water, and concrete all form excellent shielding materials. Given the intensity of the source, it is but a simple mathematical problem to determine the thickness of any shielding material which is necessary to cre- ate satisfactory working conditions in the vicinity of the source.

Methods of Measurement: There are many methods of measuring the radiation dose. Ionization chambers, such as Junos or any of the large number of GM instruments on the market, will provide accurate methods of measurement. It is important to remem- ber, however, that these instruments must be calibrated frequently to provide reliable results.

Personnel monitoring devices which re- cord the dose received by each individual may be used. These consist of film badges or pocket dosimeters which are small, port- able ionization chambers. There are several companies in the United States which pro- vide film badge service at a nominal charge per badge. It is probably not economically sound to provide your own film badge service unless this type of dosimeter is required by 800 or more employees.

Airborne Radioactive Materials

Effect: The health problem in this case results from the deposit of radioactive mate-

rial within the body. The mode of entry into the body is through the respiratory tract. Particles which are inhaled will be deposited along the respiratory tract or in the lungs. Particle size, of course, will determine the amount which will eventually reach the lung tissue. Larger particles are filtered out by vibrissae, or hair, in the nasal passages and on the mucous membrane lining the throat and larger air passages. Much of this material will be sneezed or coughed from the respiratory system.

Particles below five to 10 microns will remain airborne and reach the lung in relatively large numbers. This material will gradually be coughed up and swallowed, and a portion of it will be absorbed from the intestinal tract. Soluble materials, such as uranium hexafluoride, however, may be absorbed into the blood stream directly from the lung. Except for soluble mat- erials, very little absorption occurs from the lung.

Regardless of the mode of entry, these radioactive materials circulate in the blood and will be incorporated into new cells be- ing produced within the body. Some metals, such as uranium and radium, will be depos- ited in the bone; other substances, such as polonium, will be deposited in the liver or spleen. Since these substances are radio- active, they will then act as radiation sources within the body. They will produce their effect on a 24-hour basis.

Maximum Allowable Concentrations: As in the case of external radiation, maximum allowable concentrations have been estab- lished for almost all radioactive elements in breathing air. These maximum allowable concentrations have been established by the National Committee on Radiation Protection and appear in *Handbook 52* of the National Bureau of Standards. As in the case of external radiation, it is important to remem- ber that these standards are maximum, and every attempt should be made to maintain airborne radioactive material at the lowest possible level.

Protective Measures: Protective measures against airborne radioactive material should consist primarily of the removal of the material at its source of generation. This requires the application of adequate venti- lation at all points where radioactive mat- erial may become airborne as a dust, mist or fume. The principles involved in removing

nuisance dusts in general apply in this instance. However, because of the comparatively low maximum allowable concentration—50 mg/M³ of air for uranium—it is usually necessary to make extensive use of hoods over machines or to carry on operations in a ventilated dry box.

It is important in designing ventilation equipment to size the ducts adequately so that the material will remain airborne until conveyed to an adequate dust collector. For this reason, and because of the value of the material, it is desirable to design an adequately balanced system. If dampers are used, the material will be deposited on or near the dampers.

Less desirable as a means of protection is the use of respirators. Although there are many respirators approved by the Bureau of Mines for use in dusty atmospheres, we at Fernald have found them to be inadequate. There is no question that, properly used, these respirators would be satisfactory. Experience, however, has shown us that the average individual will not properly apply a dust respirator with the result that a false sense of security may result. Frequently, if you ask an employee to remove his mask, his face and nose will show evidence that the respirator has not been fastened tight enough to his face to give adequate protection. This we have confirmed by findings of uranium in employee's urine.

Within the last year we have, therefore, recommended the use of airline respirators. These have been installed from a central air system at sites where such protection is frequently required for maintenance jobs. At sites where less frequent use occurs, portable tanks of breathing air are used.

Of equal importance to the above protective measures is the training of the operators to do their work in such a manner as to cause the least amount of material to become airborne. An example of this is provided where a lathe is used to cut uranium metal. The chips produced are normally flushed by coolants into a reservoir at the bottom of the machine.

Frequently, burning chips will hang up on parts of the equipment. As these chips burn, a large amount of fumes and uranium oxide may become airborne. With adequate training, the men may be taught to knock

such chips into the reservoir where they will be promptly extinguished.

Methods of Measurement: It is not at all difficult to measure the amount of radioactive material which becomes airborne in the production area. By using a small electric pump, through which the flow of air can be determined, it is possible to obtain filter paper samples on which the radioactive material is deposited. Because the material is radioactive, the amount deposited on the filter paper can be readily determined with standard counting equipment. At our plant, we collect two types of samples in making a survey of the work environment.

Breathing zone samples are taken in the vicinity of the operator's nose and mouth while he is operating his equipment. A time study of the actual time spent in operating equipment is also made. General air samples are obtained in the area adjacent to the individual pieces of operating equipment, in the washroom, change facilities, cafeteria and other places, such as smoking areas, where the man may be engaged during the day. Time studies are also made in each of these other operations.

By tabulating the results of these two methods of sampling, a weighted daily exposure to the radioactive material may be computed. This should always be kept at or below the maximum allowable concentration for the particular radioactive material.

A third type of sample is also collected when breathing zones are found to be above desirable limits. These are termed "Process" samples. In this instance, samples are collected at various points about the equipment to determine the source of the radioactive material, so that ventilation may be applied to remove the material at its source of generation.

Where operations have become standardized, surveys of this type can be made infrequently. It is important, however, that new surveys be made each time changes in the equipment or operating procedures are made.

Chemical Problems

Certain materials, when introduced into the body, have a toxic effect—for example, mercury and carbon tetrachloride. It is important to remember that many radioactive materials may also have a toxic effect. Their action in the body from a toxic point

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All Other Problems

Earlier we enumerated the many health
and safety problems which we encounter in
the operations at Fernald. The problems of
high-voltage electricity, materials handling,
the use of quantities of acids, and so forth,
are problems with which you are all familiar.

Conclusion

In closing, I would like to reiterate that
the problems involved in the handling of
radioactive materials need cause no one
alarm. These problems are well understood
and adequate protective measures have been
devised. It is no more difficult to under-

stand these problems and operate a plant
within safe limits than it is to operate a
plant not handling radioactive materials.

I would suggest that any of you who are
to become involved in the handling of radio-
active materials obtain the advice and assist-
ance of a competent industrial hygienist,
and if the size of the operation warrants,
add one of these specially trained individ-
uals to your staff.

Analyze your hazards and potential haz-
ards before the engineers go to work. Plan
in advance to eliminate or at least control
all hazards. After you are in operation,
check and recheck by the use of survey
equipment and personal monitoring devices,
such as film badges.

Effective Reporting

Get Your Program Off "Dead Center"

By A. H. ZEILINGER

Consultant, Charles L. Baker & Co., Management Consultants, Estes Park, Colo.

I see no better way of approaching this subject than by being frank. By being frank I do not mean unfriendly or tactless, but to call a spade a spade.

To explain one implication of the term "dead center," may I refer to one of my early experiences. As a youth I worked in a stone quarry. The crusher was driven by an engine which had only one cylinder. The engineer always tried to stop the engine in shutting down so the crank pin would not be in dead line with the piston end, but some times he was not successful. In those cases we had to bar or jack the fly wheel around a distance to get off dead center, because no matter how much steam was turned on there would be no motion as long as the engine was on dead center. So, "dead center" means "stalled." It is apparent our safety isn't going ahead like it should. It's on dead center. Perhaps we need a bar or a jack.

Speaking of dead center, let's see why that subject comes up. More than a quarter of a century ago when I came into safety work, one of the first things I did was to take a look at the toll of accidents. Here's what I saw: 100,000 deaths, three or four millions crippled to some degree, six or eight million others receiving injuries from which they fully recovered as working units. That was the annual human toll of accidents, most of which were preventable. To all that, we must, of course, add a property loss of some five or six billions.

Today we see nearly the same picture. Of course, there are those who will say: "Well, with the greatly increased exposure, we have done well to hold the line in the war against accidents."

My frank opinion is that we haven't done as well as we should because we have so much more in the way of tools, skill and know-how to work with. So holding the line is not good enough—that's being on

"dead center." Merely holding the line will never win a war. We must get out of the trenches of complacency and move forward.

Complacency is not only one of the greatest enemies to better safety, but to all our freedoms and to all human progress and welfare as well. We forget that our enemies never sleep, and what they can't accomplish by a frontal attack, they will attempt by stealth from within. It is a highly dangerous sense of security to feel we have done pretty well to hold the line.

Another reason we're on dead center is our lack of enthusiasm. Safety is a selling job, and a good selling job is not possible without enthusiasm.

Elbow grease is another ingredient that is needed in larger measure if we'd get off dead center in our accident prevention. The will to work is one thing that must be in any undertaking if we would accomplish all that we are capable of accomplishing. You can't get off dead center with your feet on the desk top.

We've been examining you. Let's examine your safety program a bit now and see what can be done there to get off dead center.

Is your safety program popular? If it isn't, you'd better change, for safety can't be rammed down the worker's throat. With a popular program and with intelligent, vigorous and continuous leadership, much can be accomplished to keep things going forward. Remember, the same old program that was good enough for father and mother is not good enough for you.

Do you get the participation of the individual? You know full well that if a person takes part in anything, he is more interested and he'll try harder to succeed. Get everybody into the game. There's no fun standing on the sideline.

Everybody has one or several strong points. If you can emphasize those in your accident prevention program, your accident

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prevention will keep improving. So don't permit that factor to get on dead center.

There must be an opportunity for people to see results. That keeps people going. We are apt to get discouraged if we don't, and discouragement must never be permitted to rear its ugly head. That is one tool the devil will never give up, and he isn't interested in preventing accidents. He's interested only in our downfall.

I want to go back and emphasize one point a bit more. I said something about elbow grease, a common term for hard work. Accidents are like ills—there is something wrong, and I know no ill that hard work won't cure. Others feel the same way.

I once heard a works manager say to his safety men: "Go up to plant 'A'. See what those fellows are doing to prevent accidents and then come down and go to work." Yes, work will get you off dead center and it will keep you going.

Take a tip from the U. S. Post Office Dept. "Neither wind nor rain nor snow nor cold nor dark of night shall keep these couriers from their appointed rounds." Why? Because they keep on working. May I also add, "Let neither time nor age interfere in your safety building. Forget

self and think of the other fellow." Why? Well, perhaps the answer is in this little anonymous poem:

"The Bridgebuilder"

An old man going a low highway,
Came at the evening cold and gray
To a chasm vast and deep and wide.
The old man crossed in the twilight dim,
The swollen stream had no fear for him.
But he turned when safe on the other side,
And built a bridge to span the tide.

"Old Man," said a fellow pilgrim near,
"You're wasting your strength with building here!"

Your journey will end with the ending day,
You never again will pass this way;
You've crossed the chasm deep and wide,
Why build this bridge at evening tide?"

The builder lifted his old, gray head;
"Good friend, in the path I have come,"
he said,

"There followed after me today
A youth whose feet must pass this way.
The chasm that has been as naught to me,
To that fairhaired youth, may a pitfall be;
He, too, must cross in the twilight dim;
Good friend, I'm building this bridge for him."

How to Prepare and Present Reports to Management and Supervisors

By J. L. RIDINGER

Director, Safety & Plant Protection, Inland Steel Co., East Chicago, Ind.

This subject is of vital interest to all of us. Are we missing the boat with reports whose contents are too lengthy and overdone, instead of being clear and to the point?

Today every business is report conscious. Good reporting is essential to good management. It is a "must" to have good up and down communications to all levels of management. Reports should be properly prepared to contain words and figures that explain to, rather than confuse the reader.

What Is Good Reporting? It is simple, pertinent information that management and

supervisors need in order to be properly informed.

Safety is just one phase of any business. Management must be kept informed of all phases. Their time is at a premium, current and future business problems must be processed daily. Voluminous and complicated reports are frequently passed over lightly, or set aside for future reading.

Management and the supervisory group, like their employees, tire of safety reports that never change. In order to attract their attention and keep them posted, we have

found it helpful to adapt our reports to forms and terms used by them in their daily business transactions.

First, there is the *morning report for front office, department superintendents and assistant superintendents*. This report covers the events involving accidents, injuries and fires for the previous 24 hours. It is made up by the safety division and the central duplicating section. The report is available to the general superintendent's office at 9:00 a.m. and sent out to the department superintendents in the morning mail.

At times this report will have a picture story of an accident or fire.

When no pictures are used, the report is typed on a multilith mat with a multilith typewriter ribbon. The mat is put on a multilith machine and the necessary number of copies run off.

When pictures are used, the print is processed by a Kodak process.

You will note we have five groups: primary production, flat products, shapes, operating services and services. The report shows the number of minor and disabling injuries to date this year compared to the previous year for each group. It also shows the number of tons shipped per minor and disabling injury to date this year compared to a year ago. When you compare injuries with tons shipped you are speaking the operator's language.

This report also shows the number of ambulance calls to date. If you have a plant ambulance, I am quite sure you will find that 50 per cent of your ambulance calls are for non-industrial conditions, such as heart attacks, diabetics and gastro-intestinal upsets.

Whenever our fire trucks respond to a fire, it is described in the morning report. Also listed is the resume report of an accident or disabling injury.

We have found this report to be effective in keeping department heads and supervisors informed on a daily basis. It also minimizes the abuse of facts, frequently a part of "grapevine communications."

Tele-Communicator. Another media of communications is a tele-communicator. We have dial phones. By dialing Number Seven you are able to hear the message of the day. Safety messages are prepared weekly.

In addition, any mishap of general interest is recorded and put on the communicator for immediate use. This can be done by going to the recording room or by dialing a special number and recording the message from your desk. Messages are generally limited to one minute.

The communicator is also an excellent media for recognizing and announcing safety accomplishments for a department or a section of a department, such as a department that has worked a million or more man-hours without a disabling injury, or a large section of a department that works a month or more without a minor or disabling injury. It is also helpful for spot announcements to explain changes in your safety program.

Monthly Unsafe Acts Report. This report is made up by the safety division. Copies are sent to the front office, department superintendents, assistant superintendents and all foremen. Its primary use is for supervisors' meetings with the workers. Each of our safety engineers is required to submit in writing a minimum of five unsafe acts that he has observed during the preceding month. Our safety engineers must also report unsafe acts immediately to the foreman involved. In the report, the unsafe acts are listed under specific headings such as *Trucks & Tractors, Cranes & Crane-men, Running & Jumping, Safety Equipment, Personal Hazards, Short Cuts, Pinch Points, Railroads, Piling, Signs and Barricades*.

This report is given considerable attention by all department superintendents, assistant superintendents and foremen. Because it is given plant-wide distribution, supervisors and workers do not want adverse publicity. We do not concentrate on one department, but try to cover the entire plant. This avoids supervisors' feeling that we are trying to criticize one department more than another.

Graph Reports. Graph reports permit you to relate a long and informative story on one sheet of paper. For example, one graph covers 41 years of injury experience, 1913-1954, and shows the net tons shipped per disabling injury. In 1913 we shipped 1,500 tons per disabling injury. In 1954 we shipped 30,000 tons per disabling injury.

Graph reports based upon the ASA Z16.1 formula for frequency of disabling injuries are of interest to management. You can compare your own experience over a period

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Demonstration — Frequency — Severity. Even though we have been trying to educate our department heads and supervisors since 1945 about the meaning of frequency and severity, we are still not sure they have a clear understanding of the ASA Z16.1 code. Perhaps some of you are in the same predicament.

Recently we developed a simple graphic demonstration which we have found to be helpful in explaining the formula for frequency and severity.

We use a laboratory scale. Our plant works a little more than 3,000,000 man-hours a month. Our objective is a frequency of One. As you know, the formula for frequency is the number of disabling injuries, times a million, divided by the man-hours worked. In this demonstration we illustrate this objective by placing three blocks, each representing one million man-hours worked, on one side of the scale. On the other side we use three blocks representing three disabling injuries. The pointer on the scale is set to point to the figure one. Then we show our actual frequency experience for the previous month or year to date.

To demonstrate severity (days lost times a million divided by the man-hours worked) we place three blocks again, each block representing one million man-hours worked, on one balance of the scale. On the other balance we place a block representing the actual days lost during the month.

Weighted charges are represented by blocks in the form of figures. A casket is used for a fatality, which represents 6,000 days. Other figures are those of fingers, toes, hands, feet, arms, legs and eyes, with the corresponding weighted charges.

Our objective is to have less than 500 days lost per million man-hours worked. We remove the necessary blocks so that the pointer indicates our objective on a background chart. The figure representing weighted charges is very vivid and demonstrates how serious injuries create handicapped workers.

Total Injury Experience. Each month we make up a total injury frequency report for each department. This report not only shows the frequency of injuries for the department

but the frequency of each section as well, such as Rolling, Finishing, Mechanical, Electrical and Labor. The department in each section competes against its previous four-year experience, which we call a "norm." A department or section that does not have a disabling injury and reduces its frequency over a four-year norm by 25 per cent is eligible for safety smokes. A package of cigarettes, a cigar, or a candy bar is given out as a token award.

We believe it important to report the frequency of minor injuries as well as disabling injuries. The most important part of our safety program is based upon the elimination of unsafe acts. We agree with Heinrich's theory that unsafe acts beget minor injuries and minor injuries beget disabling injuries. Our true injury frequency rate contains minor and disabling injuries. Frequency rates that only include disabling injuries in our opinion represent the first stage of severity.

Supervisor's Safety Boards. We have special injury boards located in each section of a department. These boards show the minor and disabling injury experience for each foreman's crew. The board shows the monthly score and the accumulative score to date.

Our objective in using this type of board is that comparing foremen on various turns of the same section inspires the general foreman and the foremen to improve their safety performance within the section. The department head also uses these boards in rating his department by sections.

What Happened—How Injury Was Prevented. We have found picture stories of incidents where protective equipment has prevented injury helpful in selling our workers on the value of using or wearing protective equipment.

How It Happened and How It Can Be Prevented. We also use picture stories that tell how injuries happened and how they can be prevented.

We use these reports to impress workers that safety devices are of no value to the worker unless properly used.

Report of Man-Hours and Days Worked Without a Disabling Injury. Another report we find to be of interest to management and supervisors shows man-hours worked by each department without a disabling in-

jury. Departments are grouped under their respective assistant general superintendent. The report shows the number of man-hours worked during the month by each department, the number of disabling injuries during the month, the number of days since the last disabling injury, and accumulative man-hours since the last disabling injury.

This year four departments and one section of a department passed the million man-hour mark without a disabling injury. Last August, our tin mill passed the two million man-hour mark, without a disabling injury. Employees in departments that work a million or more man-hours without a disabling injury are given token awards.

Report of Formal Investigation of Disabling Injuries. One of the problems confronting every safety engineer is reports of formal accident investigations. Our principle concern is preventing a recurrence. We have found a form effective which requires that the department superintendent list the following: Date of last safety instruction given injured, who conducted the investigation, details of the accident, cause of the accident, who was responsible, discipline, if any, explanation of action to be taken to prevent a recurrence of accident, when action will take place, person or persons responsible for follow-up, and action enforcement. This report nails down the important facts necessary to correct an unsafe condition or procedure.

Superintendent's Interview with Injured Employee. This report is a companion report of the department superintendent's formal investigation report. Frequently, the injured employee is not able to be present at the formal investigation. When he is able to return to work, he must first report to his department superintendent's office, where the interview is conducted.

This meeting affords the superintendent the opportunity of getting the injured's story first hand. He can also check to find out whether or not the recommendations made at the formal investigation are being complied with.

Injury Cost Reports. Monthly cost reports are submitted to top management and department superintendents. These reports show the amount of compensation paid for injuries and occupational diseases for the previous month, year to date, and for the same period a year ago.

The report also shows our compensation cost based on a hundred dollar payroll and compensation cost per ton of steel shipped. From time to time we remind management, and supervisors, that the indirect cost of injuries and diseases are four times the medical and compensation costs.

Pin Pointing Safety Reports. To point up safety messages and post pictures on bulletin boards, we have used two gadget with considerable success. A manikin properly dressed for whatever department he is to be used in points to a bulletin board. Attached to the manikin is a Mohawk message repeater. Thirty or 60-second messages can be used on the tape recorder. The message is repeated when anyone steps on the trip mat as they pass by. This is one of the many uses to which we put our manikin and message repeater.

Briefly, to summarize the subject of preparing reports; it is important to remember. (1) Safety reports are selling aids for your safety program. (2) Always use language in comparison to that which is common in your industry. (3) Avoid complicated reports, keep them short. It is better to issue several short reports that will be read than a lengthy detailed report that will be set aside for future reading.

"Progress Indicator"—A New Technique in Reporting

By ROBERT L. JENKINS

Chief, Safety Div., Office of the Chief of Engineers, Dept. of the Army,
Washington, D. C.

The progress indicator is a method developed and used by the Office of the Chief of Engineers for gauging progress of the

safety program. The objective of this method is to tell the chief of engineers whether the performance of his safety pro-

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gram is better or worse, how each of his installations are contributing to the overall performance and the fundamental reasons why performance is better or worse.

This method is not intended to replace systems for computing injury and accident rates but is rather a means of adding them all together in a systematic fashion. To this total are added those most important elements, the reason why accidents occur and what command has done to control the causes.

Figure No. One

Progress Indicator

$$PI = N - (A + DL + PD + RC + CD + S)$$

A method of utilizing accident report data to evaluate progress of a safety program.

The progress indicator is expressed by the formula shown in Figure No. One. An important point to remember is that all data used in the formula are obtained from accident reports (DA Form 285). These reports are evaluated as submitted by the field with nothing added or deleted in the Office of the Chief of Engineers.

Accidents and their consequences which are beyond a commanders' immediate resources to correct are not included in the PI method of evaluation. Examples of excluded accidents are those involving navigation structures caused by vessels other than Corps of Engineers, drowning of a member of the public visiting one of our reservoirs, a private motor vehicle striking a fixed Government structure, acts of God such as tornado, hurricane, and so forth.

The first element in the formula is a normal whose symbol is *N*. The normal represents performance during a previously selected period. The normal is computed by applying the portion of the formula within the brackets to accident reports received during the period selected for comparison.

The PI is used to compare current safety performance of an installation with its own performance over a previously selected period. In other words, is performance better, worse or about the same as it was for the previously selected period? At OCE, the accident experience for the same period of the previous calendar year is used for developing the normal.

For example, the accident experience for the first six months of the current year is compared to the same six months of the previous year. As additional data develops, it will be possible to use the average experience for the identical periods in two or more previous years, giving a normal based on a wider scope of activity. This method departs from using zero as a base, as is customary when computing conventional rates.

Within the brackets, data originate from current accident experience. The symbol *A* signifies accidents and denotes the total number of accidents times 160,000 over the man-hours worked. The total number of accidents is the sum of all reportable accidents occurring on work or operations under the jurisdiction of the Corps of Engineers that it is reasonable to expect to be within the immediate resources of the installation commander to correct.

DL denotes days lost and is developed by multiplying the total number of days lost by 1,200 and dividing by the manhours worked. The total number of days lost is the sum of all days lost as a result of injuries to civilian, military and contractor on duty personnel and are compiled in the conventional manner of adding together time lost due to temporary total injuries and fixed charges (days lost) for fatalities and permanent impairments.

PD denotes property damage and is the amount of damage in dollars multiplied by 250 and divided by the manhours worked. This damage is from any source and applies to contractor as well as Corps of Engineers. Other Federal and public property damage are not used in this computation.

RC denotes reason for cause and is the number of units assigned multiplied by 500,000 and divided by the manhours worked. A unit is assigned to each instance where a supervisory deficiency and/or physical deficiency, either Government or contractor, produce the accident cause.

Physical deficiencies are defined as those accident factors which stem from poor construction practice, maintenance, layout or equipment.

Supervisory deficiencies are defined as those accident factors which stem from failure of supervisors at job level to direct, inspect, instruct and place the working force in a manner conducive to safe operation.

These definitions make it obvious that either one, two or none may be assigned a single accident. Selection depends on which factors, if any, are predominant.

For example, if a man falls from a scaffold not provided with a guardrail, a physical deficiency is assigned. If a man falls from a scaffold while using the cross members as means of access when adequate access has been provided by means of suitable ladders or stairways a supervisory deficiency is assigned.

If a piece of equipment is wrecked because of brake failure while being operated at excessive speed both a physical and supervisory deficiency are assigned. When neither of the two reasons for cause are involved no consideration is given to failure of the individual—for example, a man turning his ankle when he stepped on a pebble.

CD denotes command deficiency which is developed by multiplying the number of accident reports which involve such a deficiency by 12,000,000 and dividing by the manhours worked. A command deficiency is assigned to an accident report when the report indicates, on the part of Corps of Engineers command, an apathetic review, a poor grasp of the facts involved, and inadequate directions to correct deficiencies.

A command deficiency is also assigned to a report involving a fatality, permanent impairment or property damage over \$1,000, where such incidents occur in a district or separate installation due to repetitive cause. For example, if a man loses a finger operating a power saw without a guard, and, afterwards, another man loses a finger by the same cause, a command deficiency is assigned. If a fire occurs caused by an unattended salamander with resulting damage of over \$1,000, and another occurs, cause the same, with over \$1,000 loss, a command deficiency is assigned.

The symbol CD represents a weighty factor in the evaluation, which is evident from the large constant in the numerator of the formula. This is weighty because it is a determined evaluation of report data in terms of application of policy and instructions issued by the Chief of Engineers to his field commands.

Section II of the accident report (DA Form 285) is regarded as a certificate of the

commander's understanding of the problems involved and his acceptance of responsibility to clear them up. Obviously this is the hub around which the Corps of Engineers safety program revolves and therefore must be a principal consideration in evaluating safety performance.

When reports are evaluated in OCE a command deficiency is not assigned when the district engineer corrects a deficiency occurring at project level or the division engineer corrects one occurring at district level. This is one reason why a district's PI as determined by a division will rarely be the same as the district PI developed by OCE.

S denotes a surcharge which is developed by multiplying the total number of permanent impairments and fatal injuries, and the number of accidents involving over \$1,000 by 5,000,000 and dividing by the manhours worked. S was made a weighty factor in the evaluation because such serious incidents must be effectively controlled before the safety program can be considered as making progress.

It is conceded that, in some instances, severity of an injury or amount of property damage is a matter of chance. However, experience of the Corps establishes that most of our fatalities, permanent impairments and large dollar losses are foregone conclusions if certain incidents occur. For example, when a man falls from a considerable height the severity of his injuries are extreme. The same holds true if he is in contact with equipment which engages a power line. When valuable property is stored without segregation of combustibles or providing fire protection, or when heating and wiring arrangements are dangerous, the fire losses are usually large.

Since the severity of incidents of this nature are largely predictable and since practical controls are well publicized the occurrence of such accidents must have special consideration when measuring performance.

Assuming that reports for the five districts of a division have been reviewed and coded, the tabulation looks as shown in Figure Two. Note that the performance of each district is compared against itself. By totaling respective items of data, computing the PI factors, the average of all districts is obtained. In OCE each installation is

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Figure Two
Progress Indicator

DIST.	N — (A+DL+PD+RC+CD+S) = PI
A	39.7—(2.0+2.1+0.8+5.2+ 1.2+5.2) = +23.2
B	44.4—(3.8+2.4+1.9+4.5+ 3.6+7.7) = +20.5
C	21.7—(2.3+1.1+3.2+6.7+ 2.8+4.2) = + 1.4
D	24.4—(1.9+4.2+4.7+8.2+12.1+6.2) = -12.9
E	19.1—(1.4+1.6+2.1+9.5+11.0+6.1) = -12.6
AVE	29.9—(2.5+2.4+2.5+6.5+ 6.1+5.9) = + 4.0

compared with itself and the average for all is shown.

At this point the tabulation is not yet in the form of a good report. If relative numbers are used they can very well divert the attention of command from the real purpose of this system. This is particularly true of those districts or installations whose performance is getting worse but whose accident experience may be considerably better than that of the district making the greatest improvement.

For example, you can see how the people in District E might easily convince themselves that they are better than District A. In reports to command, the percentage of progress or retrogression is shown. This is accomplished by dividing the PI result by the normal.

In the Progress Indicator report as command sees it, all districts whose bars are on the right side of a median line are doing all right and to the degree indicated by percentage. The bars on the left of the median line represent the districts that are doing poorly and to what degree.

One other thing that command wants to know is why these districts are doing better or worse. At OCE, in reports to the Chief, this is accomplished by a short statement.

For example, District A shows a progression of 58 per cent due to reduction in fatalities, (two during the first three months of 1954 against none for the same period of 1955) and improvement of command (5.2 for 1954 against 1.2 for 1955). This typical short statement pertaining to District A tells the Chief why this district shows a progression of 58 per cent. This quickly indicates that command of District A is on the ball and turning in a commendable performance.

Another example: District D shows a retrogression of 53 per cent due to reason

for cause (4.7 in 1954 compared to 8.2 in 1955) and command deficiencies (6.2 in 1954 against 12.1 in 1955) and excessive property damage. Some radical changes must be brought about in this district as soon as possible to bring it more in line with the average performance of all districts.

The progress indicator is of course geared to Corps of Engineers organization and operations and is designed to highlight those factors that are believed to control the Corps accident experience. It was developed as a means of posting the Chief of Engineers as how elements of his command are performing safetywise. It is apparent that this method of utilizing accident data to evaluate progress of a safety program has many advantages to field installations.

An interesting feature of the formula is the flexibility offered by adding or removing elements. For "within the installation" purposes such things as promptness or completeness of reporting or violations of safety requirements or any other circumstance that impedes progress can be included as factors in the formula. The application as presented here is that version which meets the needs of the Office of the Chief of Engineers. The way is clear for the field to apply it as their needs indicate.

In the short time that the PI has been used by OCE, there has been much encouragement. Commanding officers are personally reviewing and signing all accident reports, and command deficiencies are becoming more and more infrequent. The resultant command actions are decreasing the number of reason for cause factors.

It must be remembered that the progress indicator is *not* reducing accident prevention to a formula; it is *not* a substitute for safety engineering; it is *not* an accident rate; and it is *not* intended as being a means of comparing one installation with another. It is

only something that tells us if the performance of the safety program is getting better or worse and *why*.

Development of the Formulas

Selection of factors and relative weights.

	Factor	Weight
	Accidents	2
Group	Days lost	2
One	Property damage	2
Group	Reason for cause.....	5
Two	Command deficiency	6
Group	Fatals and permanent	
Three	impairments	2.5
	Property damage over \$1,000..	1.5

Group One factors are entirely historical, those from which traditional injury and accident rates are developed. Each factor is all-embracing, i.e., includes all accidents, whether fire, motor vehicle, injury, aircraft, marine, and so forth.†

Group Two factors are those from which control of future accidents is developed.

Group Three factors are those which represent extreme accident consequences.

The six factors are those which are inescapable when considering safety performance. They are grouped as to their interrelationship, so that the weight value determined for each group is a fair and proper representation of its importance.

It will be noted that the total of all weights was arbitrarily set at 21. This number has no significance except to keep the weights as closely as possible in small round numbers. The weights assigned to each group however, are of very special significance in measuring our safety performance.

Group One factors are a partial measure of past safety actions and activities. By evaluating changes periodically, some reasonable assumptions may be drawn about the effectiveness of the program. However, these factors give no consideration to cause and consequence which are a result of chance or otherwise beyond reach of the safety program to control. In experimenting with accident data for several years, it was found that weight of *Group One* factors could not exceed 30 per cent of total without diluting the value of sincere preventive effort with intangibles. A total weight of six was therefore assigned to *Group One* with equal distribution of two to each factor.

Group Two factors are the dynamic factors drawn from experience, disposition of which spells out degree of competence in dealing with the future. Since *Group Two* factors largely control *Groups One* and *Three* in subsequent periods, it is the most important one in determining safety progress. Again, through experimentation, a group weight of around 50, per cent of the total was found fair and in balance. The group weight of 11 was distributed to give "command deficiency" the largest unit value since command action is the most important element in making safety progress.

Group Three factors separate extreme consequences from those which may be termed the ordinary. It is argued that the chance element governs degree of consequences. This is no more true than to argue that chance is the governor of accident occurrence. By extensive study of accidents in which these factors were involved, it was found that circumstances involved usually predicted the consequences. The control of extremes is obviously an important element in gauging progress. The remaining weight of around 20 per cent was given this group with the preponderant factor weight being assigned to fatalities and permanent impairments.

Development of Constants

In developing the formulas for each of the factors in the Progress Indicator, it was necessary to first select a denominator. Due to the wide differences in activities, values of property and equipment, and relations of expenditures to work performed, the number of manhours worked was selected as the simplest and best common denominator. The relation between some factor and manhours could be questioned at a particular installation, but since that installation's performance is compared to its previous records, the whole set of formulas evens out the evaluation.

With the common denominator and the desired relative weight established, the formula for each factor was a simple matter. Taking the factor "Accident," for example, with a relative weight of two; the formula becomes:

$$\frac{\text{Number of Accidents} \times C}{\text{Manhours}} = 2$$

$$C = \frac{2 \times \text{Manhours}}{\text{No. of Accidents}}$$

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The constant, C, was determined on the basis of the previous experience of the entire Corps of Engineers. The formulas for accidents, days lost, dollars of property damage, fatalities, permanent impairments and number of accident losses over \$1,000 are based on Corps-wide experience for the years 1952, 1953, and 1954, a three-year average.

The formulas on reasons for cause and command deficiencies are based on Corps-wide experience for the years 1953 and 1954 only, since accident reports for years prior to 1953 were not evaluated under the PI system.

It will be noted that using Corps-wide experience for computing formula constants affords some comparison between the installation and the average experience of the Corps. Although progress is measured by the previous performance of the installation, the constants emphasize any condition which results in one of the factors being much worse than the Corps average.

a. Number of Accidents

In the three-year period the total accidents was 15,995 with approximately 1,258,000,000 manhours of employment.

$$C = \frac{2 \times 1,258,000,000}{15,995} = 157,299$$

b. Number of Days Lost

A total of about 2,139,000 days were lost due to injury, including time charges for permanent impairments and fatalities, in the three-year period.

$$C = \frac{2 \times 1,258,000,000}{2,139,000} = 1,176$$

c. Property Damage

The property damage loss over the three-year period amounted to about \$10,557,000.

$$C = \frac{2 \times 1,258,000,000}{10,557,000} = 238$$

d. Reason for Cause

The deficiencies charged in 1953 were 1,804 physical and 3,279 supervisory, or a total of 5,083 on 5,543 accidents. In 1954, there were 1,185 physical deficiencies and 2,084 supervisory deficiencies, or a total of

3,269. The two-year total was 8,352 deficiencies. Manhours of employment for the two years were about 763,000,000.

$$C = \frac{5 \times 763,000,000}{8,352} = 456,776$$

e. Command Deficiencies

The number of command deficiencies charged in 1953 was 262, and in 1954 the number charged was 96, or a total of 358. During the two-year period there were 22 repetitions, making a total of 380 command deficiencies.

$$C = \frac{6 \times 763,000,000}{380} = 12,047,368$$

f. Surcharges

(1) Fatalities and permanent impairments: There were, in the two-year period, 208 fatalities and permanent totals and 178 permanent impairments, a total of 386.

$$C = \frac{2.5 \times 763,000,000}{386} = 4,941,709$$

(2) Property damage over \$1,000: During the two-year period, there was a total of 222 accidents where property damage exceeded \$1,000.

$$C = \frac{1.5 \times 763,000,000}{222} = 5,155,405$$

It will be noted that the computed values for C are not in round numbers. The desirability to have them rounded off to facilitate use of formulas is obvious. Since it was found that rounding them off to the nearest convenient value had no appreciable influence on the final result it was so done.

The adjusted formulas are as follows:

$$\text{Accidents} = \frac{\text{Number} \times 160,000}{\text{Manhours}}$$

$$\text{Days Lost} = \frac{\text{Number} \times 1,200}{\text{Manhours}}$$

$$\text{Property Damage} = \frac{\text{Amount} \times 250}{\text{Manhours}}$$

$$\text{Reasons for Cause} = \frac{\text{Number} \times 500,000}{\text{Manhours}}$$

$$\text{Command Deficiency} = \frac{\text{Number} \times 12,000,000}{\text{Manhours}}$$

$$\text{Surcharges} = \frac{\text{Number} \times 5,000,000}{\text{Manhours}}$$

Handle Your Chemicals and Industrial Wastes Safely

New Chemicals and New Uses of Chemicals Present New Problems

By HOWARD H. FAWCETT

Safety Eng., Research Laboratory, General Electric Co., Schenectady, N. Y.

"No substance is so hazardous that it cannot be used if sufficient knowledge of its action has been made available; similarly, no substance is so non-hazardous that it should be used without regard to caution."

This statement, borrowed from Dr. James A. Sterner, originally referred to toxicity. We have substituted the word "hazardous" for "toxic," and broadened the scope of its meaning. This revised statement will serve as the theme of this paper.

To make, handle, use and dispose of substances safely, we must:

1. Have an exact and complete knowledge of their hazards; and
2. Every person handling the substances must *apply* this knowledge at all times.

Most chemical accidents are due to a lack of complete knowledge. This paper will try to point out "booby-traps" that have occurred, as examples of how we may profit in the future.

Incomplete knowledge, where one type hazard so completely overshadowed another that the second was completely overlooked until serious injuries occurred, was illustrated in a class of compounds which had reached the pilot plant stage. These materials were known to be highly combustible and to have an extremely high flame velocity. Impure materials were commonly known to be spontaneously flammable in contact with air.

A pilot plant facility was built with the flammability of the material in mind. Operations began and proceeded without major incidents from fire. However, personnel began to feel peculiar when doing maintenance work on the system. The symptoms were those common to central nervous system disorders. Two individuals, who ap-

parently were unusually susceptible, became sufficiently ill that any doubts were removed that the physiological effects were real and had been caused by the compounds involved. Animal experiments finally showed the toxicity of some of these materials was similar to that of phosgene, a highly toxic compound. (Maximum allowable concentrations listed today for these materials is only one part per million.)

A drastically revised ventilation system, a simple, continuous air monitoring test, plus religious use of gas masks, prevented future exposures by the personnel involved. The fire hazard was known and recognized from the beginning; the toxicity hazard was not appreciated until much later. Both hazards were important to the success of the project.

Incomplete appreciation of the role which liquid oxygen can play in liquid nitrogen (sometimes erroneously referred to as "liquid air") prompted an investigation of the contamination of liquid nitrogen by liquid oxygen.¹ It has been found that the 13° Kelvin difference in boiling points between liquid oxygen (91°K) and liquid nitrogen (78°K) is sufficient that *impure* liquid nitrogen will become significantly richer in oxygen, since the vapor leaving the container by evaporation is always richer in nitrogen than the liquid left behind. In other words, the oxygen percentage increases in the residue. Liquid nitrogen containing less than 0.3 per cent mol per cent oxygen has been stored for a week without showing any noticeable increase in oxygen, whereas liquid nitrogen containing 15 per cent mol per cent oxygen overnight has enriched itself so the remainder analyzed 32 mol per cent oxygen. If a material of the latter composition were used in a trap where contact with combustible substances,

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such as hydrocarbons or other reducible substances could occur, an explosion is highly probable.

This is not quite the whole story, however. Even liquid nitrogen with a 99.7%+ per cent purity, can be hazardous if air is allowed to condense out in traps open on one side to atmosphere. Such condensed "air" is very high in oxygen, and explosions can result from this "liquid" in contact with flammables, such as hydrogen or other easily oxidized gases or vapors. In such systems, the continual flow of dry nitrogen gas through the system, so no oxygen-containing air may enter, is recommended.

While considering "booby-traps" in oxygen and nitrogen, the use of air-line respirators which utilize "plant air" systems should be mentioned. Unless the air supply is absolutely fool-proof, both with respect to oil, dirt, carbon monoxide and moisture, and no cross-connections with other gases, such as nitrogen, hydrogen, or natural gas can occur, the "plant air" should not be used for breathing.

Another gas which is now increasingly available in a liquid form is hydrogen. Liquid hydrogen is extremely cold, boiling at 20° above absolute zero or -422°F. In properly designed and operated systems, liquid hydrogen evolves hydrogen gas at a slow rate which can be easily vented. In event of an unconfined spill, however, an expansion of 777 times occurs in volume between the liquid compared to the gas (or, one liter of liquid becomes 27.5 cubic feet of gas). It is obvious that the manufacture and use of liquid hydrogen must be carefully engineered.

Hydrogen sulfide, hydrogen chloride and chlorine are three gases which are being widely used in cylinders ranging in size from one-pound lecture bottles to ton tanks. These gases are in a group which have an affinity for the valve packing commonly employed, and on standing the valve stem may "freeze."

A number of serious accidents have occurred when persons tried to open or close these "frozen" valves. It is good practice to see that valves are opened and closed by competent, experienced, properly-protected personnel at some remote location immediately before the cylinders are delivered inside a building. If the valves cannot be

opened by application of only a reasonable pressure, the cylinder should be returned to the manufacturer accompanied with full information.

Hydrogen gas in cylinders at 2,000 p.s.i. is handled in large amounts without incident. However, hydrogen at high pressures passing through an orifice can self-ignite, probably due to static electricity. One should be alert for such ignition and be prepared to turn off the gas, if possible.

If hydrogen cylinders are known or suspected of being contaminated with air (or oxygen), extreme care must be exercised in disposing of the cylinders. Two incidents have occurred in recent years where contaminated hydrogen cylinders exploded while trained personnel tried to vent them to air. In both cases, detonations of high order occurred. It appears that such disposal should be assigned to experienced explosives engineers, with no attempt to salvage either cylinders or contents.

Perchloric acid explosions continue to be reported, as the power of hot concentrated perchloric acid on organic or other oxidizable matter is rediscovered. A non-porous stone hood with built-in facilities for washing down the duct as well as the hood itself, is available commercially.

Anhydrous magnesium perchlorate, used as a dessicant especially where organic matter and heat are involved, continues to cause trouble. In a recent case, dehydrite (magnesium perchlorate) was used to dry an organic liquid instead of drierite (calcium sulfate).² The error was discovered and the perchlorate carefully removed by filtration. Near the end of the subsequent distillation, smoke was observed, followed by a violent explosion accompanied by a yellowish-white flash and a considerable volume of smoke and fumes.

The small quantity of magnesium perchlorate remaining in solution apparently reacted violently as it was concentrated with the organic matter at high temperatures. Far less costly would have been disposal of the liquid as soon as the error was recognized. Magnesium perchlorate should not be used where organic matter and heat are involved.

Another perchloric acid use which is far from harmless is in electropolishing mixtures. A few years ago, a statement appeared in a reputable journal that electro-

polishing electrolytes containing low concentrations of perchloric acid with organic matter are "completely harmless." Taken at its face value, this gave the impression no hazards existed since cold dilute perchloric acid is not an oxidizing agent. However, a detailed study of a typical solution of this type (6.2 per cent perchloric acid, 70 per cent ethanol, 10 per cent butyl cellosolve, and 13.7 per cent water) showed that a fire hazard, an eye hazard and an explosion hazard (the latter if the solution were evaporated on a hot-plate, not a rare occurrence in metallurgical laboratories) existed.²

Another powerful oxidizing agent is red fuming nitric acid. In view of its potential energy, it has been proposed as an oxidant for propulsion systems. Titanium and other metals have been considered for construction of systems involving titanium and red fuming nitric acid (RFNA). Although the chemist directly involved was injured, he survived, but a second chemist, who was exposed to nitric acid fumes during the ensuing rescue and first-aid operations, died three weeks later from pulmonary edema and confluent broncho-pneumonia. The oxides of nitrogen, formed when nitric acid decomposes, are powerful lung irritants and whenever encountered, adequate respiratory protection or ventilation must be used to prevent lung damage.

Decomposition of substances under conditions that may not be obviously hazardous have been reported. Inert-arc welding, in which the metal is shielded by an inert gas (such as helium or argon), produces radiant energy of wave-lengths which can decompose even low concentrations of trichloroethylene vapors in air into toxic decomposition products a considerable distance from the welding site. In view of this, the recommendation has been made that vapor degreasers should be located so their vapors cannot enter the area of the welding arc.³

Halogenated compounds, such as carbon tetrachloride, trichloroethylene, and the various Freons are known to decompose when heated. This may create hazards where such substances are heated, either by an open flame, as in welding or brazing, or where heat is applied to vaporize the solvent and dry the work to prevent corrosion from moisture.

Application of plastics as material of construction for chemicals should be noted as involving potential hazards.⁴ In the laboratory, polyethylene has been widely accepted, first as a container for hydrofluoric acid, and, more recently, for general laboratory use in place of glassware. We have noted with interest the limitations of polyethylene and can summarize cautions to be employed in its use:

1. Polyethylene softens when heated near the temperature of steam. Irradiation of the polyethylene raises the softening temperature so sterilization in a steam autoclave is possible;
2. Polyethylene becomes brittle and may crack without warning at low temperatures, such as at the temperature of liquid nitrogen;⁵
3. Polyethylene is unsuitable even at room temperatures for certain chemicals, and at elevated temperatures it can be attacked by even more;⁶
4. Polyethylene performance in the environmental stress cracking test may be greatly improved by irradiation. Irradiated polyethylene is now commercially available;
5. Polyethylene bottle cap inserts decrease the leaking danger of the bottles, but also may introduce a hazard when they stick as the cap is removed. If pressure inside the bottle is greater than atmosphere, the contents may spray out as the polyethylene insert is pryed up. Face protection, plus opening the insert on the opposite side of the bottle so the spray will be in the other direction, is obviously indicated.

One other point which should be made regarding chemicals, both old and new, is that we must keep them out of contact with persons who will misuse them. The poisoning of children, especially under six years, has shown a rising trend in recent years.⁷ It has been noted that a two- or three-year-old child will eat (or attempt to eat) almost anything, and substances like lye, kerosene and cleaning solvents must be kept from prying hands. It is just as unthinkable to allow a child to drink kerosene as it is to use kerosene to freshen a dying fire, but fatal results have been reported many times from both.

We must learn to look for the "booby-traps" our increasingly complex civilization

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Poisonings Admitted to Ellis Hospital,
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Chemicals

- 11 Kerosene
- 5 "Cleaning fluids"
- 1 Gasoline vapors
- 2 Ant buttons (As)
- 1 Camphor cube
- 1 Easter egg dye (green)
- 1 Furniture polish
- 1 Draino (lye)
- 1 Chlorox

24 "Chemical"

Drugs and Medicines

- 6 Aspirin
- 9 Assorted drugs
- 1 Ex-Lax
- 1 Dog medicine (Strychnine)
- 1 Aminophylline*

18 Drugs

*Fatal in 12 hours. All other cases recovered
without incident, within one week.

References

- 1 *The Contamination of Liquid Nitrogen By Oxygen of the Air*, by L. V. McCarty and E. W. Balis, *Chem. & Engr. News*, 27, 2612 (Sept. 12, 1949); see also D-Chem. 50, *Liquid Oxygen*, Industrial

Data Sheet, National Safety Council, 425 N. Michigan Avenue, Chicago 11, Illinois.

- 2 *Case History No. 243*, Report for the Month of July 1955, Manufacturing Chemists' Association, Inc., 1625 Eye Street, N.W., Washington 6, D. C.

3 *Perchloric Acid-Ethyl Alcohol Electropolishing Mixture*, by H. H. Fawcett, Report No. R.L. 1185, October 1954, Class 1, Research Laboratory, General Electric Co., Schenectady, New York.

- 4 *Investigation of Accident Involving Titanium and Red Fuming Nitric Acid*, December 29, 1953, Information Circular 7711, U. S. Bureau of Mines, 4800 Forbes Street, Pittsburgh 13, Pennsylvania (March 1955); see also *Injury and Death from Red Fuming Nitric Acid*, by A. J. McAdams, Jr., and S. Krop, *J.A.M.A.* 158, 1022-1024 (July 23, 1955).

5 *Recommended Safe Practices for Inert-Gas Metal-Arc Welding* (Tentative), A6.1-55T, American Welding Society, 33 West 39th Street, New York 18, New York. Price 50c.

- 6 *Plastics as Materials of Construction—A Symposium*, Indust. & Engr. Chemistry, 47, 1292-1358 (July 1955).

7 *Chemical & Engineering News*, 32, 1824 (May 3, 1954).

- 8 *Chemical Resistance of Polyethylene To Various Reagents at 70° and 140°F.*, Will Corp., Rochester 3, New York.

9 *Let's Stop Killing and Crippling Our Children*, by H. F. Dietrich, *Ladies' Home Journal*, LXXII, No. 9, p. 84, September 1955;

Common Household Poisons and Their Antidotes, 18-page booklet on household poisons and their antidotes, reprinted from the Connecticut Health Bulletin, 69, 7 (July 1955); available from Connecticut State Department of Health, Hartford, Connecticut.

Flammable Liquid Trade Name Index, N.F.P.A. No. 325A, July 1954; National Fire Protection Assn., Inc., 60 Batterymarch Street, Boston 10, Massachusetts. Price \$1.25.

Accident Prevention in Childhood—The Kerosene Hazard, by Hugh A. Carithers, *J.A.M.A.* 159, 109-111 (September 10, 1955).

Corrosive Irritants

By JACK T. GARRETT

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"Primary irritants" are materials which, from the standpoint of chemistry, would be considered corrosive. These materials act by injuring the skin, eyes, and, if inhaled, the surface tissues of the respiratory tract. This may lead to inflammation of the air passages and possibly the lungs themselves. The effects of the various irritants vary somewhat due to differences in solubility, physical state (solid, liquid, gas) and portion of the body exposed.

In any discussion concerning chemical irritants, some mention must be made of

so-called "secondary irritants." Some definitions would therefore be in order.

A *primary irritant* is a material that causes little or no systemic toxic effect in the concentrations that bring on injury or death due to its local action. This means that the corrosive action is the primary hazard. An example of this type substance would be hydrochloric acid.

A *secondary irritant* is a substance that, while being an irritant to exposed tissue surface, exhibits a greater hazard from

systemic effects. An example of a secondary irritant is hydrogen sulfide.

Irritants can be classified rather loosely by their physical form such as liquid, solid, or gas.

Liquid Irritants

1. *General.* Primary irritants may act on the skin rapidly or slowly depending on their concentration and length of contact. The more concentrated the irritant and the longer the contact, the more rapid and intense is the resulting inflammatory process.

These irritants act directly on the skin either by chemically reacting with it, by dissolving or abstracting from it some of its essential components, by denaturing the proteins of the skin, or by disturbing the membrane equilibrium or osmotic pressure of the skin cells.

These processes pertain to all irritants, regardless of their physical form. However, liquid irritants are by nature in the best physical form to cause immediate damage. It is, therefore, generally conceded that the liquid irritants are the most hazardous of all the irritants as far as external injury is concerned. This general class of materials causes the greatest number of chemical burns and chemical eye accidents in industry today.

2. Examples of Liquid Irritants

1. MINERAL ACIDS

- (a) Nitric Acid
- (b) Sulfuric Acid
- (c) Hydrochloric Acid
- (d) Hydrofluoric Acid
- (e) Phosphoric Acid

2. ORGANIC ACIDS

- (a) Formic Acid
- (b) Acetic Acid
- (c) Chloroacetic Acids
- (d) Cresylic Acid

3. ORGANIC SOLVENTS

- (a) Petroleum Solvents
- (b) Coal Tar Solvents
- (c) Chlorinated Hydrocarbon Solvents
- (d) Most Liquid Esters and Ketones
- (e) Most of the Alcohols
- (f) Carbon Bisulfide
- (g) Turpentine and Terpenes

The above irritants are all liquids in their normal physical state. However, many cases of irritation occur from solutions of solid irritants such as the caustics, the oxidizing

and reducing salts, and many organic salts, such as organic acids, anhydrides, halogenated organics, and many others.

It is not of interest here to list all of the possible liquid irritants. It suffices to point out the preceding examples.

3. Monsanto Experiences

Most burns received from liquid irritants in our company have been caused by some accidental occurrence, such as ruptured lines, spills, and so forth. These accidents are held to a minimum. Where they do occur, we have employees who are disabled in one form or another from the action of liquid irritants.

When an employee in the performance of his normal operating duties handles or comes in contact with any liquid irritant, he is provided with protective equipment, such as rubber gloves, boots, and proper respiratory protection, if necessary, since many of the liquid irritants become gaseous irritants at elevated operating temperatures. We provide emergency equipment in areas where potential hazards from liquid irritants exist. These will include air supply respiratory equipment, protective clothing, and canister type gas masks wherever applicable.

Because of the vast possibilities of contact with liquid irritants, we have found that the best program to eliminate this type of exposure within our operating plants is a strong educational program carried out by our safety engineers after thorough indoctrination from the operating supervisors and foremen of the respective operating units. The fruits of this program are apparent from the very few cases encountered in plants that handle millions of pounds of liquid irritants each year.

Concerning first aid procedures, we recommend immediate flushing of the affected skin or eyes with copious quantities of water. We recommend this procedure for at least 15 minutes for eye contact and then the patient should be referred to a physician immediately.

In many cases, the use of neutralizing solvents or solutions would be advantageous but we have found that operators can waste critical time seeking these solvents and, in general, the flushing will perform the same function even though it takes somewhat longer. We, in many cases, do not recommend the use of solvents for this rea-

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son and our experience has borne out the soundness of this policy.

Solid Irritants

1. *General.* The solid irritants depend largely on their action with moisture on the skin or other surfaces. These irritants can cause serious damage to the skin, both from their corrosive action and from their thermal heats of solution. This class of irritants is probably the least hazardous of all the materials handled because normally a worker has sufficient time to remove this material from exposed body surfaces before serious irritation occurs. However, in many cases the irritant is a liquid slurry of organic materials and in this case, the potential irritation is as bad as in liquid materials.

Solid irritants can cause delayed irritation. This can occur when a worker gets solid material on his skin without his knowledge or from carelessness in removing this material. Solid irritants, such as the caustic alkalies, are not immediately painful like the acids and if left in contact with the skin until pain is felt, serious burns may result.

2. Examples of Solid Irritants

1. CAUSTIC ALKALIES

- (a) Alkaline Sulfides
- (b) Sodium Hydroxide
- (c) Sodium Carbonate
- (d) Sodium Silicate
- (e) Potassium Carbonate
- (f) Ammonium Hydroxide
- (g) Ammonium Carbonate
- (h) Barium Hydroxide
- (i) Barium Carbonate
- (j) Trisodium Phosphate
- (k) Lime (both hydrated & dehydrated)

2. ELEMENTS AND SALTS

- (a) Elemental Sodium
- (b) Elemental Potassium
- (c) Elemental Phosphorus
- (d) Antimony and its salts
- (e) Arsenic and its salts
- (f) Chromium and the Alkaline Chromates
- (g) Copper Sulfate
- (h) Copper Cyanide
- (i) Mercuric Salts
- (j) Zinc Chloride
- (k) Silver Nitrate

Probably the most serious of all of this group of solid irritating materials are the caustic alkalies; because of the very wide application of these materials throughout the chemical as well as many other industries. This list does not by any means include all caustic alkalies. It includes the most commercially important ones and the most severely corrosive.

A second group of solid irritants includes some of the elements and salts. This group contains many oxidizing agents, reducing agents, and elemental materials that produce irritation by thermal burns.

Solutions of these materials probably pose the most serious problem. However, fine dusts of any of these solid materials will sometimes cause severe chronic irritation, particularly in cases where workers perspire freely. This would include working in areas at elevated temperature and summer operations almost any place in the country.

3. *Monsanto Experiences.* Monsanto's experience in handling solid irritants is similar to handling liquid materials, with the exception that solid materials in a finely divided state frequently cause chronic irritation. Dust control is a necessary adjunct to finely divided irritant handling. In the chemical industry, in almost every case where finely divided solid irritants are handled, exhaust ventilation is provided. Employees working in areas that handle solid irritants within our company are provided with gloves, respirators, and generally protective clothing as the necessity arises.

In some cases where finely divided irritants are used, protective creams are issued. We, however, do not depend on the use of protective creams because we feel that they are a poor substitute for good personal hygiene, and in areas where these materials are handled, shower facilities and facilities for washing the hands and face are provided. When protective creams are used, instructions as to their application and removal are given, with reasons why they should not be substituted for bathing and other personal hygiene practices.

As far as first aid procedures are concerned, we again recommend copious flushing of the skin or eyes with water and the immediate summoning of a physician. It may be of interest to note that handling certain organic solvents, such as phenol,

which has a melting point of 41°C., or lactic acid which has a melting point of 26°C., poses a problem characteristic of materials that melt in the general range of 25 to 50°C. In ordinary chemical processing experience, these materials might be either liquids or solids, and in the case of phenol, the removal of the solid material from the skin is an absolute necessity if considerable material has adhered to the skin. We recommend that after copious flushing with water, soap and water be used to remove minute quantities of these irritants.

Here again, our experience has shown that good education as to inherent hazards involved in handling these materials and the safety procedures prescribed are the best methods for eliminating accidental exposure.

Gaseous Irritants

1. *General.* Although liquid and solid irritants afford considerable hazard from skin and eye contact, the most serious hazard associated with irritants in general is from these materials in the gaseous state. The remainder of this paper will therefore be confined to a discussion of irritants that are either by nature gaseous or vapors arising from liquids or solids.

Widely different symptoms result from the action of different irritant gases and vapors. These differences are due primarily to the differences in the localities on which the irritant acts. Symptoms of inflammation, therefore, are governed by the structures affected by the inflammation and not by any fundamental difference in the mode of action of the irritant substance.

The localities affected by gaseous irritants are influenced principally by the solubility of the irritant. For example, ammonia gas in high concentrations will cause intense congestion and swelling of the upper respiratory passages and possibly rapid death from spasm or edema of the larynx. If the immediate effects are survived, there may be little serious after-effects, since the deeper structures of the respiratory tract are not reached and harmed.

On the other hand, Phosgene, even in concentrations that cause little immediate irritation, may later be fatal due to pneumonia or pulmonary edema through its action on the air cells (alveoli) of the lungs. Chlorine is intermediate in its action be-

tween ammonia and Phosgene, due to its intermediate solubility.

The selective action of the irritant gases in the respiratory tract determines the relative danger of death from them. The delicacy of the respiratory membranes, their susceptibility to injury, and the seriousness of the damage which results, are very different in the upper and lower respiratory tracts. The action of irritant gases and vapors in the nose and pharynx may render them raw by the inflammation without immediate danger or permanent damage.

It is a more serious matter when the trachea and bronchi are injured. Not only are the local effects painful, but general systemic effects develop as in acute trachitis and bronchitis from bacterial infection.

The most serious, but least painful, results of inhalation of an irritant gas or vapor occur when the lungs themselves are acted upon. The damage gives rise to an acute edema leading to suffocation or, if this danger is escaped, to pneumonia with prostration and circulatory impairment. The outcome of either process may be fatal.

It can be summarized, therefore, by saying that the locus of action of various gaseous irritants is the result of the differences in their physical properties—particularly solubility, boiling point and volatility; and not so much the differences in their chemical properties.

The harmful effect of an irritant is not in a straight line relationship with the product of duration of exposure and concentration as it is in the case of an asphyxiant like carbon monoxide. A single exposure to a high concentration of an irritant can have an intense effect and can terminate fatally.

However, an acutely fatal exposure to an irritant could probably be tolerated by the system if the concentration were halved and it was inspired over a period of twice as long. This fact leads to the conclusion that any reduction in the concentration of an irritant during its passage through the upper respiratory tract results in a more than proportionate sparing of the tissues of the lung.

2. *Examples.* Gaseous irritants are generally grouped according to their locus of action. With the exception of the fourth group, these irritants are therefore grouped according to their relative solubilities, which

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is the physical property that dictates the site of absorption within the respiratory tract. This system of grouping is that presented by Henderson and Haggard in their fine text entitled, "Noxious Gases" (2nd Edition, American Chemical Society Monograph No. 35, Reinhold Publishing Corporation, New York, 1943).

GROUP I

Very Soluble—Affecting the Upper Respiratory Tract Mainly.

1. Ammonia
2. Hydrochloric Acid (HCl)
3. Sulfuric Acid
4. Hydrofluoric Acid (HF)
5. Formaldehyde
6. Acetic Acid
7. Acetic Anhydride
8. Sulfur Monochloride
9. Thionyl Chloride
10. Sulfuryl Chloride

GROUP II

Intermediately Soluble—Affecting the Upper Respiratory Tract and Deeper Structures Such as the Bronchi.

1. Sulfur Dioxide
2. Chlorine
3. Bromine
4. Iodine
5. Arsenic Trichloride
6. Phosphorus Trichloride
7. Phosphorus Pentachloride

GROUP III

Slightly Soluble—Affecting the Lungs and to a Much Less Extent, the Upper Respiratory Tract.

1. Ozone
2. Nitrogen Dioxide
3. Phosgene

The fourth group in this classification represents the major exception to the rule of solubility. No general rule as to the locus of action applies in this case.

GROUP IV

Irritants That Are Exceptions to the Rules of Solubility

1. Acrolein
2. Dimethyl Sulfate
3. Dichloroethyl Sulfide (Mustard Gas)
4. Chloropicrin
5. Ethylchlorosulfonate
6. Dichloromethyl ether
7. Benzil Iodide

8. Methyl Chlorosulfonate

9. Chloroacetone

10. Xylyl Bromide

This group, as in all the preceding groups, is by no means complete. There are literally thousands of such compounds. The biggest single class of Group IV compounds are the halogenated organics.

In this group, no simple solubility relationship exists. For example, acrolein (acrylic aldehyde) is only very slightly soluble in water, yet it is very irritating to the eyes and the upper respiratory tract. Continued exposure to this compound may lead to lung damage manifested by edema and possible death.

Dimethyl sulfate is a powerful irritant to the eyes and upper respiratory tract and yet is only slightly soluble in water. The action of this material is apparently not due to the decomposition of dimethyl sulfate to sulfuric acid.

Because of the anomalous properties of Group IV compounds, great care must be exercised in handling them. The best clue as to the possible seriousness of exposure to such materials would come from the volatility of the specific compound at the proposed operating temperature. A highly viscous material handled at room temperature would afford little hazard since the concentration of the material in the atmosphere at breathing level would be very low.

Many thousands of these compounds have been tested for toxicity and these data are frequently available in the literature or from the suppliers. It would be a wise course of action for any safety engineer to obtain such information before allowing workers to handle unfamiliar chemical substances.

3. *Monsanto Experiences.* Before a new compound is manufactured or purchased as an intermediate, safe handling information is obtained. This may require a literature search, queries to the manufacturer, or even animal toxicity work. After such information is available, instructions are given to the workers in the area where the material is to be used.

If the compound is such that dangerous concentrations are possible in the working atmosphere, exhaust ventilation is recommended as well as the necessary emergency protective equipment. Safety showers, eye

baths and other permanently installed safety devices are recommended and installed.

The most important step in the process of manufacturing a possibly hazardous compound is in the instructions to the workers. These instructions must include recognition of the compound by smell, recognition of symptoms of exposure, escape routes from the operating area, location and instruction in proper use of all emergency protective equipment, proper fire fighting techniques, and proper first aid and evacuation procedures.

If the above procedures are followed in starting up manufacturing units, toxic exposure to irritant gases and vapors would only arise from accidents such as spills, explosions, and so forth. We do have exposure from carelessness, but we keep this to a minimum by constant reminders in safety programs and the like. I am sure that our workers feel that we sell safety like tobacco companies sell cigarettes—by constant plugging. In this case, the product is well worth the advertising effort.

First aid procedures in cases where toxic irritants are handled depend largely on the individual compound. However, some generalizations can be made. Evacuation techniques, for example, must be instilled in workers so that when an accident occurs they automatically follow a set procedure in evacuating unconscious fellow workers. If training is lax in this function, all too often the evacuator himself becomes a victim.

Proper training in artificial respiration is mandatory in areas where toxic materials are handled. The proper method of administering oxygen under exhalation pressure should be taught to the first aid attendants or nurses in the plant first aid station, and the most rapid method of contacting the plant physician should be known by all these personnel. When an unconscious worker is moved to the aid station, some one should be available to explain to the physician the details of the accident. The physician will want to know what the man was exposed to, for how long, and what first aid measures

have already been taken. These are extremely important procedures in cases of exposure to the Group III irritant gases and, in many cases, may save a life. In almost every case of toxic exposure sufficient to cause unconsciousness, time is critically important.

The above procedures are for the most part practiced by Monsanto and have contributed to the fine safety record our company holds for which we are justifiably proud.

Conclusions. In conclusion, I would like to say that control of irritant exposure is absolutely essential to the health of workers. This control must include proper protective equipment, proper first aid training, and properly designed ventilation equipment with periodic exposure surveys particularly where one of the insidious irritants, such as the group two or three gaseous irritants mentioned previously, are concerned. Careful study of the process where irritants are used must be made to properly evaluate the problem and to design control equipment.

In addition to control of process exposures, provisions must be made to protect workers during unusual conditions such as spills or explosions, and so forth. This requires thorough safety training in the proper use of gas masks and other protective equipment. Last but by no means least, workers must be trained in proper first aid practice and evacuation techniques.

The chemical industry has a very excellent record in handling irritant materials. When one considers the tremendous tonnages of chlorine, ammonia, the mineral acids, the caustic alkalis, the mineral salts, elemental substances, and even nitrogen dioxide, that are produced and handled every day, this record is even more significant.

This condition, however, did not just spontaneously happen. It was made to happen by the combined efforts of managers, industrial physicians, hygienists, toxicologists, and above all, the hard-working safety engineers. Education is vitally important here as it is in all safety work.

Industrial Waste Disposal—The Problem and Its Control

By LEWIS WARRICK
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and LOUIS C. McCABE
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Introduction

Wastes adversely affecting water and air offer a major challenge today. There has been a growing realization in this country during recent years that water supplies of unlimited quantity and satisfactory quality can no longer be taken for granted. Smog has become headline news. People throughout the nation are beginning to recognize and understand the damaging effects of pollution and are joining in an effort to eliminate and control the threat to the continued use and enjoyment of these most priceless of our natural resources.

Cities and industries are showing increasing willingness to accept responsibility for providing measures to preserve and improve the quality of water and air by protecting them from the polluting effects of their wastes.

Disposal of wastes, both in water and air, in the earlier stages of our industrial and urban development, depended almost entirely on dilution. As wastes increased in amounts, pollution problems appeared.

With regard to water, the underlying cause of the difficulty stemmed from a situation imposed by nature—that, in any region, the supply of water is essentially constant. As years have passed, the mounting pollution loadings in many areas have exceeded the capacities of waters to assimilate these wastes unobjectionably.

There is a somewhat parallel situation with respect to discharge of pollutants into the atmosphere. Dilution of wastes, such as smoke, dust, fumes, and so forth, in air, is usually a more complex matter. There are vagaries of the weather to contend with, along with many other environmental factors. These will be mentioned later in this discussion.

Let us first consider wastes in relation to our water resources. Since 1900, demands

for water have steadily increased at an accelerated rate, due to increasing population and expanding industry and their concentration in metropolitan centers. Water-carried wastes from people and industry have correspondingly increased, causing more and more pollution and rendering more and more streams unsatisfactory for general use. This is a self-compounding condition which, in a number of instances, approaches critical limits.

Problems

Water Problem: Current need for water to support community living and associated industrial developments in the United States amounts to a half-million gallons of water per person per year. Looking ahead, it is estimated that the population of the United States by 1985 will be in the 230-million range and that industrial production will be more than double the 1950 level. Water needs to sustain these new levels also will be more than double.

It is anticipated that the problem will be even more critical then, since increases in population in the next 30 years are expected to be mostly urban. This can result in an increase in sewered population of from 60 to 70 per cent over that of 1955, as compared to an overall population increase of 40 per cent. It has been estimated that the potential biochemical pollution load from both population and industry will about double during this period, bringing into even greater conflict man's need for clean water and his production of wastes.

The solution to this vitally important problem must be in the conservation of water resources, so that the fixed natural supply of water in a region can meet the progressively increasing demands. Undoubtedly, some conservation can be accomplished by impoundment of flood waters, for later release during periods of low natural flow.

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The use, however, of water-impoundment facilities to solve water-shortage problems is becoming increasingly expensive, as suitable reservoir sites are becoming less available and farther from the point of water use.

Water-pollution control through treatment of sewage and wastes is brought into sharp focus as an essential factor in the conservation of the nation's water resources. By providing treatment of domestic sewage and industrial wastes, stream quality can be maintained to permit repeated re-use as a stream flows from one city or industry to another.

An adequate supply of clean water is an indisputable asset to an industry; yet, in some parts of the country, the problem of water supply has become so acute that, for industrial purposes, it must be reclaimed from sewage-plant effluents.

The general problem confronting an industry is: What can be done to return waters used in their processes to a stream in as nearly the same condition as it was originally? Practical and economic considerations militate against the ideal solution, and the question resolves itself into: how far is it feasible and necessary to go, in waste-reduction measures, to restore waters to reasonably clean conditions?

The final utilization of waters receiving mill effluents has a definite bearing on the degree of cleanliness that must be attained. Consideration needs to be given to the uses of these waters for drinking and domestic purposes, industrial water supply, watering of stock, propagation of fish, oysters and other aquatic life, navigation, power production, agricultural development involving irrigation, and recreational purposes, such as bathing, boating and fishing. Esthetic considerations are involved, particularly in recreational areas.

The water-pollution situation is serious enough, considering only the increasing volume of sewage and industrial wastes. In earlier years, many industrial wastes responded to treatment processes in much the same way as sanitary sewage. At present, the problem of treating industrial wastes is much more complex, due to development of new industrial processes.

A multiplicity of substances not originally encountered are found in industrial

wastes today, and more can be expected with the production of a still wider variety of products. This poses technical tasks, involving waste reduction at the source, reclamation of pollutants as byproducts, or effective, economic treatment and disposal.

Research is increasingly necessary in dealing with these wastes. Effects on treatment process, on streams and on people who use the water are very poorly understood. Radioactive wastes further complicate the problem. In fact, so little is known about the significance of some of these new wastes that, despite their prevalence, there have not been developed as yet good methods for measuring and expressing the "load" they place on a stream.

Air-Pollution Problem: The problems of air pollution and of water pollution are closely related. They spring oftentimes from the same causes, they affect the same areas, and, in many cases, the wastes discharged to the air are the same that contaminate our waters. Sometimes we have eliminated water pollution by discharging waste products to the air; elsewhere, the reverse has been true, and the solution of an air-pollution problem has provided us with an equally serious problem of water pollution. In industry and community waste disposal, this interrelationship has presented some particularly disturbing dilemmas.

Just before World War II, the industrial economy of the United States was less than half the size it is now. America's mines and mills have come to the point where they now turn out, in peacetime, more than twice as much of the raw materials, machinery and things to eat, wear, live in and ride in as they did only 12 years ago. They produce two and one-half times as much steel, two and one-half times as much machinery, twice as much cement, and three times as much in the way of industrial chemicals. For every automobile that came off the production line in 1939, there were more than three in 1954; for every ton of coke produced in 1939, there was an extra three-quarters of a ton in 1954; for every barrel of petroleum refined in 1939, there was an additional barrel last year.

Such situations have led to the almost inescapable conclusion that, where waste prevention measures can be employed, they are the best solutions to our pollution

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problems. From a standpoint of conserva-
tion, the recovery of waste products is im-
portant, for there are many commodities
going up the stack or down the drain whose
total supply in the earth's crust is limited.
Some of them are in short supply in today's
market.

Air-pollution has been receiving more
and more attention in this country. Smoke,
cinders, fly ash, chemical dust, fumes and
odors, alone or in combination, are to be
found as wastes discharged to the atmos-
phere.

Smoke is, perhaps, the most common of
these. It arises from the combustion of
mineral fuels, and it has long been a corol-
lary of industrial development. Only in
recent years have a few of our smokiest
communities been able to make advances
toward the elimination of smoke nuisance.
It has long been known that prevention is
preferable to elimination, in the case of
smoke. This requires skillfully operated fur-
naces adequate for utilizing the fuels.

We shall not dwell on the cost of air-
pollution to a city; we know that it runs
into millions of dollars per year and that,
in large doses, it affects the health of the
inhabitants adversely.

Air-pollution problems are more likely to
occur with improperly designed equipment,
but enough information is available today to
keep most air-pollution at a minimum. More
important, in the long run, is the growing
interest of scientists in the fundamentals of
the subject. Before the war, there was little
interest in air-pollution; now, hardly a
month passes without at least a regional
conference on the subject.

Only within the past 10 years has air-
pollution received the scientific attention
which has been given to water pollution
since the second half of the 19th century.
The growth of cities along water-courses
brought pollution and, of necessity, the re-
search and engineering developments which
permitted the cities' continued healthy
growth. Air-pollution had not had the same
technological approach until the past 10
years, and there are not enough trained
people working in the field, particularly at
the municipal level, where corrective meas-
ures are in force. Air-pollution can borrow
from stream-pollution to advantage in meth-
ods of research control and in the training
of workers.

The work of Haagen-Smit placed empha-
sis on the loss of hydrocarbons from refin-
ery operations, storage and transportation
of liquid fuels, and loss of gasoline from
automobile exhausts, as important sources
of smog. The regulations of the Los An-
geles District now provide for control of
refinery losses, and research has been initi-
ated for the purpose of reducing transporta-
tion and automobile exhaust losses.

In recent years, more attention has been
directed to combustible rubbish as a source
of air pollution. When sanitary fill is prop-
erly operated, it offers a satisfactory solu-
tion of the waste-disposal problem, but, as
available land is utilized, there is usually no
choice of disposal method left but municipal
incineration. More research into the design
of large and small incinerators is needed,
and there are indications that this will be
done.

Throughout the record, there is frequent
reference to the effects of air pollution on
health, and most legislation is, in part at
least, based on the assumption that there
are ill effects. The relationship is difficult
to establish. Even from the standpoint of
a relatively severe short-time exposure, the
answers do not come easily.

This is borne out by the fact that the
intensive study of the Meuse Valley,
Donora, and London incidents failed to
reveal conclusive answers to all of the
questions raised. This can be attributed,
in a large measure, to the fact that investi-
gations of such occurrences take place after
they are over, and not while they are going
on. The general conclusion of the Donora
study was that no single polluting agent was
present in sufficient quantity to account for
the effects on the population, but that, ap-
parently, some combination of contaminants
occurred which was responsible.

Bearing in mind the difficulties in study-
ing these effects of a severe short-time
occurrence, it is possible to visualize the
problem of evaluating the more nebulous
effects of long-time exposure to much
smaller amounts of contamination. In the
latter case, one has much more opportunity
to study the contamination itself and, in this
phase of the work, considerable progress is
being made.

A much more difficult challenge is that of
studying the possible effects of atmospheric
contaminants on the general health of the

persons exposed. This introduces an epidemiological problem of major proportions. To date no comprehensive, conclusive studies have ever been made on any population group for the purpose of evaluating the chronic effects of exposure to air pollution.

The Detroit-Windsor international program includes an approach to this problem. A study of the proposed plan for this group gives an idea of the variables which must be taken into consideration in such a study. Such factors as density of population, economic status, race and education must all be evaluated. This will, of course, ultimately produce information as to the health of various groups.

Control

Technical procedures employed in controlling wastes have been indicated. Mention should be made of laws under which air and water quality-improvement programs are being carried out. Particular reference is made to legislation enacted in recent years by Congress relating to air and water pollution, with a few references to activities involving industrial wastes authorized under these Acts.

Public Law 159, passed by the 84th Congress, "authorized to be appropriated to the Department of Health, Education, and Welfare for each of the five fiscal years during the period beginning July 1, 1955, and ending June 30, 1960, not to exceed \$5,000,000" to provide research and technical assistance relating to air pollution. The Surgeon General of the Public Health Service will direct the program.

Other sections of the Act provide that the Surgeon General may conduct research and develop methods of preventing and abating air pollution through the facilities of the Public Health Service, and may aid state and local government agencies and public and private organizations and institutions in similar activities. Contracts and grants-in-aid may be made to these organizations and to individuals for research, training, and demonstration projects.

The Act does not contemplate the regulation of air pollution at the Federal level, as it specifically states the policy of the Congress "to preserve and protect the primary responsibility and rights of the State and

local governments in controlling air pollution."

Contrary to general belief, an authorization act does not appropriate money. In effect, it states that it is the sense of the Congress that the activity defined by the authorization should be carried out by the agency designated, specifies the maximum expenditure, and may or may not set time limits. Appropriations for the program are still subject to Budget Bureau review and action by the Congress.

The recent session of the Congress approved \$595,000 for air-pollution investigations in the regular budget of the Public Health Service and, following passage of *Public Law 159*, an additional sum of \$1,190,000, making a total of \$1,785,000 for the fiscal year ending June 30, 1956. These funds are allocated as follows:

Division of Sanitary Engineering Services

Direct research	\$ 435,000
Contract research	50,000
Training	40,000
Transfer to other Federal agencies	400,000

Division of Special Health Services

Direct research	160,000
Contract research	200,000

Research Grants

(To be administered through the National Institutes of Health)	500,000
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Total\$1,785,000

Program Development: The regular National Institutes of Health mechanism will be used for processing research grant applications for air-pollution projects. The Sanitary Engineering and Occupational Health Study Section of NIH will be used, and the research grant applications will be reviewed by the National Advisory Health Council.

Program supervision will be supplied through the Bureau of State Services' Divisions of Sanitary Engineering Services and Special Health Services. The Division of Sanitary Engineering Services is responsible for research, technical assistance, training and demonstrations relating to engineering and the physical sciences. The Division of Special Health Services has similar operations of a medical nature. Both Divisions

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Industry Task Committee: The work with industry on liquid-waste problems has been carried on since 1950 with the aid of the National Technical Task Committee on Industrial Wastes. The effectiveness of teamwork in the solution of certain waste-disposal problems prompted a broader application of this principle of coordinated efforts in solving problems involving industry. The plan called for the establishment of a nationwide committee of industries having the following functions:

1. To inventory, appraise, coordinate and promote research in developing methods of using, treating and controlling industrial wastes.
2. To facilitate the devising and adoption of uniform methods of measuring and evaluating trade wastes in water-quality control.
3. To stimulate more effective working relations on technical phases of trade-wastes problems in industry and among federal, state, and local agencies.
4. To advise on employment of the facilities of the Robert A. Taft Sanitary Engineering Center in those areas of research and development wherein they would be the most valuable to the overall program.
5. To aid in establishing those areas where major need exists for financial assistance in obtaining basic information in industrial-waste problems in water-pollution control.
6. To stimulate further the adoption of practical methods—known or yet to be developed—for reclaiming, reducing and treating wastes impairing natural stream conditions.
7. To achieve wide dissemination of information on technical developments and the accomplishments of industry; to maintain suitable relations with technical societies, professional organizations, trade associations and such other groups as issue publications reaching persons concerned with water-pollution problems.
8. To aid in promoting training activities to increase the operating efficiency of waste-recovery and treatment systems employed by industry.

9. To perform such other technical tasks relating to industrial wastes as may be necessary to stimulate improvement in the quality of the nation's water resources.

The proposal for the establishment of this committee was enthusiastically approved by the Water Pollution Control Advisory Board, established under Public Law 845.

The Surgeon General then invited representatives of major industrial categories throughout the nation to meet with him for the purpose of forming a National Technical Task Committee on Industrial Wastes, whose members would work together and with the federal government towards finding solutions to pollution problems caused by industrial wastes. The committee was organized in 1950.

Much of the technical work of the committee is being performed by work groups composed of the best technical talent available in the industries having membership in the committee.

By bringing together industries which have common waste-disposal problems, duplication of effort and unnecessary expense can be substantially reduced. Likewise, there is considerable advantage, in endeavors of this kind, in being able to assign the various tasks to groups best equipped and staffed to conduct the particular studies involved. An increasing exchange of fundamental information applicable to the individual problems of participating industries is taking place, as additional groups become active in the work of the committee.

It is not the purpose of the committee to replace or in any way conflict with activities that have already been sponsored, organized and financed by various industries. Rather, it is intended to broaden the base of technical investigation and to increase the understanding of the potentialities of stream improvement in a way that will be beneficial to industry and government alike.

Four major "task groups" were established to act as working committees in carrying out the functions of the committee at large: Task Group I—*Food Industries*; Task Group II—*Mineral Products Industries*; Task Group III—*Chemical Processing Industries*; and Task Group IV—*General Industries*.

Subsequently, task sections and task units were established to expedite the work in various special product groups. This has encouraged wide participation in the technical tasks confronting the committee.

There is research and development work being done at the Sanitary Engineering Center in Cincinnati on things of regional or nationwide importance that the States or industry can't reasonably be expected to undertake. We've been endeavoring, through cooperation with industry, State departments, interstate agencies and others, to coordinate work on the technical problems to be dealt with in overall activities to improve the quality of water resources.

Research: In research, the picture is encouraging. Increasing attention is being given by a number of industries, universities, institutes and other research centers to development of methods for reclaiming or treating and disposing of wastes, recharge of underground supplies, conservation of surface supplies in surface reservoirs, reclamation of community waste waters, and other urgently needed knowledge.

A new federal research laboratory has been completed during the past year at Cincinnati. The resources of this new Sanitary Engineering Center of the Public Health Service are being dedicated to the solution of problems of the environment for the betterment of men, including water and sewerage problems. Studies are in progress to probe the complexities of the environment—the nature and extent of pollutants in air and water; factors affecting the quality of food, and countless household items in daily use; and to learn something of how they are affecting man's health through the environment.

Likewise, the occurrence and significance of viruses and fungi in water will be explored with a view to determining whether changes in existing treatment methods may be necessary to safeguard the public interest. We know little, for example, of the effectiveness of our water-treatment processes in removing viruses and organic substances discharged into streams. We know that some of the latter are coming through water-treatment processes, but not what effect they may have on health.

All of us are amazed and bewildered when we think of the potential of atomic

energy for the benefit of man. It forces new dimensions, new formulae, new terms, new thinking upon us; we *must* learn how to use it and live with it, as we have with other new forces before it. How do we treat the wastes? How do we remove radioactive materials in water-treatment processes? What standards shall apply to installations in your communities to protect their human and other resources?

It is intended that the Sanitary Engineering Center, in addition to making its own modest contribution to research knowledge, may help to meet the even more significant need to stimulate the programs of sanitary-engineering research throughout the country, and to facilitate translation of that research into practical application.

Tasks Ahead in Improving Water Quality: In weighing waste impacts on water resources and in evaluating tasks ahead, both municipal and industrial wastes need to be considered. Where practical, joint treatment has been encouraged. Problems presented are a real challenge.

The net effect of all improvements on stream conditions is of primary concern. At present, the municipal pollution load for a sewered population of 95,000,000 after treatment, is estimated to equal the loading of raw sanitary sewage from 55,000,000 people. This number exceeds by about 19,000,000 the level of pollution which would result if the current backlog of needs, amounting to approximately \$1.9 billion, were met.

Current construction expenditures for municipal sewage-treatment facilities amount to about \$2.40 per capita of sewered population, or approximately \$230 million per year.

Looking to the future, if we assume a continuation of the present level of expenditure-per capita served by sewers, the pollution load discharged to streams in 1985 will be approximately the same as it is today. Expenditures at this rate will be sufficient only to take care of our increasing population and obsolescence, and to increase the efficiency of treatment processes required to maintain a constant residual pollution load. Essentially, the same pollution problem which plagues us today will still be with us.

The most significant factor is that these expenditures must provide for an increase in the nationwide average efficiency of treat-

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ment processes from the present 42 per cent BOD removal to an estimated 65 per cent, to prevent an increase in pollution.

In order to eliminate the current backlog of municipal sewage-treatment construction, future per capita expenditures based on sewerer population must be increased to 190 per cent of the present level to accomplish the task in 10 years, 140 per cent in 20 years, or 120 per cent in 30 years. Nation-wide average BOD-removal efficiencies would, under these assumptions, climb from the present 42 per cent to 68 per cent, assuming the 10-year period for making up the backlog, 73 per cent for a 20-year period, and 77 per cent for a 30-year period.

Based on present techniques, these average figures mean that we will have reached the upper limit of practical treatment methods, as we know them today, sometime during the next 20-to-30-year period, and that local areas will probably feel the pinch even before then.

The picture for industrial wastes, based on biochemical loadings alone, can be even more critical, as production is expected to be more than double during the next 30-year period. Compared to industrial processing in 1920, industry has made great strides in the past 35 years in reducing the discharge of pollutants to streams. This has been accomplished by in-plant process changes, reducing wastes at the source through increased processing efficiency, recovery of byproducts and construction of waste-treatment facilities.

It has been estimated that from two and one-half to four per cent of all construction costs in the chemical industry are for pollution-control equipment. The overall annual expenditures of the chemical industry for pollution control are estimated to be about \$40 million. It is the policy of chemical manufacturers not to authorize new plant construction which does not include provision for the treatment and elimination of water- and air-borne contaminants. In older plants, modernization programs in many cases have provided effective abatement facilities.

About five years ago, a National Association of Manufacturers survey of water usage and waste treatment in industry showed that 37 per cent of all paper mills in the United States had waste-treatment

plants. After that, the construction of waste-treatment plants in the pulp and paper industry proceeded at an accelerated rate.

A recent survey of 329 mills by the National Council on Stream Improvement for the Pulp, Paper and Paperboard Industries, Inc. indicated that 180, or 55 per cent, of the mills in the survey sample have constructed waste-treatment plants of one type or another. Based on this recent survey, the Council estimated that the industry has spent in the neighborhood of \$70,000,000 for waste-treatment-plant construction over the past 10 years. A recent report indicates substantial pollution abatement.

Despite such encouraging progress, it has been estimated that industrial pollutants still discharging to streams are equivalent to the BOD loading of about 110 million people—over twice the estimated discharge in 1920 before acute water-pollution problems began to develop on a national scale. In order to maintain a reasonable degree of stream cleanliness in the future, it will be necessary to increase the efficiency of removal of industrial pollutants to double the present levels, through additional increases in process efficiency and improved waste treatment.

These considerations involve only waste loads of a biochemical nature. The problems involving removal of more complex waste elements and radioactive wastes can be of even greater health and nuisance significance and will probably require even greater expenditures for satisfactory treatment.

Tasks Ahead in Reducing Air Pollution: Other federal agencies will be asked to undertake projects needed by the Public Health Service to develop basic data necessary to solve specific air-pollution problems, for which they are qualified by staff competency or possession of special facilities. The U. S. Weather Bureau, the U. S. Bureau of Mines and the National Bureau of Standards have participated in preliminary discussions with the Public Health Service concerning projects of this type.

Many research and development requirements of an air-pollution program may be met more economically in private or public laboratories or institutions having specialized facilities and competencies which can be used to supplement the projects of the

PHS. As examples, the following types of projects may be cited:

1. The development of *specialized instrumentation* for field measurement of specific air pollutants.
2. Investigations of atmospheric-pollution problems requiring the *temporary services of persons* possessing unusual skills of a high order.
3. There is need for estimation of *economic effects of air pollution in terms of damage to materials, vegetation* and possible loss of time and efficiency of workers.
4. Problems related to the dispersal of air pollutants can be *explored in wind tunnels* available in several institutions.
5. Organizations outside the PHS have skills and facilities for developing *index plants for measuring levels of air pollution*. Contracts may be placed with one or more institutions to evaluate this possibility.
6. Some of the universities have laboratories set up for *development of air-cleaning devices and equipment*. Contracts for specific investigations may lead to the development of improved methods and devices for removing dusts, fumes and odors from effluents.

Some characteristic research grants recently recommended by NAHC and approved by the Surgeon General are:

<i>Institution</i>	<i>Amount</i>	<i>Description of Project</i>
University of Cincinnati.....	\$69,209	The design and organization of a study to relate the incidence, prevalence and prognosis of human diseases to air pollution in an urban area.
Detroit Department of Health..	\$20,000	A comprehensive study of the effects of air pollution on health.
University of Southern California, Los Angeles, California	\$10,982	Determination of acute and subacute biologic effects of air pollution.
Utah State Agricultural College	\$43,107	The effect of atmospheric fluorides on man.
University of Cincinnati.....	\$11,730	Classified bibliography of atmospheric pollution with particular reference to its effects on man.
Jefferson Medical College....	\$11,126	Absorption routes of inhaled air contaminants: Intestinal vs. pulmonary deposition.
Harvard School of Public Health	\$14,634	The physiologic response of animals and human subjects to atmospheric pollutants.
University of Southern California, Los Angeles, California	\$36,784	Investigation of the effect of breathing smog air on pulmonary function in man.
University of Michigan.....	\$63,420	Atmospheric pollution by aeroallergens.
University of California, Berkeley, California	\$14,375	Particulate air pollutants resulting from combustion.

At the suggestion of the White House, the Departments of Agriculture; Defense; Commerce; Health, Education, and Welfare; Interior; the Atomic Energy Commission; and the National Science Founda-

tion have appointed representatives to the Interdepartmental Committee on Community Air Pollution. As the air-pollution program develops, it is planned to appoint a committee for air pollution, with repre-

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Summary

Pollutional wastes pose serious problems. Conservation of the quality of our water resources to meet various uses and expanding needs, industrial water supply included, is highly important. Much needs to be done to meet the challenge of air pollution. Co-operation of all concerned is advocated in proceeding with tasks ahead in reducing both air and water pollution.

Such procedure, in developing essential technical information on waste utilization or treatment and improvement in water quality, is illustrated by the organization and activities of the National Technical Task Committee on Industrial Wastes. Accomplishments in this cooperative program of industry and government already are indicative of progress to be expected through joint action in taking care of technical aspects of problems presented. Much work remains to be accomplished. The key to future progress is *teamwork*.

Illumination and Safety

Glare

By DR. GLENN A. FRY

Dir., School of Optometry, The Ohio State University, Columbus, Ohio

The word "glare" may be used to designate many different types of things which are bad about a lighting installation. Fortunately, however, we can identify specific types of glare and cope with them. In order to explain the difference between various types of glare, it will be helpful to review a few facts about the process of seeing.

When a person looks at an object he points his eye so that the image-forming mechanism of the eye will form an image on that part of the retina called the fovea. When an image falls on this part of the retina, it can be seen in finer detail than images falling elsewhere on the retina. The space in front of the eye is called the *field of view*. The object looked at lies at the center of the field. The part of the field which lies outside of the central part of the field is called the *surround* or the *periphery*.

A light source in the surround, or periphery, of the field of view may be a source of distraction or annoyance, but it also produces actual discomfort. This is what we call *discomfort glare*.

The light source in the periphery of the field of view may also interfere with the visibility of the object. The pupil of the eye admits a beam of light from the light source which passes through the media of the eye to a peripheral portion of the retina. As this beam passes through the media, light is scattered on to the part of the retina which receives the image of the object. The impairment of vision produced by this scattered light is called *veiling glare*.

Peripheral light sources may also affect the pupil of the eye because whenever an image of a bright source falls on any portion of the retina, this makes the pupil constrict. This may be good or bad. At low levels of illumination, the total amount of light that enters the eye from the object is cut down, and this interferes with the visibility.

At high levels of illumination, there is

light to spare, and, if the observer has difficulty focusing his eye on the object, reducing the size of the pupil makes this easier. Older people who are trying to look at close objects without the aid of bifocals are usually grateful to have glare sources placed in their fields of view.

There is another kind of glare called *blinding glare*. For example, if, when light is entering the eye from the periphery, the eye turns to look at the light source and then turns back again to look at the object, the momentary glance at the light source will modify the state of adaption of the central part of the retina so that when he looks back at the object, he will not be able to see it as well as before he looked at the light source.

Up to now we have been discussing the harmful effects of having a light source in the periphery of the field of view, but we must not overlook the fact that the light has to be there in the first place in order to illuminate the object which the eye is trying to see.

The illuminating engineer must provide adequate illumination for the object and at the same time avoid the harmful effects of having light sources visible to the eye. He may use a concentrated light source enclosed in a diffusing globe. Or he may use a luminous ceiling which will adequately illuminate the object but will not seriously impair the visibility of the object and will not produce annoyance, discomfort or distraction.

In illuminating an object, the first thing to aim at is to provide an adequate quantity of illumination. In addition, however, the illuminating engineer must pay attention to the wave length composition of the light, that is, the color of the light. In the third place, the illuminating engineer must pay attention to the distribution of light sources and lighted surfaces surrounding the object. In the fourth place, he must consider differen-

tial illumination for the object and its immediate background.

The distribution of light sources and lighted surfaces surrounding an object is especially important when the object is three-dimensional. When one has to deal with a situation like one, for instance, in which the parts of a watch are laid out on a flat surface, it is quite important to provide shadowless illumination in order to avoid confusing the parts with their own shadows.

When one is attempting to read black letters on a mat white paper, the distribution of the light sources in the field surrounding the printed page is not too important. However, if the paper happens to be glossy, it is necessary to design the lighting to avoid specular reflection which can literally make the print invisible, or else one must angle the printed page in order to avoid these reflections. This type of interference with vision is called *reflected glare*.

This brings up again the point which was made at the outset; namely, that the word *glare* can be used to designate a number of different kinds of conditions found in a lighting installation. Reference has already been made to four different kinds of conditions which can be designated by the word *glare*. To recapitulate we have already mentioned *discomfort glare*, *veiling glare*, produced by stray light, *blinding glare* and *reflected glare*. The last three of these are collectively called *disability glare*.

There are many jobs in industry, such as the inspection of roller bearings, which require special kinds of lighting. A roller bearing has a polished surface, and one can make use of specular reflection to discover a crack which shows up as a fine black line on the surface. Examples of this type can be found without end.

Another type of problem is illustrated by the inspection of filaments of radio tubes. The tube is held against an illuminated background so that the object has to be seen silhouetted against the bright background. This arrangement involves differential lighting of the object and its background.

Not only do we have to get light from the light source to the object, but we also have to get the reflected light from the object to the eye, and this part of the process of seeing becomes complicated when the space

between the eye and the object is filled with fog, as is often the case on the public highways. In most situations, however, scattering by the atmosphere between the object and the eye is of no consequence.

In designing a luminous environment, the optometrist, or ophthalmologist, and the illuminating engineer must set up specific aims in providing lenses and light for the performance of a task. To be specific, they must aim at:

1. efficient seeing,
2. comfortable seeing,
3. safe seeing,
4. seeing without fatigue, and
5. seeing without permanent impairment of vision and health.

Since the topic of discussion today is illumination and safety, I will omit saying anything about fatigue and permanent impairment of vision and health, but I do want to say something about the relation of safe seeing to efficient and comfortable seeing.

There are situations, such as driving an automobile at night or landing an airplane, in which efficient seeing and safe seeing are practically the same thing. On the other hand, we find a native carving a canoe in the middle of a jungle infested with wild animals. Keeping the eyes and ears peeled for wild animals is only incidental to the major task. If a man is working at a desk, efficiency is the all-important factor, and safety is of little or no consideration.

In cases where both safety and efficiency are involved, the distribution of emphasis varies from job to job. In the case of a job like packing cartons in a warehouse, very little light is required to do the job efficiently; safety is much more important, and one can probably get by with a level as low as five foot candles. However, when seeing becomes critical and efficiency is paramount, one expects to find the minimum specification of the illumination to be 30 foot-candles or more.

Within the attainable levels of illumination, the higher the illumination, the higher the efficiency. It is difficult, however, to provide higher levels of illumination without introducing discomfort. The upper limit is, therefore, determined by the ability to keep the environment free from sources of discomfort.

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The most important thing I can say to people who are concerned primarily with safety is that the requirements for efficiency are generally much higher than requirements for safety. Hence, the safety engineer is entirely justified in setting a generous safety factor for safe seeing; the additional light is needed for efficient seeing anyway. Cost of lighting certainly has to be considered in any situation, but the thing that really sets the upper limit for both efficient seeing and safe seeing is the ability to keep the environment free from discomfort.

I am certain that when a safety engineer first hears the expression *luminous environment free from discomfort glare*, he is apt to regard this as a high-sounding empty phrase. This is not the case. In the first place, we have learned to deal with discomfort in a quantitative way. In the second place, we have begun to understand the causes of discomfort. The role played by discomfort, therefore, cannot be treated lightly.

If an observer is looking at a fixation point in a uniform field and a patch of brightness is suddenly exposed at the center of the field, there is a definite level of brightness of a flash above the brightness of the background at which it produces discomfort.

Luckiesh and Guth have determined to what extent the border line between comfort and discomfort is affected by applying the flash at different points in the periphery of the field of view. One of the problems under consideration is the evaluation of the effect of a combination of glare sources located in different parts of the field of view and having different brightnesses, different sizes and different backgrounds.

I would like to describe an investigation carried on at The Ohio State University which aims at understanding the causes of discomfort produced by the flashes of light. It also aims to provide a basis for predicting the effect of a combination of glare sources presented in the field of view at the same time.

One of the major causes of discomfort resulting from a flash of light is the constriction of the pupil of the eye. By means of an infrared photographic technique, we have been able to obtain continuous records of the change in pupil size produced by a flash of light, and we have found that

flashes of light bright enough to produce discomfort are well above the threshold for producing a change in the size of the pupil. As a matter of fact, a flash of light which is at the border line between comfort and discomfort produces a change in the diameter of the pupil amounting to about half of a millimeter or more.

The constriction of the pupil is one of the principal mechanisms contributing to the discomfort, because, if the pupil is paralyzed with homatropine so that it no longer responds to a flash of light, the threshold for discomfort is considerably raised. The discomfort which does occur under these circumstances is qualitatively different. It is undoubtedly associated with the tension in the muscles, producing closure of the eyelids and the auxiliary muscles associated with squinting. When extremely bright flashes are used, this leads to irrepressible blinking and tearing.

Techniques have not yet been worked out for evaluating the effect of the combinations of glare sources at different points in the periphery field of view.

Experimentally, we have dealt so far with flashes of light. This has been done deliberately because one can measure with considerable precision the pupillary response to a flash of light. It is found, however, that discomfort may be obtained from glare sources which are continuously presented in the field of view. It is believed in this case that the discomfort arises from fluctuation of the pupil size which depends, for the most part, on movements of the eyes. Needless to say, there are many aspects of the problem which need further investigation, but at least we have learned enough about the nature of discomfort produced by glare sources to regard it as something real and tangible.

Finally, it ought to be pointed out that comfortable seeing not only sets the upper limit on the amount of light we can provide for efficient and safe seeing, but seeing with comfort is itself an asset to safe seeing. This is no better illustrated than in the case of driving an automobile on the highway at night with an intermittent exposure to a succession of passing automobiles. This can be nerve racking to the point of making the driver less safe. The safety engineer, therefore, should be just as much concerned as the illuminating engineer in the design of luminous environments free from discomfort.

Muscle Tension, Illumination and Safety

By DR. LEONARD MEAD

Chairman, Psychology Dept., Tufts University, Medford, Mass.

The material to be presented in this paper is a report of work which has been in progress at Tufts University for the past several years. There have been many individuals¹ in our Department of Psychology and its Institute for Applied Experimental Psychology, who have worked on various phases of this topic. I am only one of many collaborators.

Our work is not complete. What will be presented is a story whose ending is not yet known. The central theme has been the attempt to develop a portable electronic device which will record muscle tension continuously and signal to the wearer when his state of muscle tension has reached a low level.

We shall show you how muscle tension is related to general alertness, a psychological trait which has significance in many common tasks, such as automobile driving or assembly work, whenever there is monotonous repetition of stimulus and response.

Alertness is also a requirement in watch situations like those of the civil defense aerial lookout, the radar observer or the sonar listener; here, one must be prepared to detect a signal the first time it occurs, although the stimulus may not appear for weeks, months or years. Deterioration of alertness in these kinds of jobs may have serious consequences for the life and safety of the performer and his associates.

Our early work was supported by contract with the Special Services Center of the Office of Naval Research. Some of the visual fatigue work and the development of our visual performance test has been supported by the Research Fund of the Illuminating Engineering Society. During the past year, additional electronic development and further psychological research has been sponsored by the Quartermaster Corps Research Headquarters of Natick, Massachusetts.

The report of our studies on muscle tension will constitute the major portion of

¹ Particularly Isaac Behar, Florence Gray, John L. Kennedy, Stella Mayne, Roland C. Travis and Bertam Wellman.

this paper. Our long range goal was to select some body mechanism (muscle tension or some other physiological indicator) as an index of efficient performance. The first problem here, obviously, is how do you measure and define efficient performance?

There are literally hundreds, or even thousands, of individual acts of behavior (in the work, home or laboratory situation) whose efficiency can be studied. It seemed to us that criteria which could be used to ascertain efficiency fell into either of two categories: *gross bodily behavior*, and what could be called *under-the-skin* measure of performance.

Examples of *gross bodily behavior* measures are the following:

1. Speed of work
2. Units of production
3. Errors
4. Discriminative capacity
5. Accidents and near-accidents
6. Pay
7. Supervisor ratings
8. Reaction time
9. Test scores

You will recognize each of these indices as a possible indicator of overall performances in a working or test situation. The measures relate to total individual behavior and can be determined by an outside observer or experimenter independently of the individual being rated or measured.

An *under-the-skin* index of performance, on the other hand, requires the knowledge and cooperation of the subject and involves the measurement of a particular biological function. Among the performance indices which might be found in this category are the following:

1. Heart rate
2. Blood pressure
3. Pulse rate
4. Respiration
5. Brain waves
6. Eye movements and blinks
7. Body chemistry
8. Temperature
9. Metabolism

10. Psychogalvanic skin reflex
11. Muscle Tension

Although our research efforts eventually led us to select muscle tension as the most suitable "under-the-skin" index, our immediate experimental goal when we started out was to find and utilize any "under-the-skin" measure which correlated highly with one or more of the acceptable gross-body-behavior indices. We would have been content with any one of the "under-the-skin" measures, providing that the index finally selected had the characteristics required of any measuring device. It should be sensitive to actual changes in bodily performance and not subject to artifacts; it must be responsive to quick changes as they occur; it should not interfere with general body behavior; it must appear under relevant circumstances and conditions; it must be non-discomforting to the individual being studied; and it should have such convenience features as being light in weight, easy to use, portable, economical to construct and free from maintenance. This is a rather formidable list of desiderata, but I hope to be able to show how we achieved some of these goals.

If you will recall the various possible "under-the-skin" measurements and compare them to those desiderata of a suitable device, you can see that quite few of these "under-the-skin" measures are automatically eliminated. Such indices as metabolism, or the chemistry of the body fluids and organs, were discarded because of the complexity of recording these factors without interference with routine body behavior; it might also be discomforting. Other items—heartbeat, blood pressure, respiration, and so on—were eliminated because they did not satisfy our requirements with respect to sensitivity or responsiveness to quick changes.

As we began experiments, therefore, it seemed on *a priori* ground that the most fruitful initial leads might be one or more of the following: eye movements and blinks, brain waves or muscle tension. Previous experience recording and analyzing eye movements and blink behavior led us to eliminate these as indices because they themselves are so often a component of the many human tasks about which a judgment of efficiency is demanded.

This left us either brain waves or muscle tension as candidates for our "under-the-

skin" measures. Some of the apparatus which we had available for the recording of biological potentials generated by the brain and muscle tissue are: pre-amplifier and calibrator, amplifiers for each recording channel and four-channel ink writer.

Many hours were consumed running off hundreds of feet of tape while recording both brain and muscle electrical potentials from college men in various stages of alertness occupied in various tasks. The amplification system used in stepping up electrical signals coming from the subject was varied systematically in gain magnitude; the system also selectively emphasized various frequency bands.

For those unfamiliar with the electrical correlates of tissue, it should be emphasized that the wave frequencies vary between one and 400 cycles per second, with amplitudes from a few microvolts to a few millivolts. Both neural (brain) and muscle tissue give off these electrical waves. Actual characteristics of these waves differ quite markedly, however, the brain giving off wave-like pulses whereas muscle gives off spike-like potentials.

Our electrode placements were shifted in location on the head and active muscles of the neck, shoulder, back, arms and legs, in order to discover the most effective placement for the electrical potential takeoff. Calibration procedures were followed to provide frequent checks on the fidelity of the amplification and recording units.

Our brain wave experiments turned out to be disappointing for several reasons: (1) some subjects characteristically showed slow brain waves, some relatively fast brain waves, some others no brain waves at all; (2) the brain waves of most of the subjects failed to change in any systematic way with changes in states of alertness, boredom and weariness; (3) for those subjects who showed brain wave changes as they approached sleep, the changes usually occurred too late to warn the subject of his deteriorated condition.

These experimental results showed us it would be difficult to establish clear-cut relations between brain waves and alertness changes by any simple device showing when electrical impulses were predictive of un-alertness.

We discontinued the recording of brain waves and turned our attention to the

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It has already been emphasized that there are differences between frequency of occurrence of brain waves and muscle action currents. In general, brain waves of any magnitude occur at lesser frequencies than muscle action potentials. And in single muscle fibers under slight voluntary contraction, the frequencies of spike type waves range between five and ten per second, with occasional rates of three per second. With increasing contraction, maximum frequencies of 30 to 50 per second are regularly observed for single muscle fibers in healthy muscles. On the other hand, in a muscle which is totally relaxed, there is little or no action current activity.

Another factor of note is that the amplitude or strength of the spike varies not only with the electrical potential changes in the muscle, but with the distance of the recording electrode from the active muscle units.

Turning back now to early experiments in which we recorded both brain and muscle activity, you will recall that we were using four independent amplifying and recording channels. Quite by accident, we noticed that, as the subject became progressively more drowsy, electrical potential output in the frequency band of about 40 to 200 per second also progressively decreased. This occurred for a number of subjects.

The phenomenon caused us to change our recording techniques, to develop and install electronic units emphasizing the high frequency electrical potentials of the muscles, to record muscle potentials along with brain waves coincidentally on the same tape. Electronic impulse counters, which would record impulses only a few microvolts in magnitude, were used to record the number of action potentials of a particular size which occurred per unit of time.

Here, the author showed a slide demonstrating a count of action potentials recorded by three of these electronic counters, each set to record the number of impulses above 5, 50 or 100 microvolts, respectively, at four different tension levels. The electrodes were attached to the right biceps muscle. The tension levels were: hand relaxed, hand raised, hand lifting—1.5 pounds, and hand lifting—3.0 pounds. The biceps, on the average, exhibits about two

spikes per second during the relaxed period at the five micro-voltage level and practically no spikes above the 50 micro-voltage level. As the tension increases, the number of spikes increases for all three micro-voltage settings.

Another slide showed the relationship between frequency of action potentials and tension levels for three different amplitudes of action potentials. The curves showed that the rate of spike impulses increases with increasing tension, and that this rate differs depending on the micro-voltage cut off.

Data of this kind demonstrated that recordings of all muscle spikes, above the five micro-volt level should be taken in studies on alertness changes, even for very active muscles like the biceps. To record below the five micro-volt level becomes hazardous because normal noise level of the amplification system is around three microvolts. Before we could use this knowledge in further experiments, additional electronic development was required.

Additional instruments required in order to accomplish our new objectives were: (1) electronic counters; (2) a voltage discriminator; and (3) a rate indicator.

The electronic counters were used to count muscle spikes as they occurred at the site of the electrodes. The voltage discriminator could be used to cut out voltages at different levels. The rate indicator showed the rate of occurrence of muscle spikes of a particular frequency level. Our system allowed us to record frequencies between 0-25, 0-50, 0-100, and 0-200 cycles per second. The new rate indicator and the electronic counters could be used interchangeably, depending on the type of record desired.

Now that we were partially instrumented, we had to find the best electrode placement for the most dependable indication of waning alertness. Considerable evidence shows that different muscles will be involved to different degrees in the same task, some very active, others almost, if not totally, relaxed.

In our search for the most suitable electrode location, electrode placements were made over a variety of muscles during the performance of many simple and/or monotonous tasks. In various experiments, we

put them over muscles of the neck, back, arms, legs and on the face. After many test sessions it became clear that we should avoid an electrode placement on those muscles which were involved in bodily adjustment to gravity, or in making adjustive responses to environmental tasks. In either of these instances, the decline in alertness is masked by the local muscle activity. (Muscles of the back came close to qualifying in this regard, but we discarded this type of placement because of possible embarrassment or inconvenience to the subject.)

Finally, we decided upon a placement over the eyebrows or supra-orbital muscles. This region just above the eyes is not significantly involved in many kinds of bodily adjustments to gravity, but has a definite tie-up to ocular adjustments. In attentive visual tasks it is also close to brain activity. This placement also permits the use of a head band, cap or helmet for mounting the electrodes, which are made of sponge rubber. Each sponge rubber disk is half an inch in diameter and about a quarter of an inch thick, with a lead-out wire imbedded in it. Before applying the sponge electrode, the rubber disk is saturated with a salt glycerine solution and held on the skin with adhesive tape or a head band.

One of the monotonous tasks effective in producing unalertness is a simulated lookout task. Here the subject was required to watch a clock hand move uniformly around a clock face. Very occasionally, and sporadically, the clock hand would move two jumps rather than one. The more alert the subject, the less likely was he to miss those times when the hand made two jumps rather than one. A single test session lasted two hours, during which time 25 signals might be presented.

We recorded muscle tension from the eyebrows continuously. When the looked-for stimulus occurred, we also recorded the subject's reaction time. And we could tell if the subject missed the signal altogether.

As you can imagine, reaction time slowed down as the alertness level became lower, but there were only six misses of 253 clock-hand signals for a total of ten college student subjects. Evidently Tuft's students have a high tolerance for boredom!

But variability in reaction time progressively increases as tension level gets lower. All the missed stimuli occurred at the lower tension levels.

Since reaction time seems acceptable as a gross-body-measure of alertness, we now tried to collect data on reaction time at varying tension levels. An additional experiment was performed in which the stimulus requiring a response was presented at varying tension levels, from high to low. Try to imagine a situation in which, as you become more and more unalert, or sleepy, you are presented with a sound or a light requiring your quickest response. Sometimes the signal occurred when you are very alert; other times you have almost dozed off. Reaction time is shortest when tension level is highest. Mean reaction time becomes much longer at lower tension levels. At such times, there is also the previously observed increase in variability of response time.

Having obtained this interesting correlation between a *gross-body-measure* and an *under-the-skin* measure, we proceeded to undertake electronic development which would take account both of the magnitude and frequency of muscle spikes. A device was developed which integrated the size of the electrical impulses for approximately one second. This newer apparatus was packaged in two black boxes which were portable and did not require a roomful of permanently located electronic apparatus.

Considerable research was devoted to the task of calibrating the new portable device and conducting studies on the day-to-day reliability of the amplifying, integrating and recording systems. We also used the device in conducting further laboratory tests on look-out behavior and other kinds of tasks, such as simple assembly work, reading and solving mathematical problems. These further studies continued to demonstrate that, under those conditions, when the subject showed unalertness to the point of dozing off, there was a general decline in the bioelectrical output from the forehead region of the head.

We also found interesting variations in the average tension levels of different subjects while performing different kinds of jobs; this suggested to us that it might be possible to evaluate the physiological com-

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ponents of a particular job by means of the Alertness Indicator.

Our portable device was installed and tried out in a number of real life or field situations. It was used with radar operators in a Navy combat information center team training center in Boston. It was tried out in an ordinary private automobile. We attached it to a truck driver during an all-night truck run. An electrician on watch as controller man in the maneuvering room of a submarine cooperated as a subject during various watch periods on two three-day cruises. And finally, it was used to test the bioelectrical output of an Air Force subject during a 17-hour continuous run as pilot of the flying laboratory of the aero-medical laboratory of Wright-Patterson Air Force Base.

There was an interesting and expected relationship between the electrical activity picked up from the truck driver and particular driving conditions. Although perhaps scientifically desirable, it is not possible under field conditions to arrange circumstances whereby the subject becomes dangerously inalert to the point of perhaps precipitating an accident. No fortuitous accident occurred due to lack of vigilance or sleepiness! However, it may be possible to utilize the Alertness Indicator to signal automatically to the operator when he is approaching a condition of dangerous inalertness, or low muscle tension. In the present instance, our driver was alert when he should have been and only became less tense when no danger was involved.

In a 17-hour fatigue run on an Air Force pilot, the subject controlled his plane continuously during this period except for two brief times when he was forced to land, once in order to refuel and the second time to change batteries. The Alertness Indicator was set so as to trip a relay when the bioelectric output of the pilot reached a low level. An examination of the table shows that there is a decline of alertness shortly after the flight has begun. Then there is a long period during which the tension level remains high above the relay pull-in point. Next, there is a period near the end of the task when the subject's alertness hand falls to the point of operating the warning signal, recovers, falls again, recovers, and so on.

During two of these periods, while the

Alertness Indicator relay was activated, the co-pilot reported that he took the controls for a few moments. Whether there would have been an accident if the co-pilot hadn't taken over the controls at these two times, or whether the Alertness Indicator would have warned the pilot of his condition in time to avoid the accident, we shall never know. An end spurt is observed shortly after the end of the flight during which the pilot's tension level stays well above the relay pull-in point.

It was at this stage in our investigation that the Illuminating Engineering Society asked us to study the possible uses of the Alertness Indicator as a means of specifying illumination standards in various occupations. This problem of specifying optimal illumination standards has many economic and human implications. The Illuminating Engineering Society has been interested for many years in developing objective means for standardizing light levels and developing recommended practices for different seeing situations.

This society has long sought a non-subjective, biologically and psychologically valid method on which to base their recommended practices. It is well known that visual acuity increases with illumination up to around 10 or 15 foot-candles, and that, with uniform surroundings, acuity increases with illumination up to 1,000 or more foot-candles.

There is also some evidence that an increase in illumination may be accompanied by increases in performance or productivity in industrial situations. If it is true that acuity and performance do increase with illumination, we may ask the question: Are these increases made at the expense of greater demands on the performer? Thus, even though seeing or performance improve with an increase in luminance, perhaps the individual has to work disproportionately harder to achieve this gain. What we are asking here is whether or not there is an actual increase in the physiological cost of visually-directed effort. It was hoped that the muscle potential output or the "under-the-skin" measure which the Alertness Indicator provided could measure physiological cost of seeing.

An experiment was made in which muscle tension level was recorded simultaneously with reading rate (measured by number of

words read per minute). Illumination varied between less than one to over 100 foot candles. Type size was standard 10-point. There was a slow increase in muscle tension potential independent of illumination during a test run of over 70 minutes.

In the second run, which followed the first one by ten minutes, the book was moved to twice the normal reading distance at the shaded portion of the curve. For the unshaded portions, the book was returned to normal reading distance for that subject. The increased distance was accompanied by a marked increase in muscle action potential which seemed to be independent of the illumination level. The subject reported considerable more effort to read at the doubled distance.

Another test was run with a more severe reading task. The book was old and in smaller, eight-point type. The ink was faded and the paper yellowed. The reading rate was directly proportional to the illumination, and changed more than in any other test. The muscle action potentials had a pronounced upward trend throughout the period of falling and low illumination, declined briefly when the illumination increased, then resumed an upward trend. From these results it would appear that as far as physiological cost alone is concerned, there is no need for high foot candle levels when reading a well-printed book with comfortable surroundings. However, when the task is of great difficulty, more illumination is required for lowest physiological cost.

The results of these observations prompted us to devote some time to the development of a standard test of visually-directed behavior. One of the best standardized tests with which we were familiar had been developed by Dr. H. C. Weston of London, England. His test consisted of a series of circles (Landoldt rings) with gaps in them located at different positions around the ring. The task required of a subject was to locate and mark the gap. The test could be varied in difficulty by using circles and gaps of different sizes. Weston has also demonstrated that the test scores were systematically affected by changes in illumination and contrast of the rings.

We have developed a similar test. We have had printed test sheets with three sizes of gaps which, when viewed 14 inches

from the eye, subtend five, three and one minute of arc respectively. During the past several months we have tried all three of these sizes on ten subjects. Illumination was varied between 500 foot-candles and .01 foot candle.

It had been our plan during these tests to use the Alertness Indicator at the same time our subjects were performing this visually-directed task. But, unfortunately, we began to be plagued by electrical interference. Consequently there was so much electrical noise on the record it was impossible to differentiate the muscle action potential output of the subjects from the electrical noise. This set-back to our plans was especially provoking because so many of the early studies were primarily concerned with the elimination of ambient electrical interference.

In comparing average test scores for all subjects at the three sizes of test object and at all illuminations with similar data obtained by Weston in his original experiments, it seems quite clear that we are obtaining the same general interactions between test object size, illumination and performance as Weston did. Our illumination range was slightly greater, however. Because of slight differences in testing methodology and technique, the actual performance scores on the Weston and Tufts tests should be compared only relatively and not absolutely. The relative trends, however, are quite similar and it would appear that we have developed a test which provides a measure of differential performance under varying conditions of illumination.

What is now lacking are the muscle potential measures given off by subjects under test conditions similar to those just described. Our efforts are now being directed toward this goal.

During the past year we have obtained assistance from the Quartermaster Corps Headquarters Command, which has enabled us to undertake the development of a new and improved Alertness Indicator. We finally located the source of our electrical interference. It was a new television transmitter nearby!

Our new device has a specially developed differential in-put circuit which eliminates ambient electrical noise from the electrical potential signal generated by the subject.

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The bioelectric impulses are fed to a high gain amplifier, which is transformer-coupled and employs four transistor stages. Our new model also has four plug-in units which provide different frequency characteristics, making it possible to conduct further research on the optimal band width for electrical recording of this sort. The amplified signal can be viewed on a cathode ray oscilloscope and may be read off a meter on the front panel of the instrument. A relay is provided to signal when the output from the subject falls below a given level. The instrument is completely powered by two small self-contained batteries, and no connection to a power line is required.

This instrument is the most versatile, most portable, smallest and lightest device which has been developed up to the present time. Its dimensions are 19 by 7 inches on the front panel which fits into a chassis three inches deep. Its overall weight is about 12 pounds. During the past summer we have been learning how to use it, studying its operation characteristics and calibrating it under different conditions of

use. Some of the early work done with subjects in various states of alertness has been repeated. We have taken records continuously for three different all-night sessions, while our subjects went through various stages of wakefulness and sleep.

Although we have now come to the end of my paper, you can see that our story has not been completed. If the experience gained in the use of our new model continues under other conditions, it is our hope during the next year to tie up, once and for all, the relationship between muscle tension, illumination and performance on representative types of human tasks.

It is still our hope that we will be able to develop a reliable device for the measurement of muscle tension which can be used to signal to an operator when he has reached an undesirable state of alertness. There are, obviously, many situations in modern life where such a condition would be a threat to human safety. An automatic apparatus which would inform an operator when this incipient condition was about to occur would have valuable applications to many circumstances of every-day living.

Noise — What You Can Do About It

Measuring the Noise Exposure

By HAROLD W. CROUCH
Eng., Eastman Kodak Co., Rochester, N. Y.

Noise has been defined as unwanted sound. I think this is a good definition. For example, the sirens on the fire apparatus coming down the street might be considered noise. But if it is your house that is on fire, it would not be noise—at least by the above definition.

The reasons for measuring noise vary. We may be concerned with whether the level is high enough to cause loss of hearing. Or we may be interested in its annoyance value in the office or conference room, or its interference in communication in the work room. The problem may be its neighborhood annoyance value.

The measurements that are made differ in each case. However, the instruments used are the same and the units are the same.

Frequency-Level-Continuity

Sound has three main attributes—frequency, level and continuity.

Sound is wave motion in air. It consists of small pressure and rarefaction areas travelling out from the source at a definite speed. In air at normal temperatures, it is approximately 1,100 feet per second, or a mile in five seconds.

Musical Sounds

The ear is sensitive to these pressure waves when they follow each other at rates from about 20 a second to 15,000 a second. The rate at which these arrive at the ear is called the "frequency" of the sound. We express it as "cycles per second."

The sound pressure level or *db* level of the noise—is a measure of its loudness. It depends on the pressure difference—in the travelling pressure waves which we said caused sound. The higher the pressure the louder the sound. We measure this pressure with a microphone.

To express the level of a sound we use a unit called a decibel.

This is a very convenient unit—it is the log of the ratio of the average pressure in the sound wave to a reference pressure. It indicates the amount of energy in the sound.

Increasing the energy 10 times raises the *db* level by 10. Doubling the energy increases the level three *db*. When the energy is doubled, the ratio of the energies is two. The log of two is three-tenths, and 10 times this equals three. The reference level is taken as the threshold of hearing, or the weakest sound that can be heard by the average good ear.

Various Noise Levels: Loud sounds are made with a very small amount of energy. One watt of sound energy in this room would raise the level to over 100 *db*.

Cutting the noise in half is not very much reduction, but reducing it to one-tenth is a real improvement. A large magnitude of noise reduction is necessary to "quiet" a noisy operation. Cutting the noise in half will probably not be satisfactory.

The third factor—continuity, or intermittency—is much harder to evaluate or express as a value. There is no question that it is important in loss of hearing, or in annoyance studies. I have built an instrument that measures the time the noise is above various levels.

Instruments

Now let us look at some of the instruments used to measure noise.

Survey Meter: The survey meter is the simplest and most convenient instrument to use. One of the various makes of survey type meters consists of a microphone mounted in the top, an electronic amplifier and an indicating meter. This meter will read noise levels from 40 *db* to 130 *db*. The

dial on the left has a setting for A-B-C weightings. This controls an electrical network that reduces the response of the meter to the low frequencies.

Ear Sensitivity: The ear is less sensitive to low frequencies; that is, it takes more energy for the ear to hear a low frequency note than sound in the 1,000-4,000 cycle range. As the loudness of sound increases, the ear approaches equal sensitivity to all audible frequencies. At the threshold of hearing, it takes 38 db higher level to hear a 100 cycle note than a 1,000 cycle one. Going back to our db formula—this means it takes 6,000 times as much energy to hear a 100 cycle note at the threshold of hearing as a 1,000 cycle note.

A B C Curves: The A B C network sensitivities are used to correct for ear sensitivities. The C network is flat. It is used for normal loud sounds and at any time a frequency analysis is made of the noise. The B and A networks are used when measuring lower levels, such as in offices or conference rooms. The B position is used for levels of 85 to 50 db and the A for still lower levels. The A-B-C weightings have been specified as American Standard Association standards for sound level meters and are found on all sound level meters.

The survey type meter is a very valuable instrument. It is almost always the instrument to use in the first assessment of a noise problem. But it has a number of limitations.

Sound Level Meter: When further information is desired about noise, a sound level meter should be used. This meter—and there are a number of makes and modifications—will give the same reading as the survey type meter if held in the same position, but it has a number of advantages. The most useful is that the microphone can be removed and connected with a cable of almost any length. Also, the type of microphone can be changed.

Another very necessary feature is that the output is large so the "noise" can be passed to a band analyzer.

Octave Band Analyzer: An octave band analyzer divides the audible range into eight bands, each one octave in width. Other types are available which analyze in one-half or one-third octave bands.

This instrument tells you what "kind" of noise you have; that is, whether it is predominantly low frequency or high frequency. Most energy or noise is in the low frequencies. High db readings are in the higher frequency bands. The instrument also indicates the energy in each band.

There are other types of band analyzers.

Narrow Band Analyzer: The narrow band or sharp band analyzer is an instrument that covers only a very narrow range of frequency at a time. With this instrument, you can "pin-point" the offending frequencies. This instrument is only useful when the noise tends to be of particular frequencies, like some motor or transformer noises.

Sharp Band Analyses: The readings from this instrument are plotted on a continuous scale, not in the eight equal divisions as was done with the previous analyzer.

B K Analyzer and Recorder: The analyses we have been talking about could have been made with graphic recorders. Graphic recorders are mechanically operated analyzers. They draw a curve showing the results of the noise analyses. There are a number of makes. This instrument consists of a microphone to pick up the sound, a sound level meter to amplify it, a one-third octave band analyzer and a means of recording the output on a chart that is pre-printed and kept in step with the analyzer. The recording part is at the bottom. One particular advantage of this instrument is that the recorder will respond at a high rate, so rapidly changing noises can be more faithfully analyzed.

The instrument is frequently used to measure the changes in noise level over a period of time. The rate the chart moves is variable over a wide range so the measured period may be from a few minutes to many hours on a short length of chart. The instrument will record change in level at rates up to 1,000 db per second.

Magnetic Tape Recorder: Magnetic tape recorders have a real place in the noise measuring field. Their use is twofold: (1) to make a record for future reference (These records are very useful if changes are to be made to reduce the noise), and (2) to sample the noise, and store it for future analyses in the laboratory. Data storage systems of this type are particularly

useful when there is only a limited time to collect the data, or the particular type of analyses desired cannot be decided at the time. It is very convenient to "sample" the noise with the tape recorder and then "analyze" it in the laboratory with a graphic recorder.

To be useful, the tape recorder has to be portable; it probably should operate from the 115 volt lines. Its power requirements should be low enough so that a converter operating on a storage battery will operate it. This makes it possible to operate it from an automobile or in other locations remote from power lines. This becomes particularly important in neighborhood annoyance problems.

Fidelity of recording, however, cannot be sacrificed for portability. High fidelity in the audible range is obviously of extreme importance. Moreover, the instrument must be so arranged, or modified, that it is capable of reproducing the level of the original noise. You must be able to calibrate it—and maintain the calibration. This is frequently done by replacing the continuous attenuators with step attenuators.

When recordings are made, it is desirable to play a known noise onto the tape for a reference. This can be done with a microphone calibrator. It has been said that in many cases higher precision noise measurements can be made by first recording on tape and then making the analyses in the laboratory, where time and interference is unimportant.

Our objective in any noise investigation is a survey of the area or the analysis of an industrial noise source.

The measurement of noise is an art. We have a lot of electronic instruments to aid us, but the results we get depends to a large extent on how we use the instruments.

The development of a technic of measurements is very important—it is the art of noise measurement.

Microphone in Use on Cable: The location of the microphone is surely the most important single factor. In survey work and measurements made to determine personal exposure, the best location is at the operator's ear level. However, when measurements are made the operator should be out of the way to prevent the shielding of the microphone.

The exact location of the microphone is important when machines are being analyzed, and when measurements are made close to the source of the noise. A small change in the location may give a measurable difference in level. The location becomes particularly important when changes are to be made and you want to determine what reduction has been achieved.

Hood: The calibration or sensitivity of the instruments change and measurements should *never* be made without checking the calibration of the instruments used. There is available a small hood, containing a loud speaker and attached oscillator with which the calibration can be checked in the field.

The db level of the noise, as indicated by the meter on the sound level meter or analyzer, is not simple to read. More often than not, the pointer is in constant, random motion, often over a range of several db. Very few industrial noises are constant in level. It is common to see the readings vary three, five, or even 10 db.

When this happens, the best reading is often difficult to decide upon. One rule commonly used is to record the reading as three db below the peak indicated by the meter if the variation is over six db. This peak reading depends to a considerable extent on whether the meter response is in the slow or fast position.

Records

I believe the most important thing I have to say concerns the keeping of records. All too often records of measurements made some time ago are not clear because it is not known where the microphone was, how close it was, what was going on, how many machines were running, and so forth.

The type of work being done varies, and this to a large extent determines the details desired on the record form.

On the back of the form should be a place for a sketch—and this is most important. Below this, you should have space for a number of analyses. The locations should be indicated on the sketch by letter or description. There should also be a note as to the particular operation going on when the analysis was made.

In survey work, a blue print of the floor plan is very useful to spot the location of the readings taken.

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The presentation of the results of the measurements is the *meat* of the investigation. The results are not much good if they are not seen, or, as more frequently happens, are not understood by the people who see them. It is important that they be presented so their significance can be readily appreciated. To me this means a report with a concise summary and clear, simple sketches and charts.

For example—the results of a general survey might be presented with figures showing the level in db throughout the area,

so that the locations of high level are easily noted.

Or you might draw contours, like weather maps, to indicate the variation in noise level. You can then tell, for instance, when noise from a machine is bounding off a wall, and thus raising the general noise level in a whole area.

Frequently you will have some kind of band analysis taken of some of the noise when a general survey is made. This can be indicated by letters on the plan, and the curve of the noise can be included in the report on separate sheets.

Methods of Reducing Noise

By J. C. RADCLIFFE

Supvr. Industrial Hygiene Unit, Medical Section, Ford Motor Co., Dearborn, Mich.

I would like to be able to say that you can find in one textbook the methods of reducing noise. I know of no such textbook. There have been numerous articles written in many scientific journals regarding specific noise control jobs. They usually follow certain prescribed avenues of control. But each one, even though following a certain avenue, must be tailor-made for the specific noise source.

If your company is planning a new building or manufacturing site, you are fortunate in the opportunity presented. Many dollars can be saved by building-in noise control features. The laying out of work processes, the location of noisy machines and the segregation of as many workers as possible from noisy areas will do much to minimize your future problems. (The article by Bonvallet & Karplus, in the December, 1953, *AIHA Quarterly*, gives general bands of noise levels to be expected in different types of industries, and specifically those being produced by different types of machines and processes.)

Operations involving *impacts* will be noisy, especially on large metal plates. Balancing noise reduction against costs of changes in work-processing must depend on particular applications. The following list of changes is given as a few obvious examples of alternate processes which cause noise reduction,

without regard to economic factors. This is a guide for the engineer:

1. Welding instead of riveting.
2. Compression riveting instead of common pneumatic riveting.
3. Pressing or rolling instead of forging.
4. Grinding instead of chipping castings and welded joints.
5. Electrically-operated tools instead of unquieted pneumatic tools.
6. Selection of less noisy types of conveyors.
7. Avoidance of dropping hard materials during handling.
8. Mechanical stripping of work from dies instead of air blast stripping.
9. Low speed process machinery instead of high speed machinery.
10. Substitution of materials; for example, fabrication of plastics is usually less noisy than sheet metal fabrication.
11. Wide spacing banks or rows of noisy machines instead of close spacing.
12. Hot working of metals instead of cold working.
13. Belt drives instead of noisy gears.
14. Substitution of less noisy materials used in friction processes, as in brakes and clutches.

Experience in his own field will enable the plant and manufacturing engineer to recognize and avoid the use of noisy machines and processes when possible.

Personal Protection

The use of ear protectors may be indicated under conditions where noise cannot be controlled by engineering. Nearly all ear protectors are effective in the high frequency region, but at low frequencies, where a tight fit is important, there is less need for attenuation. Contrary to usual opinion, speech understanding in a high noise level is often improved by ear protectors. The noise is reduced as well as the speech, and the speech-to-noise ratio is unchanged, but the levels at the ear are in a region where there is less distortion and better understanding.

The principal difficulties in using ear protectors are sanitation and discomfort, but these handicaps are being overcome. Enforcing the wearing of ear protectors is usually more difficult than enforcing safety goggles or shoes, but alert management can popularize and enforce their acceptance.

Reduction at the Source

Prevention of noise at its source appears to be a promising method of noise reduction. It is often difficult or impossible, since noise energy may be an unavoidable portion of the mechanical work done. Methods of reduction which follow are listed under types of noise sources:

Impacts: Where a material is hammered, sheared, tumbled or peened, the impact is a necessary part of the work and is always accompanied by noise. It is difficult to reduce this noise. However, if an impact can be made less sudden, the noise will tend to change from a sharp crack to a thud and will be less objectionable.

In a punching operation, one portion of the die can be made to enter the work first and convert the process into a shearing action. When punching involves a multiple die which makes several holes at one stroke, the die can be stepped to convert a single intense impact noise to several lesser noises.

Prevention of unnecessary bounces from a hammer-type blow also will be effective. In tumbling, impact noise on the containing cylinder can be decreased by suitable lining.

Rattles, Lost Motion, and so forth: This type of impact noise can be classed as minor

impact and the remedies are fairly obvious. Proper inspection and maintenance, securing, stiffening or damping of loose panels and replacement of worn parts, are effective. Elimination of rattles prevents low frequency energy from being transformed into more undesirable high frequency energy. Significant noise reduction can be obtained by these simple control means as great as 10 decibels.

Friction: Considerable noise can be made by frictional forces in general and in grinding, clutches or brakes. Part of the noise of cutting metal and wood can be classed as frictional noise. Motion along a contact surface creates force variation if the surfaces are not well lubricated. The frequency characteristic is rich in high frequencies, usually because of resonances in the part excited. Clutches and brakes tend to squeal, grinding produces broad band noise, and other friction noises are of the squeaking and scraping type which have objectionable high frequency energy.

Remedies include lubrication, substitution of materials, especially in brakes and clutches, changes in shapes of cutting tools and sharpening of tools which become noisy with wear. Gear noise is caused partly by frictional forces as well as variable forces at tooth impact frequency. Some improvement can be obtained by lubrication, substitution of helical or worm gears for direct gears, use of plastic or fibre gears, and reduction in speed.

Fluctuations in Gas Flow: Turbulence in the escape of compressed air or steam causes a loud hissing or roaring noise. When the air velocity is not being used, a simple muffler is effective. This, for outlets having small air flow, may consist of a can filled with steel wool or any other means of slowing down the escaping gas. Reductions of 10 to 15 decibels are possible.

When the air velocity serves a purpose, such as cleaning out chips, stripping or removing parts, noise appears to be unavoidable at the present state of knowledge. The least that can be done is to keep the air flow at the minimum velocity necessary for the operation by using a reducer valve in the line.

Sound Absorption

Total Enclosure: Noise in the air can be kept from spreading by almost any type of enclosure. Porous sound absorbing mate-

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rials are of direct use in reducing sound transmission through a wall, but of little value on the inside of an enclosure to reduce the sound level which must be contained. Transmission loss can be greatly reduced by using double walls with an air space. In some cases, an extremely noisy machine or area can be totally enclosed to take advantage of large noise reductions of 20-45 decibels.

Complete covers over a noisy part of a machine are another useful method in noise reduction. Whether a small enclosure over part of a machine will do a good job of noise reduction should be checked by trial with an improvised cover first. If such a cover gives promise, a cover made of: (1) an impervious barrier such as sheet metal, 16 gauge or thicker, (2) rubber-like material to seal the edges and vibration isolated fasteners, and (3) absorbing material inside the cover to absorb sound and prevent build-up of noise, should be designed.

Partial Enclosure: The term "partial enclosure" is used for noise shields and enclosures which have openings greater than a few per cent of their area. Noise radiation from these openings is the principal path of noise flow from partial enclosures, since the transmission loss of the barrier is at least 20

decibels. Sound absorbing linings must always be used inside these partial enclosures, or there will be little noise attenuation.

This type of enclosure is useful mainly in giving a shadow effect for workers who otherwise would be in the high level direct noise field. Basically, an operator is not protected in this type enclosure, but nearby operators are.

Space Absorption: The most common use of sound absorbing material is a general or overall method of reducing noise in enclosed spaces. However, absorptive materials used on ceilings and walls of a general work area give a reduction of noise levels in the reverberant field at a distance from the noise source, but absorption will not decrease the level for workers less than five to 10 feet from the source.

In most practical installations of area-treatment with absorbing walls or ceilings, there would be a maximum reduction of about 10 decibels. In addition, area treatment will "push back" distant noises and allow an operator to hear his own machine better.

Specific Noise Control Measures

Following are a few examples of noise control attempts made in certain industries:

HEAVY DUTY DRILLING OF TRANSMISSION HOUSINGS

Frequency in cycles per second	Noise Intensity in Decibels			
	Machine A		Machine B	
	Before	After	Before	After
Overall			Both A & B	
			Before	After
20-75	106	86	112-117	89-92
75-150	104	87	112	87
150-300	102	85	108	90
300-600	102	88	108	86
600-1200	112	83	110	89
1200-2400	105	82	112	84
2400-4800	103	75	106	83
4800-10KC	98	65	104	77
Sones	1268	173	100	66
			1485	193

The *before* readings refer to a dry drilling of this cast iron housing. The *after* readings refer to drilling with an oil lubricant. This change from dry to oil-lubricated drilling has reduced the loudness by approximately 87 per cent.

VIBRATING SCRAP CONVEYOR

Frequency in cycles per second	Noise Intensity in Decibels			
	Under Conveyor		Spot Welders Location	
	Before	After	Before	After
Overall	104	97	101	96
20-75	92	92	90	90
75-150	91	91	90	90
150-300	92	92	93	92
300-600	93	92	92	92
600-1200	97	90	94	90
1200-2400	98	93	94	93
2400-4800	96	91	93	87
4800-10KC	88	82	85	80
Sones	550	383	440	342

The *before* readings refer to a vibrating scrap conveyor as originally installed. The *after* readings refer to the same conveyor after an adjustment of the angle of the conveyor. The spot welder was in the nearest work location to the conveyor. Under the conveyor is a main aisle. This change in angle of the conveyor has reduced the noise intensity by approximately 23 to 30 per cent.

FOUNDRY KNOCKOUT OPERATION

Frequency in cycles per second	Noise Intensity in Decibels	
	Operator's Area-Vibrating Screen	
	Before May 1953	After April 1954
Overall	112	105
20-75	111	102
75-150	109	102
150-300	107	103
300-600	102	103
600-1200	103	104
1200-2400	100	104
2400-4800	94	93
4800-10KC	88	83
Sones	835	756

The change in *before* and *after* readings is effected by the application of dum-dum to one wall and the ceiling. This change in wall absorption decreased the sound intensity only 10 per cent. As can be observed, this dum-dum application was most effective in the low frequency ranges. Further correction is still needed in this area.

M-07 ALLIED WHITMAN CO., AIR HOIST

Frequency in cycles per second	Noise Intensity in Decibels	
	Before	After
Overall	114	87
20-75	90	80
75-150	103	85
150-300	104	81
300-600	94	76
600-1200	100	74
1200-2400	107	74
2400-4800	107	73
4800-10KC	112	65
Sones	1116	105

Before readings refer to the noise from the compressed air exhausting from a compressed-air operated hoist. The *after* readings refer to conditions found when the compressed air exhaust was equipped with a muffler. The use of this muffler has reduced the noise intensity by 90 per cent.

Decibels
Readers Location
After

96
90
90
92
92
90
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SCRAP BALER ENCLOSURE

Frequency in cycles per second	Noise Intensity in Decibels	
	Before	After
Overall	120	94
20-75	114	90
75-150	118	88
150-300	104	86
300-600	108	86
600-1200	112	85
1200-2400	116	80
2400-4800	114	80
4800-10KC	106	76
Sones	1634	194

The *before* readings refer to noise at the baler operator's position when scrap is dropped from the metal slot conveyor into the baler pit. The *after* readings refer to conditions found after an acoustical booth was built around the operator with just a small door opening to the side. In addition, air release discharges from valves inside the booth had been silenced. This acoustic enclosure and air release control, reduced noise intensity by 85 per cent.

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SCRAP BALER-SPACE BAFFLES

Frequency in cycles per second	Noise Intensity in Decibels	
	Before	After
Overall	115	113
20-75	94	85
75-150	95	87
150-300	99	92
300-600	105	101
600-1200	111	103
1200-2400	112	110
2400-4800	111	109
4800-10KC	106	104
Sones	1766	1435

The *before* readings refer to noise levels at ear level of the baler operator when scrap was dropping from the metal slot conveyor into the baler pit. The *after* readings were taken at the same location during the same operation with sound space baffles in position over the baler pit. These baffles effected a 19 per cent reduction in noise intensity.

RUBBER WHEELS vs. STEEL WHEELS

Frequency in cycles per second	Noise Intensity in Decibels	
	Steel Wheels	Rubber Wheels
Overall	111	99
20-75	99	91
75-150	105	92
150-300	106	95
300-600	108	95
600-1200	104	90
1200-2400	103	85
2400-4800	96	80
4800-10KC	92	75
Sones	893	275

The *steel wheel* and *rubber wheel* readings refer to an empty metal tote box being pulled over a wooden block floor at standard speed.

SCRAP METAL CHUTES

Frequency in cycles per second	Noise Intensity in Decibels			
	Single Wall Chute	Double Wall Chute	Single Chute Tape Outside	Single Chute Tape Inside
Overall	92	87	91	86
20-75	77	72	75	73
75-150	78	81	78	77
150-300	78	78	75	75
300-600	87	78	78	78
600-1200	87	77	87	80
1200-2400	90	77	85	79
2400-4800	88	77	83	77
4800-10KC	85	77	78	73
Sones	260	124	174	110

The readings shown indicate in a test set-up the noise levels obtained by dropping a five-eighth inch diameter steel ball, eight inches onto a steel chute.

Planning an Audiometric and Ear Protection Program for Plants in Small Communities

By ROGER P. MAAS, Ed.D.

Hearing Consultant, Employers Mutual Liability Insurance Co., Wausau, Wis.

Hearing measurement stations are a logical starting point in a program of industrial hearing conservation. Usually these can be established in plants in large cities where specialized medical service is available and where large numbers of workers make practical the expenditure. An otologist is obtained to conduct a complete program under the standards established by the American Academy of Ophthalmology and Otolaryngology, hereafter known as AAOO.

Our problem in Wisconsin, where we have been forced into a program to protect both employer and employee from the effects of noise, has been in assisting numerous smaller plants in cities under 30,000 population to develop facilities to conduct pre-employment hearing measurements. We prefer "hearing measurement" to "test" because it eliminates some undesirable psychological connotations contained in the word "test." We don't want to encourage the man to feel that he must try devious methods in order to "pass" to qualify for employment. Actually, it is a measure of hearing acuity before the man comes on the job, just as we measure a man's height, weight, blood pressure, and so forth.

Similar expressions of what we are getting at might be a hearing check, inventory, examination, evaluation, audiometric reading or audiogram. Over 75 per cent of the installations in Wisconsin are in small plants having little labor turnover or new hires. I hope that these suggestions primarily aimed at the small plants will be of help to those of you in the larger plants which many of you represent.

We have found that an excellent starting point is to approach the manufacturer's council or the industrial committee of the chamber of commerce or its equivalent, which calls a meeting of its membership. An otologist, who is informed on the AAOO subcommittee on noise in industry's research program, and a legal expert selected to give a history of the problem with emphasis on the need and purpose for establishing a func-

tional hearing conservation program, usually result in a highly successful kick-off.

I would suggest to those of you beginning programs in smaller communities that you use the terminology "industrial hearing conservation program." It is easier to put across. All of us are interested in conservation, whether it is natural or human resources.

I have attended a number of meetings where the AAOO film, "The Ears and Noise," or the NBC film, "The Effects of Noise on Man," which was part of the search series, have most effectively oriented the group as to problems and what to do about them. In our own state, the Medical Society drew up a guide entitled *Recommendations for Planning Hearing Conservation Programs in Wisconsin Industry*, which you can obtain by writing to the State Medical Society, Madison, Wis. This carried a lot of strength because the program came not from management or the insurance company but from our own doctors, who felt that industry had a responsibility.

The next step is for representatives of plants to decide upon a local hearing conservation committee to work out details of the program, presupposing, of course, that the need is established and that the group chooses to take definite action. One of the communities I know having a little labor turnover and feeling that it did not pay for each little plant to purchase an audiometer for just a few new workers each year decided to ask the local visiting nurse association if it would be willing to carry on the program of hearing measurement.

In other communities, the hearing conservation committee may ask the cooperation of the local hospital, medical clinic, general physician or the local vocational school to undertake this program. The local or neighboring otologist, who was consulted at the very beginning and present at the meeting of the plant representatives, said that he would be glad to supervise the station and assist in training the audiometric techni-

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cians. We have found most otologists willing to do this because they feel that their time is more profitably spent in seeing the many referrals and not carrying the program of pre-employment audiometric screening. They tell us, "Send us those who need our specialized medical services."

Every facility in every community program should be supervised by a qualified otologist. The VNA, to follow one very workable plan through in more detail, decided to undertake the project because they already served industry with part-time nursing service and felt that these contacts with industry would assist them in selling more of their services to the public. Besides, these worthy community organizations need the extra margin of income. In the meantime, the plants assess themselves 25 cents per man on their payrolls to purchase an audiometer and to build or buy an audiometric examination program.

You can't evaluate hearing properly in just any old place. The noise levels must be those conforming to the standards established by the AAOO. For example, in the band of 75 to 100 cycles, the permissible level is 45db. In the next band of 150 to 300 cycles, 35db. is required. If this is not done, environmental noise invalidates the audiogram. If you think it is an easy matter to meet these rather rigid requirements, ask someone who has tried it. Many plants where noise levels are high everywhere feel that the only solution is a commercial installation which carries a guarantee of attenuation or removal.

How can you get a noise level survey?

An insurance carrier or health department is prepared to do this. It is possible that the noise levels are not too high to treat a moderately quiet place acoustically without too much expense.

Shall we get a small examination room or a large one? The larger room accommodates both the audiometric technician and the subject.

The answer usually is dependent upon space requirements. The AAOO seems to favor a smaller room with a technician outside of the booth. This is constructed with a rather large observation glass installed so that the technician can communicate with the subject through signals. Some feel that the contact of technician and subject brings

about valid audiogram data. This is a matter to be decided on an individual basis.

Audiometers range in price from \$150 to approximately \$500. Audiometers are no longer approved by the American Medical Association's Council of Physical Medicine. I would invite representatives of available companies to explain what they have to offer because each instrument presents unique features which, with the help of the nurse, technician and the purchasing director, will have to be evaluated. Talk to nurses and technicians who are already using audiometric equipment.

Remember that you are screening workers using air conduction threshold examination techniques, and those having hearing losses are sent to the otologists for more complete evaluations. For this reason, an expensive instrument with extra gadgets is hardly a necessity, unless you have a consulting otologist come to your plant for the referrals.

Having an audiometric examination room meeting the required noise levels and an instrument with the frequencies recommended by the AAOO, we are ready to train our technicians. Nurse, X-ray or laboratory technicians are naturals for this work, but alert responsive personnel from a general office can also become skilled technicians. According to the AAOO, about 12 hours of training time, including an hour or two of actual practice with the instrument, is recommended in order to obtain valid audiograms.

There is much more to audiometry than the mere pushing of buttons and dialing. Preparation of the subject for procedure and understanding individual differences is paramount. There is a psychology of obtaining responses from the individual and the ability to teach. If the local otologist cannot find time to assist in this part of the program, find out if the nearest college is holding short courses for nurses or technicians. These are excellent because the otologists who conduct these training programs give the student excellent background material, which is motivating and adds interest to the job.

Audiometry can be a boring routine job or it can be a highly interesting and challenging skill. We know that we get more accurate data when more complete training programs are given. Usually it is necessary

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to include physics, anatomy and physiology of the ear, care and operation of the instrument, the recording of audiogram data and the techniques of obtaining responses from people.

At this time, the local hearing conservation committee reports back to its membership that things are ready to go. Each new worker is given an appointment, always before he begins the job, and the technician administers the measurement. This takes from 10 to 15 minutes including filling out the history and making a duplicate record to be retained in the station files.

I do not believe that you can make a valid audiogram in five minutes if one considers the fact that sometimes it is necessary to repeat frequencies when extraneous noise is present or if a subject is slow and needs to have more time so that one can be sure of his responses. A good technician always explains the procedure carefully, demonstrates how the audiometer works and then allows the subject some actual practice, probably two or three frequencies before recording the data permanently. A copy of this original audiogram is mailed at the end of the working day to the employer, who never fails to inform the man if the record indicates the need for otological diagnosis.

In one state, audiometric data cannot be used as legal evidence unless the man is given the information regarding the results of his evaluation at the time it is made. To implement this vital step of referral, some industries pay the worker part or even all of the cost of the diagnosis.

Figures seem to indicate that approximately 25 out of 100 men seeking employment have hearing losses indicating the need for medical attention. In other words, in the absence of this audiogram data, these plants in 25 employees out of 100, would be purchasing previous employers' hearing losses.

At the end of each month, each industry is billed for the hearing measurements it received. A recent survey indicated that the average cost to industry per examination in smaller communities utilizing cooperative methods was \$2.

Where the program breaks down in actual practice, I regret to say, is that not enough men get to the ear physician. We need to emphasize this part of the program more

vigorously. The hearing conservation committee continues to serve the official administrative body for the plants, and it is appointed each year by the executive committee of the chamber. This group sees to it that the proper financial arrangements are carried out between the agency, whether it is a hospital, clinic, private physician, visiting nurses association, and so forth. Quarterly reports are made on the program to the chamber just as other committees report.

In one city, 100 per cent of the industrial firms participated, and even the fire and police commission and welfare department asked if they could use the facilities as part of their pre-employment training and processing. Employees in these non-noisy occupations were referred by their employers to otologists if the audiograms indicated hearing losses. One employer said, "It is an inexpensive procedure and one which the new employee appreciates." I believe you can sell the idea of hearing conservation more easily than if you would use the "fear approach" because of impending claim costs.

I have given you a pattern which has been successfully used in establishing hearing measurement facilities in small communities. The reason why I believe it works is because of the age-old principle that when people thoroughly understand a new development and are active participants who share in the responsibility for carrying out its objectives, the program cannot help but be successful. In several of our very small communities, the leading industry purchased an audiometer and gave it to the hospital so it could be used by all of the doctors for the benefit of all the people.

Ear Protection Programs

The heart of the problem is "How to get the ear protection on the man!" In the early days most of us were quite discouraged about this and many of us gave up, but I believe we can now take a more optimistic attitude. Each day I hear of more instances where 100 per cent programs are in effect. The recent research of the AAOO and from some of the larger industries, such as Allis Chalmers in Milwaukee, have proved that ear protection devices work. We now know that a man who faithfully wears them is practically guaranteed against further loss through noise exposure. The average ear plug attenuates and reduces noise from 20 to

30 decibels, which reduces the most dangerous noise levels to a safe exposure. We also know that the wearing of plugs does not interfere with signals or oral communications—in fact, it improves them.

Where we have failed in the past is that we have let ourselves be talked out of it by the men themselves. We must propagandize the use of ear protective devices with the same vigor and energy that we have used with eye protection and safety shoes.

Many plants I have visited have 100 per cent ear protection because they have carried on vigorous long-range education programs. Some plants have gone so far as to have compulsory programs with the features drawn up in their labor contracts. I suppose the difficulty is probably due to the fact that this program is new among workers and anything new must be interpreted and reinterpreted.

I think I have a good analogy. Last October in the exhibition hall of the Safety Congress, I asked an exhibitor who was exhibiting a curtained enclosure for isolating noise at its source in order to protect the other workers in the plant, whether it bothered the operator to be enclosed in this manner. He replied by stating that men now spray in paint booths while a number of years ago they sprayed in the open, and not too many years ago men welded in the open while they now do their work in enclosures. He felt that, likewise, men in noisy jobs would have to learn to work in isolation in order to protect the other employees from harmful noise.

We can learn something from this. The world is changing. New things come and we have to adapt ourselves to them. I doubt if anyone came to this convention riding a bicycle.

Probably the person best prepared to supervise ear protection programs is the nurse or first-aid man. This person might discuss ear protection at safety meetings and show the different types. One such plant had a meeting and the nurse suggested that six men try different types of ear protective devices and report back at the next meeting, which they did. It was reported that speech and warning signals could be heard easily with protection. One man who worked in a 100 decibel noise level area said that when he got home after wearing

ear protection he could enjoy his television set much more because the ringing in his ears was gone. These are techniques which help us sell programs.

Some industries have learned that it helps to have a variety of ear protection equipment rather than to push one single type. The person in charge of the program says, "Try this one and come back in a week and tell me how it works. We have other kinds and we can try until you have a good fitting." If we have a choice, it makes the proposition that much more attractive.

Posters also aid in the educational campaign, but we must not be discouraged, and we must keep whittling away until each man is using the proper ear protection. In conclusion, here are some pointers to help us:

1. Ear protection is a long-range educational program enhanced by posters, demonstrations and explanations at safety meetings. It is a selling job best taken care of by the doctor, nurse or first-aid man trained in the fitting and handling of ear protection devices.

2. All devices seem to show about the same coefficient of reduction but they work better in the high frequency noise levels than the low ones. The fit of the device is important. Lubrication promotes the efficiency of all types. If they are not too comfortable, they may not be doing their job. Some temporary discomfort must be expected if protection is the goal. You have probably heard that safety shoes and glasses are also a source of discomfort. Don't be talked out of it.

3. Give the man a choice of an ear protection device and keep a string on him until he finds something that works. It is a well-known fact that even individual ear canals differ in size. A small device may be well suited to the left ear, but a medium one may be indicated for the right ear. Obtain a case displaying all of the plugs you can get. Let the man see the different kinds.

4. Wear different types of protection yourself and carry on a personal research project. How can you honestly and convincingly tell a man about the comfort and helpfulness of ear devices unless you can say, "I have worn this kind myself." Give the man some suggestions based on your own personal experiences.

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5. The safety engineer and nurse must shoulder this responsibility for the job or it will not get done. Ear protection devices have been developed for every noisy job, and until we can reduce or abate the noise at its source, our first and primary job without question, we shall continue to find new

ways to get them on the men who benefit from using them.

Finally, I believe that we are successfully expanding the hearing conservation program in our plants, and we can look happily toward the future because we are beginning to get encouraging results.

Off-the-Job Safety — An Important Field for Management

Do It Yourself—But Do It Safely

By THOMAS J. BERK

Safety Consultant, Metropolitan Life Insurance Co., New York, N. Y.

All day long, week after week, the man or woman in the plant or in the office goes about his regular job, whether it is to produce or to solve problems. He does it with great dispatch, through education and experience.

In evenings and on weekends, however, you are likely to find this same man has swapped his white collar or jumper for rolled-up sleeves. In his hand is a hammer, chisel or paint brush. He is deeply engrossed in painting, or building, or repairing something about the house.

This is the modern-day trend of do-it-yourself. We find more and more people turning their hands to making, repairing or re-doing something around the house, themselves.

What disrupts this healthy picture of domestic tranquility? The fact that about 650,000 persons in the United States annually suffer disabling injuries while doing their own home repair work and fixing. Most of these victims are found among families residing in single or private dwellings. These families account for about 63 per cent of the total population, yet suffer 90 per cent of all home accidents.

What lies behind this great movement? It may be the lack of skilled or competent mechanics or tradespeople; the economic problems of having to employ someone else to do something on an employee's income; the old axiom of, if you want something done, do-it-yourself. Or it might be a throw-back to our forefathers who had to do everything for themselves!

The fact remains that in any suburb, any weekend, the man of the house is apt to turn into his own handyman. He is painting a porch, painting a pipe or, in many cases,

building his own home from foundation to roof top. He's a member of a family that, while it *has* some money, wants to *save* some. For this reason, he has decided to "do-it-himself."

If you ask the man of the house why he does it himself, chances are he will say, "It costs too much to get someone else to do it." Even though his own paycheck may be bigger than it used to be, by the time he has taken care of his family and paid his taxes, he hasn't much left to meet the high cost of services.

Population growths, the trend toward owning your own home, and living in the suburbs are all part of this ever-growing pattern of do-it-yourself. It is the rare person who owns a home and doesn't want to tinker with something in it. The shorter work week, with more free time, allows additional opportunity to do-it-yourself.

Manufacturers have realized this trend and have provided equipment ideally designed for the home workshop. For instance, more painting is done by the home owner now than ever before, and paint manufacturers have lent a willing hand by developing new kinds of paints and applicators. The owner doesn't have time to learn the skills of the professional, and these products are made easy to use. But unfamiliarity with the hazards and toxicity of some paints has often led to permanent injury and even death—sometimes to the do-it-yourselfer, sometimes to other innocent persons, or children.

In many instances, the "roller-coater," for applying paint has taken the place of paint brush, and the open pan has taken the place of the paint can which could be conveniently covered when not in immediate

use. The oil- and lead-mixture paint has been complimented with water color and synthetic rubber base products, and these paints have all been aimed directly at the home owner.

Yet, despite the fact that, through education, we have tried to warn people about the tragic results that have occurred to babies or children who have chewed on furniture or woodwork painted with lead paint, we still find them painting children's furniture, window ledges, and so forth, with lead base paint. The Paint Manufacturers' Association and the American Standards Association have been extremely cooperative in this educational program. Some cities have passed laws requiring paint containing lead to be adequately marked to call attention to the hazard.

The trend to home carpentry is growing. Anyone can use a hammer to drive a nail, or a saw to cut a piece of wood. But even the simple operation of sandpapering can be dangerous. My questions are: Can they do it without injuring themselves or someone else? Will it be necessary to replace the object they are attempting to fix? Will they have to call in a tradesman to replace the whole floor or wall they have tried to repair? Will they have to throw out the chair or table they have tried to fix before they cause an injury?

In industry, we call these non-personal injuries, or property damage. They are occurrences that good management will not tolerate, that many households cannot afford. So, there is a lot more than just words to the phrase, "*do-it-yourself, but do it safely.*"

I recently read of a case where a father was cutting a piece of wood with a portable electric saw without a guard. As he pulled the saw through the wood to his side, his 27-month old child came up from behind him, right into the revolving blade. The youngster was so severely cut about the head and face that he died.

Another man drew a similar portable saw back so that it put a seven-inch cut in his thigh, severing an artery and resulting in death.

As I read about these two terrible things, I could not help but think: what kind of a safety program existed where these two men were employed? Was the absence of a saw guard on the home tool evidence that there were no guards on power equipment

on the job? Was the safety education and training on their jobs, whether in a plant or office, so lax that the men were not aware of the dangerous condition they create when a guard is not provided and kept in place? Certainly, our safety education program should be aimed at creating in the employee such safety-mindedness that he will automatically do things in a safe way, whether it be driving, walking or doing something around the house.

Maybe it is high time we review our own safety programs. Maybe we should review our own consciences, too, to determine whether we have the courage of our convictions to make "safety" so worthwhile to our employees that safety education will have a lasting effect. What we need is courage—courage to know we are right in trying to stop accidents, courage to know we must do something about stopping off-the-job accidents. If it is courage that prompts a man to stand up and live by his religious beliefs, then we as safety men and women will have to become religious about our Crusade for Safety.

In industry, we employ experts to purchase our materials. The same care should be used in selecting the material we are to work with at home. The selection of "good" wood is all important when planning a carpentry job. Plywood manufacturers have kept up with the times with a product that is cheap, versatile and workably safe. At one time, you could get plywood only in a standard size, four by eight feet. But this size was too big, too awkward for the home owner, and too often, in trying to handle it or cut it, there was an accident. Now you can get plywood in small sizes known as "handy panels."

Other types of lumber have been used in greater quantities by the army of do-it-yourselfers who are now doing the "big" job themselves. You find them replacing floors, beams and studs, erecting complete homes. Obviously, this kind of endeavor requires some knowledge of how it can be done properly and safely. Hundreds of do-it-yourself books, kits and plans are offered, not only for homes but for boats, furniture, sheds, and so forth.

One of the first things the man of the house wants when a home is purchased is a work bench. But how many know how to build a safe, adequate work bench? How

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many are aware that there are, in existence, patterns designed to help him build his home work bench? The McCall's Corporation, well-known for their dress patterns, now have patterns for wood and metal objects, including a work bench. The pattern is ironed on to the wood, and all the home owner has to do is follow the outline and make himself an ideal bench. Patterns throughout the years have been the backbone of industry. Today, they can serve as a help to do-it-yourself, but do it safely—and, we might add, a help towards *doing it well*.

The professionals who put linoleum on floors or paper on walls are seldom called in to do their work today. Now, the man or woman of the house does it. New types of materials and easier methods have shown home owners they can do the job themselves. However, manufacturers again were alert and made available convenient, easy-to-handle products, such as tile floor coverings of linoleum, cork, rubber, plastic and asphalt. This has eliminated the need for a lot of tools and a great deal of skill and patience required to put into place the large-sized product formerly used. But again we run into the hazards of the lay person doing a professional job—unsafe use of tools, improper layout of the job, and lack of knowledge of hazards of products involved, particularly the flammability and toxicity of some of the solvents contained in the mastic.

We laugh at cartoons showing rolls of wallpaper and pots of glue sitting on the head of someone who has fallen while putting up wallpaper, or the innocent helper who has had this stuff thrown at him. However, we must not lose sight of the fact that a fall from a ladder or other structure at home can result in as painful an injury as one on the job.

The do-it-yourselfer has a new and highly-skilled servant to do the work of professional hired hands—the power tool. It is a blessing, yet it can be, when improperly used, a great hazard. I do not mean only the hand electric or pneumatic tool, but many types of machines now used to do heavy work around the house—the power lawn-mower, the washing, drying and ironing machines, woodworking tools and others.

These man-made devices have been offered to us as conveniences, means by which we can do things easier, quicker and more

efficiently. But should the use of these equipments result in a personal injury, the unit cost of such an operation is too expensive. If the use of modern-day do-it-yourself equipment causes accidents, the only way out is to go back to the old fashioned way of doing things. Many *much more dangerous* machines are being operated in a safe manner without personal injuries every day and night in our factories.

Perhaps we are prone to leave our safety learning behind us when we leave the plant or office. We just seem to forget the simple, basic precautions, such as properly positioning ourselves to do the job, proper placing of tools, being sure everyone is out of the way before starting or using a machine, the hazards about the point of operation. These simple but ever-important requirements for the control of accidents seem to be readily forgotten when we do a job at home.

Yes, even the simple but strictly-enforced safety rule of "grounding" all electrical equipment is ignored. And yet, the working conditions in our homes are seldom as good as those on the job. The wet cellar floor around the ungrounded washing machine makes a "perfect" setup for a shock.

The dampness of the cellar makes it much easier for electrical currents to stray from a power tool that is not grounded, sending them through our body to give us a shocking awakening—or deadening. The low voltage service in a household is often looked upon with disdain by workers who operate poly-phase equipment. They forget that, under certain circumstances, these low voltages can be as fatal as the higher voltages.

Some manufacturers of portable electric tools have taken steps to help users of their equipment escape shock. On each tool of Black and Decker there is attached a tag giving special instructions for grounding the tool. The tag is affixed to an adaptor which permits the use of the three-prong grounding-type plug in a standard convenience outlet. In addition to the instructions on the tag written in English and foreign languages, one page of the instruction manual is devoted to the importance of grounding portable electric tools.

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of family life not nearly as organized as it might be. On the job, it is quite different. What we find there is an environment controlled by safety regulations that have been set up by law and by the employer and usually with the employee's cooperation and approval.

Metropolitan's Do-It-Yourself Program

Many of us enjoy hobbies and, realizing this fact, Metropolitan is holding a series of hobby shows for the 15,000 employees in our home office. Planning for this show, we were surprised to learn the many ways in which our people enjoy their leisure hours! About 10 per cent returned a form sent to them. These reports indicated many of them had interests in such things as graphic arts, handicrafts, mechanical and technical pursuits, sports, home and 109 other hobbies.

Some of the leading interests were those that came under the general category of do-it-yourself. As you might expect, we were interested in making sure employees who were engaged in do-it-yourself activities were doing them in a safe way. Accordingly, an exhibit was planned for a week's time, during which seven categories of do-it-yourself were displayed. These categories include carpentry, electrical, alteration and mending, painting and paper hanging, plumbing, slip covers and drapes, and wood finishing.

As in all home office activities, the safety bureau is invited to advise regarding safe conditions and safe practices. During the development of plans for the show, I asked that those doing the demonstrations should use only safe and proper tools, equipment and materials; maintain their booths in a safe manner; and, while demonstrating, to point out during their talk that what they were doing was being done in a particular manner to avoid the possibility of injury.

At each of the booths, qualified men and women demonstrated how to do a job. We prepared for each one of them a list of precautions to be followed, and we stressed how important it was for them to point out safety measures taken while they were doing the job.

In the manual industries, such as carpentry, painting, paper hanging, plumbing, and so forth, stress was placed on knowing what tools, materials and equipment were

required to do the proper job. Those participating in the carpentry exhibit and demonstration were told about grades and uses of different types of wood, how to use sandpaper, equipment available for the safe application of same, the proper use of hammer and chisel, and so forth. They were shown the importance of having sharp tools that were set properly, and advised how they could tell when a tool needed to be re-set. The demonstrators also advised how various carpentry problems could be handled and took a more common type of job, such as repairing a chair, as an example.

Supplementing the booths used to demonstrate the seven fields of do-it-yourself work were other exhibits, including available pamphlets on the various fields of do-it-yourself; an adult education booth which listed the names and locations of local schools sponsoring adult education courses in the area; films on how to do-it-yourself, and so forth. The safety bureau also had an exhibit booth. Our demonstrator discussed unsafe handling of tools and equipment from a general aspect.

We had on display examples of unsafe tools and equipment that should be discarded from the home. This included a ladder with a broken side held together by string; cold chisels and hammers with mushroom heads. Danger points were targeted by red spots. From each was a ribbon extending to a safety message. We also had safety posters on display and arranged to have posters carrying a specific message placed in all other booths.

We had about 9,300 visitors to the hobby show. In order to help the demonstrators bring in as part of their talks the safe practices followed in their work, a list of safety recommendations was developed for each booth. For example, the recommendations sent to those demonstrating painting were as follows:

It is suggested that while demonstrating your hobby, you call attention to the safety aspects of the technique you are using. Here are some of the things you may wish to keep in mind by cautioning your listeners to:

Be sure of adequate ventilation of room before starting to paint.

Be sure ladder is safe, no broken steps or side rails, no rough edges.

Safety feet on straight ladders, proper angle while using straight ladder, proper location of ladder to avoid over-reaching.

Wear safe clothing, no loose sleeves, low heels.

Prevent fire or explosion by disposing of cloths into covered metal containers.

Use a safe can for solvents (call attention to the fact that open cans containing solvents for cleaning brushes, and so forth, are dangerous. They should be covered when not in use.)

Use only safe solvents.

Avoid using paints that contain more than one per cent lead on furniture, toys or trimmings in house where it is possible for children to chew on same.

Use proper techniques in pouring solvents (see page 25 of the booklet *How to Do It Safely*).

We were able to obtain from the Home Insurance Company a supply of their fine booklet, *How to Do It Safely*. These were distributed to any interested during the hobby show. In sending our recommendation to the demonstrators, we sent along a copy of this booklet and called their attention to the pages on which items of their hobbies were discussed.

One of the other items that was stressed during the demonstrations was the fact that home repairs could be properly made by the home owner up to a certain point, after which it was required by local ordinances to have licensed people do the work. This was particularly true in plumbing and electrical work. In the plumbing area, we stressed particularly that special care was to be exercised when handling or using caustics, impressing upon our people the importance of following instructions given by manufacturers.

Safe practices and safe conditions were woven into the discussions given by the electrical demonstrators, who were quite careful in making sure that no unauthorized repairs or installations were made or discussed. They felt that certain things of

importance were necessary to be understood by home owners. For example, they went into the following areas:

Chart meter—fuse box. They showed how the meter should be read. They explained the fire hazard and the purpose of the fuse in the line and stressed that a fuse of not greater capacity than the line should be used.

Only the positive approach was used in the demonstrations. The use of a penny in place of a fuse was not explained or demonstrated. Instead, the importance of proper replacing of the fuse was stressed, and demonstrated, including the actual pull of the switch, removal and replacing of the fuse and the closing of the switch.

The basic fundamentals of electricity were discussed. The gauge of wire was compared to the size of water pipes; it was felt that, in this way, more people would understand it. In discussing the size of wires, the audience was reminded of the purpose of the fuse. We also had a demonstration of how watts were measured. This was followed by the charting of a typical home circuit. In this explanation of the load on the wiring system, the amount of the watts input was shown by various sizes of pictures of appliances. For example, a small picture of the refrigerator and television set was shown; whereas, a toaster and an iron were shown enlarged.

These were two of the do-it-yourself areas covered. We also discussed carpentry and wood finishing, alteration and mending, paper hanging and slip covering and drapes. For each of these, a set of precautions was prepared which the demonstrators used.

Home owners can do-it-themselves without getting hurt or injuring others. There are many valuable aids available to assist in the easy, best and safe ways to do-it-yourself. The subject of do-it-yourself safety is the kind of thing that your workers will accept. They will welcome ideas and suggestions from you that will make their home work safer.

Fact Finding—Off-the-Job Accidents

By ROBERT H. ALBISSER

Safety Mgr., Chemical Div., Merck & Co., Inc., Rahway, N. J.

I have appreciated the seriousness of off-the-job injuries for some years, but I was never truly aware of the full significance of off-the-job safety until we began gathering data at Merck. Other speakers on this program have and will tell you of the manifold advantages of an off-the-job safety program. I have been asked to discuss the fact-finding aspects of the problem.

I'm going to confine my remarks to two things: one is *the need for factual information on the non-occupational injuries experienced by our workers*. The other is to *explain a method that has been successfully used and to convince you that the gathering of off-the-job statistical information can be easily accomplished*.

Before mentioning statistics, forms and procedures, let us briefly review our needs. We know that our employees in fairly good numbers suffer off-the-job injuries. We know that these involve a great deal of needless suffering and economic loss. However, many of us don't realize just how much these accidents are costing our employers in dollars. Perhaps of even greater significance is the indirect cost of non-occupational injuries. Whether an employee's services are lost due to an on-the-job or off-the-job accident, the result is the same. We lose the services of a skilled worker.

Another question often asked is: Why gather information on accidents we can't do anything about? We haven't any control over what our employees do after they leave the plant.

In a sense, this is true, but we must not lose sight of the fact that accidents involve people, and people do not want to be injured, in spite of the fact that some people really go far out of their way to become an accident statistic. We may not be able to tell people what to do while they are away from the plant, but we can tell them and keep telling them of dangerous practices that cause many accidents. Maintaining a constant awareness of accidents, especially those involving people our employees know, is bound to have a favorable effect.

Safety engineers know that we can't prevent all accidents. We are just not that smart. But we do know we can prevent many of them, and the occupational injury statistics prove it. Suppose we cut off-the-job accidents by only 10 per cent. You'll agree that is not being over-optimistic, when industrial injury frequencies have been reduced upwards of 90 per cent by a good safety program.

If your ratio of off-the-job injuries is about the same as that of the few companies I know who have kept records, a 10 per cent reduction of off-the-job accidents is practically the equivalent of having no occupational injuries. For off-the-job disabling injuries are just about 10 times more numerous as on-the-job injuries!

In our chemical division for the first nine months of this year, some 5,000 employees have had 104 off-the-job injuries. During the same period, these people have had 11 work injuries. DuPont's off-the-job frequency for the first seven months of 1955 is running over 10 times their occupational rate.

So far, we have been dealing with a few general reasons for gathering statistical information. Fundamentally, we need the information for the same basic reasons we compile statistics on occupational accidents. We want to know the size of the problem in number of people involved, days lost and cost. More important, we want to know what types of accidents are involved. If 90 per cent of our people are injured in auto accidents, we don't need to spend practically all of our efforts on promoting home safety. Let's concentrate where the needs are greatest.

Finally, we need statistical information to measure results to guide our activities and, to put it bluntly, to help justify our efforts.

Contrary to what you may be thinking at this point, the gathering of off-the-job statistical information is a relatively simple job, and it is not time-consuming. It's essentially a three-step operation which involves establishing a procedure for obtaining the

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basic information from the employees, assembling it in a summary report and disseminating the information.

Obtaining the basic information can be done in a number of ways. Many plants require employees to clear through the dispensary before returning to work after a sick leave or unexplained absence. This is almost essential in some states which have compulsory disability insurance. If you have such a procedure, all you have to do is enlist your medical department's cooperation. The doctor or nurse merely checks off the cause of an off-the-job injury and notes the number of days lost on a summary form. This form can be sent to you weekly or monthly or for any convenient period. I like this plan best, but there are methods which may be more satisfactory for your purposes.

You may ask supervisors to note off-the-job injury absences on time sheets. Then request the payroll department to forward the information to you. Perhaps it may be easier to have supervisors relay the information to you directly on a separate form. Often your benefits manager, who administers the medical-surgical, hospitalization and sick benefit plans can supply you with the basic information.

I'll explain sample forms and the breakdown of the information later. However, you will note that I haven't mentioned names, departments, dates, nature of injuries or the usual items found on the average occupational injury report. I don't believe we should complicate this business unnecessarily. There's no use gathering a lot of information you don't know how to use. I'm glad to report that the people I know who are gathering off-the-job statistics are in full agreement with me on this point—keep it simple.

Summary reports can vary from a fine printed bulletin to a mimeographed memo. The information can be included in existing routine safety publications or house organs. The present practice is to issue monthly reports showing the number of disabling injuries for the current month, year to date as compared to the previous year, days lost, and the causes.

One of the principal values of off-the-job injury information is in creating an awareness to the problem. Therefore, we should make every effort to have the data reach as

many people as possible. Keeping the information on file for future reference won't do much good. It is also nice to know how you compare with the other fellow, so we should cooperate with those compiling industry and national off-the-job statistics. The Manufacturing Chemists' Association is about to start releasing the off-the-job injury experience of its cooperating member companies. The Council is also in the process of developing reporting forms and procedures.

The determination of off-the-job injury rates may be somewhat of a mystery to you. M.C.A. reporting companies are arriving at the exposure hours per month by multiplying the number of employees by 312. The 312 is arrived at by subtracting from the number of hours in a week (168) the normal sleeping hours—56 and normal working hours—40, which leaves a balance of 72. Multiplying 72 by 4½ weeks equals 312, the monthly off-the-job hours per employee. Admittedly, this is not an approved A.S.A. standard method, but if, later, a different figure is adopted, you can always adjust your figures accordingly.

As for the off-the-job severity rate, that poses somewhat of a problem. I recommend that you forget it for the present and merely publicize actual days lost. Estimating the degree of permanent partial injuries which occur off-the-job is rather difficult. It is also doubtful that if it were possible to evaluate these injuries and include time charges based on A.S.A. Z16 Standard, the severity rate would be significant.

Forms that I am familiar with for summarizing off-the-job injuries all have the same agency classifications. You will note that there are three general classifications—Transportation, Home, and Public, which refer to a previously established statistical breakdown used by the National Safety Council.

DuPont has been using this form for several years. It has been adopted by M.C.A. The National Safety Council's Off-the-Job Committee is considering its adoption. My guess is that most people like it, since no one, to my knowledge, has come up with a radically different form.

Off-the-job safety is tremendously important, and it is our responsibility to do something about it. At least, there is no logical

reason why we can't complete the first step. Finding out the magnitude of our problem and the type of accidents responsible. It is relatively easy to assemble off-the-job statistics. Disseminating these alone should, by creating and maintaining an awareness

of the problem, will begin to bring about a reduction of off-the-job accidents.

The results will be worth many times your efforts, and you will be able to show your employees that your off-the-job safety program is truly worthwhile.

Dividends On the Job from Off-the-Job Safety Programs

By ARTHUR F. TYRA

Safety Div., Union Carbide & Carbon Corp., Cleveland, Ohio

American business, long concerned with the safety of employees at work, is now emphasizing another phase of accident prevention—off-the-job safety. Most of you here today are safety engineers or supervisors. In addition to saving lives, preventing pain and suffering, and the loss of earnings to individuals, your efforts have helped to increase the productive capacity of your plants.

This phase of safety will present a challenge to you, as it has to all of us. It provides an opportunity for you to serve as leaders in the field of human relations that will bring greater security and happiness to American homes.

It is not necessary for me to quote a lot of statistics about the number of lives lost, the people maimed for life, and the general economic waste resulting from off-the-job accidents.

Long holiday weekends that should bring dividends of happiness have returned debits of sadness. It has become a common experience that on the day following a long holiday weekend, plants are uncertain as to the number of employees who will be unable to return to work because of injuries sustained off the job.

"Eleven Children Die in Bus Crash," "Eleven Die as Plane Strikes Houses," "Five Killed on Turnpike," all of these headlines appeared in one city's newspapers on one day. All of the accidents are not on the highways, however. We read about people being killed or injured in the home by falls or fire. We learn of hunting accidents and drownings.

In industry an accident in which five or

more lives are lost is classified as a disaster. It is a credit to our industrial accident prevention work that disasters occur very rarely. However, off-the-job disasters are reported almost weekly.

It is ironical that in America, where we have done so much to improve the standard of living, we have not done more in off-the-job accident prevention so that people may enjoy the benefits of their work. I feel confident, however, that once we are stimulated to take action in off-the-job safety programs, we will reduce the toll of lives that accidents take in our homes, recreation, and on the highways.

Up to the present time, our efforts in accident prevention have been mainly directed to saving a man's life or preventing injuries to his body while he worked. This was done, for example, by placing guards on the equipment he used, and through education. In this phase of accident prevention—off-the-job safety—we are taking a more thorough approach to our safety problems. We are now thinking in terms of the whole man; that is, his family, his friends, his community, his total environment. The family, as a unit, is the most important factor in this new approach to safety. Obtaining the group participation of the family is necessary to make a safety program successful.

I would like to describe briefly some off-the-job safety activities that have been producing dividends in several of our plant areas. I hope that they may help you bring about some new productive ideas.

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eral meeting in the local movie theater. Previously, all employees had been notified by letter and by bulletin board notices, so that a large group was present. Movies were presented and favors were distributed to the children. During the intermission, members of the plant's safety organization explained the need for safe practices in the home and the nature of the new program they had planned.

Sometime after this meeting, letters and an application went out to all employees inviting membership in home safety committees. Each employee-member of a home safety committee was given a certificate which gave him a formal connection with the off-the-job safety group.

After the committees were established, literature on many phases of the safety problem was distributed at regular intervals. This information went not only to members but to all employees. Much of this material was obtained free from the National Safety Council, insurance companies, automobile associations, government agencies, and industrial firms.

Once a committee was in existence, it was possible to conduct surveys to determine the most frequent causes of accidents and to work out a plan to emphasize these hazards. Forms were available for reporting home accidents. Monthly schedules of projects were prepared. For example, in June and July, vacation accidents were discussed; in October, rules for fire prevention were included; and in December, Christmas and New Years accident problems were given attention, both for the home and on the highway.

Many plant safety personnel frequently go outside their immediate area of responsibility to organize school driving clubs and to teach first aid to girl and boy scouts. First aid equipment and movies are being made available through the plants. Some of the schools have bought their own equipment and are continuing the program. Plant safety supervisors have been called on to inspect school workshops, for the purpose of recommending correct equipment guarding, also to assist in establishing safe practices for students.

Much of the time spent by the safety representatives was after-hours and connected with other community activities like parent-teachers' associations, civic clubs, and other

organizations who welcomed informative talks on safety. Some of these groups are now conducting their own safety programs.

One plant arranged an elaborate display of safety equipment available in the plant and invited the townspeople in to look at it. Safety consciousness was brought about, and many wives went home more aware of the need for home safety.

Safety demonstrations are frequently made a part of plant outings. On one picnic, a panel of four persons was formed with the job of guessing the hazards represented by another employee. Such games, even when lighthearted, tend to make spectators remember the causes of accidents.

In one case, on a television program, members of a little league baseball team were interviewed and asked questions on safe recreation—how they made ball playing, for example, less dangerous by wearing plastic cap liners. The plant safety director figured that a lot of young TV fans would learn that safety is not a sissy's business.

Essay contests on safety were sponsored by several plants and a great deal of interest was developed. Prizes, such as bicycles, were awarded to the winners.

Employee publications have been found to be a good way to get safety information across to employees. One plant magazine recently ran an article with pictures, that told the things a wife can do to help prevent accidents. Some of these are: help the husband get sufficient rest, help maintain a serene family life, try to understand the husband's financial problems, maintain good family health, observe safe practices in the home, and eliminate worry over personal health. Such articles when well-thought-out can do a good job for any off-the-job program.

I have only mentioned a few examples of methods used by some plants to encourage safety off the job. As part of the program, the corporation focussed public attention on safety through institutional and plant-community advertising. Numerous others could be talked about, but perhaps these will give you an indication of the type of approach we are making.

The effect that an off-the-job safety program has on plant accident experience is an interesting study. The accident experience of four plants, from 1950 through 1954,

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showed a marked reduction in both frequency and severity rates of accidents on the job after 1952, when the off-the-job programs became really effective. We do not attribute all the improvement to off-the-job programs, but we do feel that they have contributed a great deal.

The absentee rate over a period of five years from one of our plants with a well organized off-the-job safety program showed a marked overall decrease starting in 1954.

The extent of these activities and the area covered is best illustrated by the following items from an annual report from one of our plants. "We concluded 138 safety programs consisting of safety films and talks. Ninety-five of these were held in schools with an attendance of 14,329 students. Forty-three were held with civic groups with an attendance of 2,110 adults . . . concluded six radio programs and a television program dealing with home and off-the-job safety . . . our visits included tours in six counties adjoining our plant."

Let us now, more specifically, attempt to list some dividends on the job from off-the-job safety programs. In safety work we think of dividends in terms of human values, benefits from our efforts, rather than in financial returns. However, we must realize that our industrial system is built on financial returns, profits. As individuals, we can improve our way of living only through the successful operation of our industries. The following is a list of some of the immediate benefits of an off-the-job safety program:

1. It creates good employee relations and improves the morale of the working force.
 - (a) Improves attitude of employee on the job because he is released from worry due to injuries to self or family.
2. It produces a stable working force.
 - (a) Reduces labor turnover.
 - (b) Reduces absenteeism.
 - (c) Employee maintains high earning power.
3. It prevents loss of employee through death or total disability.
 - (a) Reduces overtime cost of replacement for an injured employee.
4. It creates good public relations.
 - (a) Better selection of applicants, people

who want to work in a safe organization.

5. It creates less plant problems by:
 - (a) Reducing cost of rehabilitation.
 - (b) Reducing work in auxiliary departments such as employment, medical, and training departments. Reduction of work in medical departments permits staff to do more preventive medical work.
 - (c) Preventing loss of production due to idle machines when employee is absent.
 - (d) Reduces on-the-job accidents and damage to equipment as employee becomes more safety conscious.

Probably the greatest dividend is the development of safety consciousness in our children, for they are the future employees and leaders in industry. In preventing one child's death, we have prevented needless family unhappiness. We may also have saved an Alexander Graham Bell, an Edison, or an Einstein for our country.

From this list of dividends accruing from an off-the-job safety program, it is apparent that the employee, employer and the community all benefit from these safety activities.

Up to the present time there has been some hesitancy by industry in taking the lead in off-the-job safety programs because:

1. Safety supervisors feel they do not have sufficient time to devote to these programs in addition to their plant safety work.
2. Cost and time spent on these programs are thought to be excessive.
3. Industry has been hesitant to enter into any program that might be considered paternalistic.

There may have been some basis for these attitudes in the past, but our experience in five years of off-the-job safety programs indicates that these reasons or fears are not sufficient to preclude off-the-job safety programs in industry.

We believe that a safety supervisor can include an off-the-job safety program with his plant activities, if he plans his work and is willing to put a little additional effort into his job. We feel that this activity is part of his community and civic responsibility.

In our experience, the cost of an off-the-job safety program is really insignificant. There are many agencies that furnish materials and services at little or no cost. The time spent on off-the-job safety need not be great for any one person, since there are many people, agencies, associations, and civic groups that will help carry on the program. The National Safety Council has considerable material available for these programs and is ready, willing and anxious

to give assistance in promoting this phase of safety.

In 28 years in industrial relations work, I have yet to know an employee, his wife or his family, who objected to anything being done to further personal well-being, providing it was done sincerely. I am sure that industry, with its tremendous reservoir of talent and experience in accident-prevention work, will be commended for taking the lead in this humanitarian program.

Offices Have Accidents, Too

Offices Have Accidents, Too

By WILLIAM C. BARBER

Asst. Vice-Pres., Asst. Dir.—Engineering, Michigan Mutual Liability Co.,
Detroit, Mich.

The idea of safety in offices is really not such a new thing. People in offices are just as susceptible to accidents as other individuals in more hazardous jobs. Maybe you think safety is all big things like new fire escapes, guards on equipment, sturdy furniture. It doesn't have to be. It could be the dozens of little things we do every moment without much thought—even throwing things in the waste basket. Nothing is so small or so insignificant that it can't have serious, far-reaching consequences.

If people hurt themselves in the office by slipping on a paper clip, they feel it just as much as a fellow who falls because of a spot of oil on the floor. They can lose just as much time and money, and you have to bear the same amount of indirect cost.

Have any of your girls ever slammed her finger in the desk drawer? Before the echoes of her howl drifted away, I'll bet you saw Mary and Jane whizzing by to see just what had happened to Betty. Already, the accident has cost you money. Betty's smashed finger is hurting so badly that she is preparing to go home. Mary and Jane are still offering sympathy. Their production is affected for the remainder of the day.

And you are very well aware that when Betty returns to the office tomorrow, she will be worth only about half her normal wages, but you must continue paying her in full. Meanwhile, the overhead still continues—lights, heat and rent must still be paid, even though Betty is not producing.

I realize that this is a far-fetched example of indirect cost. We all know that injured workers are actually the heaviest losers. They and their families must bear the physical pain and suffering that accompanies every injury. And even though, dollar for dollar, their losses may be less, show me the employee that can afford the financial burden of injury.

Well, then, how can we keep our office people from getting hurt? How can we get our office people to work safely? What is office safety?

It is only natural for beginners in any phase of safety to look for an ideal program or pattern, some sure-fired way of selling this thing—and it is only natural to be disappointed when they find that the plan that brought safety into Joe Duke's group landed like a lead balloon with their own crowd.

If you were handed an assignment, for instance, a booklet describing employment opportunities in your company, would you call up a neighboring firm and ask for, and reproduce, a booklet they had been using? No, you wouldn't. You would look into their material, true, but you would give it a great deal of thought. You would determine just what you wanted to cover. You would take into consideration the individuals you were appealing to, those who would be using the booklet. Any number of things would be carefully thought out and planned. A safety program should be like that—something carefully thought out and planned.

Before we give any further thought to a plan in our office safety program, let's take a look at what constitutes a whole, sound safety program.

Three things should be considered: safe working conditions, safe environment, and, most important, management.

Here you have safe environment, safe working conditions and safe practices all based on the foundation of a safety-minded management, from the top down.

Thus we know a safety program depends almost entirely on you as supervisors. If you really want a good safety performance, you can have it.

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found a conscientiously safe working group. Every supervisor should be a safety supervisor.

Any person who values his job will try hardest to accomplish whatever it is that his boss wants most. If the boss is sold on safety and makes it clear that is what he wants, his people will try their darndest to give it to him. And they will keep on giving it to him as long as he wants it. They must feel with the boss that safety is a vital part of the job. Your people know when you are sincere and when you are just giving a matter of "lip service."

Safety isn't something tangible that you can haul out and set on your desk. Your people can't see you touch it, can they? But they can see you. They can hear you. They can feel your sincerity, your belief. If you are enthusiastic about safety and show it, it is contagious. You don't have to build-up safety. It doesn't need exaggeration claims. Just tell the truth.

Don't think you are the only player on this team. Everyone must carry a share of safety responsibility.

How much more effective it would be if a supervisor would study and analyze ways for creating in his employees the desire to work safely, the desire to eliminate unsafe practices! Every employee must be made to feel that he or she personally is necessary for any plan of safety or production to succeed. There is a need for high morale. Why do some of us fail to get it?

Could it be that, too often, we criticize severely and fail to build up a desire for improvement? You know how you appreciate a pat on the back. Try showing your approval when your people are doing a job in an outstandingly safe manner. You'll accomplish a lot more that way than if you wait until you have an accident and then go about raving about unsafe methods.

When you receive an accident report do you just note your initials, or do you analyze the report carefully? Do you find that often the reason shown in the report isn't a true cause? Perhaps the employee was worried about his little son, who is critically ill; or furious because someone banged a fender of his new car; or all excited over his new fishing equipment. A smart supervisor observes his people and gets to know

them. He knows that any strong emotion decreases a person's ability to think clearly and act efficiently, making him accident-prone.

I know it is tempting to use the term "carelessness" when analyzing the cause of an accident. You might say the word "carelessness" has grown into an alibi for supervisors. They are unthinkingly placing the blame on the injured worker, who certainly didn't care whether or not he got hurt. It's almost an admission that he, as a supervisor, is making little or no effort to understand and guide the actions of his people.

In getting to know his people, a supervisor will find that some don't stop to think. With them, safety must become mechanical. Safe working habits, such as closing one file drawer before opening another, must become a part of their working pattern. With these people, close, positive training is required. And remember—if the individual hasn't learned, the instructor hasn't taught.

Yours can be a dream of an office—everything accident proof, except the people working there. It's not enough to remove safety hazards. Every person must get into the habit of thinking safely at all times, including you.

Sometimes we need help in keeping safety alive in our groups. An office safety program can do just that. Let's discuss briefly several programs used successfully by organizations with good safety records.

First, we have the safety observation plan. This plan provides for making on-the-job observation of office conditions and unsafe acts of employees, and taking immediate steps to correct them. By correcting hazardous conditions and unsafe acts, you naturally are reducing the number of potential accidents.

We have also seen the safety committee plan in use. This is particularly effective in larger offices. The initial committee must be carefully selected, since they are laying the ground work for subsequent committees. The committee generally consists of three people with one designated as chairman. The supervisor makes himself available to the committee for consultation. Terms for the committee members are adjusted so that as one member leaves, a new member is added each month.

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When a committee of this sort is considered, it might be wise to set forth in writing exactly what they can do, how far they can go, and how they can go about doing it. I find our safety committee quick to observe unsafe conditions and actions and correct the situation. They talk safety to their fellow workers, particularly to the newcomers in our office family. It is surprising to see the live, safety ideas that these committees come up with.

The smaller office groups might be interested in a safety engineering plan. The same general procedure is followed as with safety committees, except that one person is designated as a safety engineer responsible for all safety activities for one month. The office of safety engineer is held on a rotation basis, each individual taking his turn. This has been highly successful because it utilizes the principle of competition.

Some groups prefer the safety meeting plan. They have regular safety meetings. But don't just squeeze safety into scheduled meetings ahead of time. Show the schedule on the bulletin board and list some of the points you will discuss. In that way, you give safety the stature it deserves. If a safety meeting is not a thought-out plan, it is better not to have it. Some groups find that by gearing the next meetings to comment and suggestions brought out in these monthly meetings, their interest is stimulated and held more easily.

Next is the safety inventory. What is a safety inventory? Just that—you are taking inventory of the standing of safety in your office—existing hazards there might be, recommendations as to possible treatment, the way your people feel about the safety program and their suggestions for improvement. Do you know where the fire extinguisher is in your office? Or your first-aid kit? And where is your air-raid shelter? Do you see how including questions such as these could give you a wealth of material to work with in your safety meetings? A word of caution: this can be touchy if it is done too early in the safety program. You might get a flood of recommendations that you just couldn't handle. It might be wiser to reserve this device for use as a check-up. It could be much more effectively used in this way. It *could* be the means of giving a safety program "a shot in the arm."

Let me tell you about the little gimmick that our people really enjoy in our general office. It is called *Pluto*. Pluto is the saddest, most dejected looking rubber dog you have ever seen. He is in a position peculiar to dogs, sitting down. And before him is written, "I was unsafe." If I perform an unsafe act, Pluto is placed on my desk, and there he sits until someone else goofs. Then, real quick-like, I present Pluto to him or her.

Did you know that, by the end of 1955, every employee in our engineering department actually will have received first-aid training? This is not only something they can use on the job, but something they can take home with them. First-aid training is a terrific tool in accident prevention programs. When people realize what can happen to them in an accident, they begin thinking, and then they do a better job of selling.

And how about housekeeping in your offices? Is it just housekeeping, or is it good housekeeping? Cluttered desks and cluttered minds prove a fertile breeding ground for accidents.

Whenever you get an idea on safety, jot it down. Put it in your desk or in one of your pockets. You may throw 90 per cent of your notes away, but I bet you will come up with some good material in the remaining 10 per cent.

Of course, there are posters, booklets, bulletins and any number of safety tools you could use. These are all gimmicks, and they should be treated as such. When their value is worn out, dispose of them. Or put them aside for revival at a much later date. But, for goodness sakes, don't attempt anything and everything at once.

We have been talking about the way people respond and the way they act. It makes you think perhaps safety is a state of mind. And perhaps the best tool might be right up here—between your ears. We could say that safety is a way of life, a happier, more fruitful way of life.

Set an example. Sell yourself on safety, give it some thought, come up with a plan, and you will sell safety to your people. Try to understand their thinking. Guide them in their thinking, and, before you realize it's happening, you will have your people wanting to work safely.

Safety Is a Way of Life

How Do We Get People to Recognize and Accept the Value of Intangibles

How to Sell an Intangible

By MRS. JEAN WADE RINDLAUB

Vice-Pres., Batten, Barton, Durstine & Osborn, Inc., New York, N. Y.;
Member, Board of Dir., National Safety Council, Chicago, Ill.

What is the problem of selling an intangible? What do we live by? What, after all, is a *tangible*?

A tangible—and I hope Mr. Webster won't argue with me—is something you can *see or taste or feel or touch*. What, I ask you, that you can *see or taste or feel or touch* could begin to measure up to the long list of words men *truly* live by?

Does ice cream taste as sweet as *love*? Is a padlock half so strong as *faith*? Is a heated brick as warm as *hope*? Is gold as bright as a baby's *smile*? Is it muscles and veins and tendons you feel in a *handclasp*? Is it lipstick you remember of a *kiss*? Is *work* just a way to fill a day—or *rest* just a way to *waste* a night? Is the head of a pin you see and touch as all-important as the billions of atoms that you *know* are there—although you nor anyone else can see them?

Money is tangible—*honor* intangible—but how often have you known men give up one to gain the other? A job is tangible, character is intangible, but don't you want *both* for your children? The things men live and work by, the values we commit our lives to—these remain in the realm of intangibles.

I don't know why we put it like that. The truth is—and every advertising person worth his salt would admit it—that in our business we sell *tangibles* through *intangibles*.

I spend a lot of my life selling cake. Do we advertise cake as so much flour and shortening, so much energy and nourishment? *Like fun we do*. We *understand* our customer. We know that no woman bakes a cake for herself alone. We know there's a little bit of love in every cake a woman bakes, and we move in on that

intangible to sell a whale of a lot of cake mixes.

I spend the rest of my time selling soup, good soup. What's quicker and easier than to open up a can of soup? But do we stop by saying it's quick and easy? No. We sell intangibles, the roses of good health that soup will put in children's cheeks. We sell *ideas*—soup on the rocks, soup for breakfast, soup shakes. We make something new and exciting of soup—and we sell a lot of it.

These are days when life and jobs are a lot less compartmented than they used to be. The best education is the broad-based education, the one that relates its varied subjects to a total whole. The best man in the job, employers are coming to realize, is the *whole* man—the man who sees his job not just as a cog but in its relation to the whole wheel.

The man who looks upon safety as a way of life, rather than a path to a paycheck, does his whole job better. The man who understands his customers or his company's employees—*your* customers for safety education, the man who sees their life plainly, does a better job of selling them the intangible of safety.

When you start to sell a tangible or an intangible, or to change or develop a point of view, you have to *understand* your customer, and you have to build your project into your customer's picture of the *good life*.

Let's talk for a moment about both of these things. How can you *understand* your customer? Well, for one thing, you can take a reflective look at the fast-changing

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Think, for a moment, about this half century of ours. Think of the life of a boy born in 1900. Could any man have foreseen the changes ahead for that bit of humanity—from the horse and buggy to the car, plane and jet—from slow mail to wireless, telegraph, telephone, the Atlantic cable and radio and television? From 10-day boats to the Queen Mary (just this year, for the first time, more passengers flew the Atlantic than crossed by ship)! From gas lamps to indirect lighting. From sulphur and molasses to sulfathiazole. From palm leaf fans to air conditioning. From coal stoves to electric ranges built in the wall. From coal cellars to home freezers. From lantern slides to Cinerama. From radios with earphones to portables for your purse.

The boy of 1900 lived in a house that had never known an electric stove or washing machine, a dish washer or vacuum cleaner, toaster or electric iron. The country storekeeper who sold his mother cheese cloth for diapers knew nothing of crackers in packages and was only beginning to sell food in cans. He had never seen a soap flake, a detergent or a bug bomb, frozen foods, canned milk or baby food, cake mixes or brown and serve rolls. The department store his rocking horse came from had never sold a radio or a TV, a sun lamp, zipper or wrist watch. A man could buy a suit, but a woman would find it hard to buy a ready-made dress or a permanent wave. Mother got along with no more cosmetics than a little rag she called "My shammy." The old man manned his office minus bookkeeping machines, electric typewriters and ball point pens.

Think on these things. They are steps toward seeing your customer plainly, steps toward understanding the kaleidoscopic world in which he has grown.

Those were the tranquil years of the early 1900's. It wouldn't have been hard to sell safety then. Men lived at a slower pace. A single life, a single illness, a single accident—these things had tremendous importance. Then came the war years, when a single life lost some of its individual significance. And then the mad 20's, when the rush began, and the sad 30's, when one man's troubles seemed very small in the light of all men's trouble. And then the turbulent 40's, when

trouble became, for many people, almost a way of life itself. And the constantly demanding, challenging, stimulating years since the Second World War.

You are talking to men who have seen and shared a great show, men who have proved their capacity to survive such assortments of strikes, shortages and spirals, unrest, unhappiness and uncertainty, earthquake, dust storms and hurricanes, and somehow come through determined to find for themselves a little fun, a piece of peace, a chance to do less worrying, more living.

Am I making this up? No, I'm finding it out. The psychologists are telling us this, and our business these days is knee-deep in psychologists. And there are such solid sources, as the 20th Century Fund's new survey of *America's Needs and Resources*, reporting that today for the first time our people have quit being afraid. They are no longer asking themselves, "Can I earn enough to live at all?" but, "What kind of a life do I wish to lead?"

A social psychologist put that in another way recently. "For the first time," he said, "in any country in the world, the majority of Americans are no longer afraid they will starve." He did not say they will not starve. He just said that they have stopped expecting to. And right up to the present day, that has been the major preoccupation of most of the people in any country—not how do we eat, but do we eat at all—

"Today," says the 20th Century Fund's report, "a man may choose between a mean house with a good motor car and a good house with a poor motor car. He may choose to live in slums with television rather than in a humble but decent house without it. He may decide whether to support churches and schools handsomely and skimp on movies and tobacco. *Each man*," and this is the important fact, "*makes these choices according to his picture of the good life.*"

That is the significant sentence for you. *Is your product—safety—in the good life?* Of course it is! But it won't be unless you find some effective way to put it there.

See your customer plainly. See what has made him what he is today. And see the good life as he wants to live it. Then link safety to the things that matter most to him.

Don't sell intangibles—sell tangibles, the things your customer wants in the good life.

Sell safety as a means to an end—the family fun, the good times, the good living, that can be the lot of the man who gets through the day safely.

The man who is less afraid is not, unhappily for you, a more cautious man. The man who has been around, who has looked trouble in the eye, is not, unfortunately for you, the easiest man to talk out of taking a chance. What can you do to make safety a part of the good life as he sees it?

You can quit putting so much emphasis on the purely personal—the life you save may be your own. You can appeal to your man's deepening sense of awareness that no man is an island. You can encourage him to think of himself as the guardian of his fellowmen. You can build bridges of understanding between men and their machines, management and men. You can help educate your people to know the function of the machine, the end uses of your product, the function of the company in the community.

Are these things safety education? Yes, they are—if they give a man more pride in his work, increases his self-respect, his kinship with the man at the next bench. For safety is more than common sense, more than the instinct of self-preservation—it is a way of life. It is easier for the man who is a heart-and-soul part of his organization, who understands the human needs his company satisfies, who has a sane, well-balanced and good humored relation toward life, his family and his work.

Build men like these, *grow* men like these, and you won't need safety education. That's why I urge you to understand your customers, share their lives, find out their hidden motivations, not only for their part in your personal growth but because they are a part of your responsibility to your customers. As you enlarge your own horizons, as you widen your understanding and deepen your sensitivity, you will bring new perspective, new strength to your immediate job. You will think of safety as a way of life—a way that starts, as so many good things do, at home.

You may want to take part yourself, and encourage your men, to share in little leagues or Big Brothers or boys' clubs, Scouts or other activities that will help you to grow responsible citizens who are capable of caring for their fellowmen. You might find yourself helping your men to widen their horizons by adding an extra skill, an extra body

of knowledge. Anything that makes a man more of a person makes him want to take on a deeper share of neighborly responsibility.

"There are only two things we can leave our children," a mother once said. "We can leave them roots. And we can leave them wings." I think that is a good motto for the man who is selling an intangible. Help people to put down roots—roots of deeper understanding of their company deeper faith in themselves and their fellowmen, a deeper sense of belonging to the community, and you are contributing not only to their safety but to their growth. Help your people to have wings—to read statistics in terms of human values, to understand the greatness and the glory of saving lives, preventing grief, to feel greater confidence and faith in themselves because they have caught this wider vision. You cannot give your people this kind of purpose, this kind of a dream, without first having it yourself.

So the first step in selling your intangible is to feel it deeply yourself, to dedicate yourself to safety as a cause, not a career; to make it a part of your life. Let your customers catch this contagion from you. Have a *positive*, not a *negative* program. Lead from *strength*, not *weakness*. Make no *little* plans.

The more personal, the more emotional, the closer to man's basic wants you can come in selling him safety, the more effective you'll be. What are these basic wants and needs? They are very simple, really. You could write the list yourself.

A man wants a woman, and a woman wants a man. A man and woman want sons and daughters. They all want to be loved and understood, respected and liked. They are hungry, and they want to be fed with a minimum of work and a maximum of satisfaction. They are weary and want to be housed with a minimum of worry and a maximum of comfort. They are busy—they want to be clothed with a minimum of trouble and a maximum of good appearance. They are lonely islands, and they want understanding and things to help them to be understood. They get up in the morning and work hard all day. They go home tired, and there is always something to worry about. Somebody is mad, or sad, or broke, or blue. They have big worries and little worries. And the days and years go by, and things don't work out the way they hoped.

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These are the people you are talking to about safety, your customers. Somewhere, somehow, they are waiting for you to make safety part of the solution of their problems.

I read a question somewhere recently: "Are you part of the problem—or part of the solution?"

You can be part of the solution for your customers' lives. You can fit safety into their picture of the good life. Do it quietly. You don't have to shout. Talk in simple words they can read and understand. Do it help-

fully with a little extra service in every word or line, a little smile, a little fun.

Do it understandingly in a way that makes it very clear that you know they have troubles and you want to help. Do it with ideas—not just words, or pictures—ideas that will make your customers' lives gayer, brighter, simpler or, in some definite fashion, more livable, as well as just simply safe. Speak to your customers in a voice that sounds like you. They'll listen, and you'll feel better for it.

How to Sell Intangibles in Life Insurance

By JOHN O. TODD

Special Agent, The Northwestern Mutual Life Insurance Co.

In the first place, we both sell insurance in a way. You sell people on doing the things that insure them against having the accidents—we sell insurance to provide the financial reimbursement when for some reason your sale fails.

Another point that we have in common is that we both have to sell an idea of pure intangibles. Ideas are elusive but precious things. It has been said that when one man has a dog and he gives it to another man, then when they separate only one man still has a dog. But when one man has an idea which he gives to another man, when they separate there are two men with an idea.

There's another point that we have in common. Did you ever stop to think that almost everything that the consumer buys today he uses today and pays for tomorrow. But in life insurance and in safety you pay first before you can use the product that you buy. That makes it a much more difficult sale because it is easy for people to think in terms of pleasures of the moment and to postpone the memory of paying.

A fourth way in which we are very much in common is that the result of what we do is much more beneficial to the buyer than it is to the seller. If you teach a man how to run a machine properly so that he won't have an accident but he doesn't buy the idea and he has an accident, for you it's a sad day—a failure—for him a much

greater loss. If I try to help somebody to form a program for their financial success through their life insurance that they don't buy, then the man who has his disaster and didn't buy means a small loss for me, but he may lose his business. So the first key to intangible sales is the belief on the part of the seller and the ability to convey that belief to the buyer, but the buyer's interest comes first.

Perhaps there's no better example of how this has been done than in the field of medicine. The doctor to be successful must sell or persuade you with his patience to take some severe medicine even to the point of a dangerous operation. Do you think for one moment that he could succeed in that sale if it were not for the fact that you believed that he recommends it in your best interest rather than malign his own thoughts. The medical profession has not always had that acceptance but by virtue of the fact that the vast majority of men who are practicing medicine practice in that way, today the vast majority of doctors are accepted on that basis.

My job, it seems to me, is to make men think, to help men to think about their problems, to discover what their problems are so that they can find solutions for them. And if I can do that, I can construct the right kind of a sale.

I have long been a believer that the best way to accomplish a sale of an intangible

is to follow the adage of Ben Franklin who said, "Men are best convinced by reasons which they themselves discover."

I should like to give you an example of what I mean out of my own experience by asking you to think through with me your own situation to the solution of financial success. Imagine for a moment that you and I are alone in a room. I have come to your home or your office to discuss your affairs. Think with me so I can show you what I mean by asking you to think about your problem.

I'll call you Bill, regardless of what your name is. Bill, tell me if there was something that was easily within your power to do but would make a difference between possible financial saving and certain financial success would you do it? What percentage of your present income would you like to have as permanent income some day? What do I mean by permanent income—why permanent income is money at work—temporary income is men at work. Any time you quit work your temporary income terminates. I realize that you'd like to have it all, but if it were permanent income you wouldn't have to save any more money, would you? You probably wouldn't have to pay as much income tax, and you certainly wouldn't have the expenses that you do in going to work every day, maybe you could get along on 60 per cent, 70 per cent, 50 per cent, no less than 50 per cent you say—in other words to be financially successful you must accumulate enough to produce 50 per cent of your income.

If you were to quit work tomorrow, what percentage of your present income would be permanent? Five per cent, 10 per cent? Ten per cent? How many years have you been working? Twenty years? And you're half the way through, aren't you as far as economics are concerned. So in half the time you've accumulated 10 per cent and you need 50 so you're 20 per cent along the way. Tell me, following your present plan how long will it take to accumulate enough to produce 50 per cent?

Supposing you don't have that long. Will the need for the income be any more or less? Isn't it fair to say that something rather drastic will have to be done if you are to be successful financially according to your own measurement? Tell me, Bill, would this be a fair statement then of your

problem? Would it be correct to say that your problem is to accumulate in the time that remains enough money to produce the difference between 10 per cent and 50 per cent of your present income?

The point is that you must believe implicitly in what you say and what you sell. As far as our sale is concerned all we have to do is to discover the problem, then put on the other man's shoes and apply our technical knowledge to give him a solution that will lead him out of his problem.

So to summarize how do we sell intangibles? There are four principal points. First, preparation—which seeks to cover every possible area before approaching a sale; second, to find the problem, to discover and to help men discover what their own problems are so that they will seek to buy our product for the solution; third, an application of the Golden Rule, putting yourself in the other man's shoes and seeing to it that what you recommend for him would apply with equal force to yourself. The fourth is how do you think?

I don't know whether you ever get discouraged—maybe in your business you don't have the kind of problems that we do in ours, but the life insurance man takes an awful beating, particularly in the early years when he must spend his time trying to sell people who don't want to see him. So, it's easy for the life insurance man to get discouraged. I have long felt that thoughts are very real. We tend to be what we think we are, and I have found that most people agree with this philosophy. If that's so, I've often wondered why there is such a gap between what people accomplish and what they apparently want. Isn't the key to it in the word apparently? "The problem is to keep the little things from interfering with the big things." The problem is to attain self-discipline.

If this is the problem then here are two ideas that have been very useful to me and I'd like to pass them on. They are very specific in their point, and they're based upon the conviction that there is a law of minds which is just as inexorable and as firm in its operation as is the law of gravity. That law of mind believes anything which you ardently desire, vividly imagine, honestly believe in and expectantly act toward will inevitably come to pass. We could

Safety Services to Industry By the States and Provinces

The Ideal State Safety Program and How the U. S. Department of Labor Can Help

By PAUL E. GURSKE

Dir., Bureau of Labor Standards, U. S. Dept. of Labor, Washington, D. C.

The Congress established the United States Department of Labor to promote the welfare of the wage earners of the United States, to improve their working conditions, to advance their opportunities for profitable employment, and to administer and enforce statutes designed to advance the public interest.

One phase of this broad mission involves the safety and health of wage earners, responsibility for which has been delegated to the Bureau of Labor Standards.

Since except for responsibilities under certain statutes, the federal government has no direct responsibility for providing leadership in the safety field, the Bureau provides a safety consultation service and tools which will help others achieve leadership in the areas where needed.

The safety consultation service encompasses all aspects of safety in federal establishments, maritime operations, industrial safety under specific laws, and aid to states.

This discussion concerns itself with an ideal state safety program and with safety services of the Bureau of Labor Standards available to the states.

Under our American industrial system, safety is primarily a management function. However, states have the responsibility to see that all employers provide safe workplaces according to certain acceptable minimum standards.

In the past, the primary emphasis by states has been on guarding of machines and equipment and the elimination, or control, of physical hazards. Many states now realize that to do an effective safety job they must be more than just policemen enforcing laws and regulations. They must supply the highly professional service that a trained

safety engineer gives to employees in the large business concern.

Safety training, safe work practices, good supervision, engineering control and proper selection and placement of personnel are some of the elements that wide awake management uses to prevent accidents on the job.

But we must not overlook the fact that an effective state safety program has to include an internal and an external element, *internal* meaning a safety program for state employees, and *external* meaning safety services to aid administration of the various laws affecting wage earners in the state.

When we consider the variety of hazards and exposures in proper administration of state penal institutions, state schools and hospitals, state police, public roads and motor vehicles, public buildings, state agriculture and conservation of natural resources, we realize the importance of a state safety program covering state employees engaged in these activities.

A suggested organization for such a safety program would include:

1. A governor's safety committee including such persons as the labor commissioner, the industrial commissioner, and the commissioner of public safety. The chairman would be appointed by the governor.
2. A departmental safety organization, including:
 - a. A safety coordinator appointed by the commissioner of each state department to be responsible for administering safety activities within the department.
 - b. A department safety committee including at least three top level

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spend many hours to amplify or possibly to qualify that statement, but for the moment I want you just to assume that it's true.

What can we do to put so great a power into our hands? First, you must be sure that what you want is right. You begin to imagine, you begin to believe in the possibility of attaining that thing which you know is right. Then you go about doing whatever it takes to accomplish it with complete confidence that the result is as good as done. How can you have that confidence? Well, if you don't have it in yourself you can borrow confidence. If someone else whose opinion matters to you believes you can do it, you will not let that person down and you can do it.

And so, here is my first specific idea. Seek out the problem, find the solution that you know is right, prepare for it completely, and then go about doing the things that it takes to finish the job. And the second specific is this. Give your mind a chance to work; the little annoyances and hindrances of the day burden us all and our conscious hours of free thinking are all too few. With that kind of interference

it's almost impossible to think through those big objectives and the things that you want to accomplish.

For my part I have learned when I have such problems that the hour in the morning before breakfast—before the family is up, before the telephone rings, before there is any interference—is my best opportunity. At such a time I will sit down and command my mind to go to work. I'll ask myself—where do you want to be 10 years from now—then five years, then next year and then what must I do today in order to take steps in that direction? It doesn't matter if the answers are often the same, the point is that it clears the track, it makes it possible to see where you are and find out whether you are on the track or not.

Now this is not limited to material things alone—happiness, human happiness is the prime objective and material things are only a part. I believe that it is no more impossible to reach out and tune your mind to receive from the Great Universal Power than it was impossible to bring in words and music and pictures through TV. The power is all about us—all we need to do is to tune our minds to receive it.

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3. Adequate funds for developing educational and promotional materials, as well as to support the other aspects of the program.
4. An effective and adequate records and accident investigation system.
5. Regular and periodic educational and training meetings of safety and supervisory personnel.
6. Regular and periodic inspection of state property and equipment.

When we consider the safety services a state should provide in the administration of laws affecting the health and safety of wage earners, we find that authority should be provided by legislation:

1. Placing general responsibility on employers to maintain a reasonably safe place to work.
2. Giving the state labor agency authority to formulate occupational safety rules and codes for the health and safety of workers under proper legal safeguards.
3. Providing for the assistance of advisory committees made up of employers, employees and technical experts in the formulation of safety rules and codes.
4. Authorizing the state labor agency to carry on educational programs in collaboration and cooperation with employers and employees.

The inspection service which implements this type of safety authority should provide a minimum of one regular inspection of each establishment annually, with additional ones as necessitated by review or hazards, injuries, complaints and suspected violations.

The number of inspections to be expected of each state safety engineer in a year depends upon the types of industry in the state, size of individual establishments, distance from one part of the state to another, travel facilities available, and the number of laws to enforce.

To insure getting good factory safety inspectors and keeping them, certain qualifications and inspection standards should be established.

A competitive merit test administered by

the state civil service procedure, or by an important non-partisan board, should be designed to bring into the service men with an adequate and predetermined degree of technical and practical knowledge.

A one year probationary period of training and experience, with a final qualifying examination by the board administering the merit system, should be given all newly-appointed inspectors before permanent appointment.

Equally as important as appointment and training is a reasonable assurance of permanence of office for competent inspectors. The system should give qualified inspectors the protection of civil-service tenure or its merit-rating equivalent.

How can the United States Department of Labor help the states in this type of program?

To promote the safety, health and welfare of wage earners, it is necessary to have certain minimum adequate safety standards which will help effect uniformity throughout industry.

The Bureau of Labor Standards participates in the activities of the American Standards Association in the development of American standard safety codes. At the present time, the Bureau is represented on two standards boards and 37 technical committees.

The Bureau promotes the adoption of ASA safety standards by keeping the states advised of the adoption of new standards, by suggesting the use of ASA standards as the basis for state codes, and by using ASA standards as the basis for safety codes drafted by the Bureau at the request of states. In this way, the Bureau hopes to achieve better uniformity of state codes.

It is estimated that approximately 70 per cent of the industrial injuries in this country occur in smaller plants where the safety program is weak or non-existent. Such plants are seldom serviced by their insurance carriers and receive only occasional assistance from state factory inspection agencies. To meet this problem, the Bureau has developed a special industry program to devise tools and aids for improvement purposes.

The state agency responsible for occupational safety, with the help of safety spe-

cialists from the Bureau of Labor Standards, selects a specific industry which requires concerted attention for the purpose of reducing industrial accidents and work injuries. A review of state injury records, of known hazards, and of importance of the industry to the citizens of the state helps to determine the selection.

In cooperation with the state agency, the Bureau provides the services of safety engineers to study the hazards in selected plants in the industry, to analyze the problems and operations of the industry and to develop engineering and educational data to be used in the promotion of a concentrated safety program.

The safety staff of that Bureau then compiles this data and prepares flow charts showing the sequence of the important operations and the principal hazards in each operation.

These materials are printed and made available to the state. In addition, safety committee instruction pamphlets are prepared outlining a yearly safety program which covers a specific hazard of the industry each month. Suitable posters and promotional aids are also developed.

As a result, a tailor-made safety program is available for a concentrated effort of six months, a year, or longer.

To obtain over-all participation in this special industry-wide safety program, it is suggested that the state agency appoint a publicity committee consisting of safety personnel from industry, civic service groups, insurance companies, the press and radio. This committee promotes the program through its members, publicity channels, publications and activities. The Bureau

helps develop promotional aids for this purpose.

Before such a program is put into operation, the Bureau conducts a two- or three-day training session for state safety personnel to acquaint the state's staff with the details of the program and give specific instructions on the hazards and corrective measures to be used by this industry. A session on "How to Sell the Special Industry Program" is included in this training.

State safety personnel then make personal contacts with each plant in the industry. They discuss the program with top management to enlist cooperation, to survey operations as to help needed, and to get the injury-frequency rate for the previous six month or yearly period in order to be able to compare safety records before and after the program is inaugurated. Assistance is given in organizing a safety committee or other personnel to make use of the program material.

The state agency reproduces the materials developed by the Bureau and sends them to the participating plants each month for the program period.

At the end of the program period, state safety personnel again contact each establishment to evaluate results of the program. Injury-frequency rates before and after the period of the program are compared. Plans are then made for continuing the program as a long range one. To date, special safety programs have been developed for 29 different industries.

Some examples of improved industry injury-frequency rates as a result of this type of program are shown in the table at the bottom of this page.

<i>State</i>	<i>Industry</i>	<i>Injury-Frequency Rate Reduction</i>
North Carolina	Brick and Tile	9%—6 months
		25%—2 years
		36%—3 years
New York	Scrap iron and steel	65%—6 months
Iowa	Woodworking	49%—6 months
Arkansas	Logging	23%—6 months
Indiana	Limestone quarries and mills	24%—6 months

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The training function of the Bureau is to make available to states, federal agencies and other groups a modern concept of safety training to help implement existing safety efforts.

There are several safety training courses given, each with a specific objective. They are directed to the state factory inspector, the state or federal agency supervisor, the trade union representative and persons responsible for handling similar training within their own units.

Bureau training experts conducted 81 different courses during the past fiscal year. The total attendance at these courses was 1,725 persons.

A new departure in the training function was a course conducted in Virginia under the joint sponsorship of the Virginia Manufacturers Association and the Virginia Department of Labor and Industry. This course was conducted for industry representatives.

Bureau training experts prepare instructor guides, student outlines, visual aids and safety promotion materials to enhance the value of the subject matter. Students are provided with reference materials and educational materials pertinent to the subject matter to help them apply their knowledge to existing problems.

Specific courses offered are:

- 150 hours covering broad scope of accident prevention fundamentals.
- 30 hours for state, federal and industrial supervisory personnel on basic accident prevention at the supervisory level.
- 12-16 hours covering the place and responsibilities of trade union personnel in accident prevention.
- 30 hours teacher-training course in the techniques of presentation of safety subjects for training personnel in the field.
- 30-60 hours in specific field of construction safety.
- 30-60 hours in specific techniques of chemical products safety.
- 30-60 hours in the field of electrical hazards safety.
- Special courses covering specific safety problems as they arise and are requested.

The teacher's training course has been prepared to enable state labor department personnel to conduct training courses in safety within their respective states.

An attempt is being made to expand co-operative safety training classes in states, sponsored jointly by state labor and industry departments and trade associations such as the National Association of Manufacturers.

One aspect of the work of the Bureau is keeping technical consultation and development activities current. Several hundred technical inquiries are received yearly from states, municipalities, unions, and private industry requiring constant research into new fields of safety endeavor and recurrent studies in existing fields.

To provide technical safety aids in a form which can be used effectively by state factory inspectors, small plant supervisors and small safety committees, approximately 100 bulletins, booklets and charts on safety and health have been prepared and issued. Work is constantly in process to expand this service.

Assistance is provided state agencies in drafting and revising safety codes or regulations. This service includes making surveys of the state industrial problems, making comparative studies of existing national and state standards, and drafting suggested requirements for final revision and adoption by the state agency. Consultation service is provided state code committees, and upon request, Bureau safety engineers participate as expert witnesses in final public hearings on proposed codes.

On request, state and governmental agency safety programs are studied and appraised for effectiveness. Specific recommendations are then offered with respect to methods of improvement and additional activities which might prove beneficial.

In fact, at the present time, Bureau safety engineers are working with four states (Maryland, Virginia, Iowa and Minnesota) helping them to organize a complete safety program for all state employees in all state agencies. The experience gained in these four states should be valuable in helping other states organize similar programs.

Under the Longshoremen's and Harbor Workers' Act, responsibility is given the

administering authorities to make studies, investigations and recommendations with respect to safety provisions and causes of injuries in employments covered by the Act. The Bureau of Labor Standards has been delegated this responsibility. There are approximately 500,000 workers under this Act located at 100 major ports in some 31 states.

Safety activities of the Bureau in states having ports involves promoting and stimulating interest of steamship operators, stevedore companies and shipyards in developing and maintaining an effective safety program.

Injury reports are analyzed to determine basic causes of injuries, and regular visits are made by Bureau safety engineers to observe conditions and activities and make recommendations for control and elimination of hazards. Safety programs are evaluated and recommendations are made concerning policies and promotional activities.

Shipping associations and insurance companies are contacted to promote joint action in the interests of longshoring safety. Periodic on-the-job safety meetings are arranged and conducted as a part of safety training in cooperation with management and unions. Technical information dealing with recommended safety standards is provided with the objective of developing and promoting the adoption of uniform voluntary safety codes throughout the stevedoring industry.

In covering the various ports last year, 116 stevedoring companies, 26 shipping companies, 35 marine trade associations, 12 insurance carriers and 34 union locals received safety services of one kind or another from Bureau engineers.

While the fiscal year 1954 was an "off" year as far as a President's Conference on Occupational Safety is concerned, the results of previous conferences go on and on.

Reaching small business by community action, an expressed goal of the May, 1954, President's Conference, was quickly realized in Hagerstown, Maryland. The first Cumberland Industrial Safety Conference brought together representatives from a four-state area to stimulate safety activity in plants and to offer practical aid in accident prevention, particularly to supervisors, foremen and others responsible for safety objectives.

The value of the community approach to occupational safety has been demonstrated for some time in Oregon, where 31 community conferences held in 1953 showed an eight per cent reduction in work injuries in 1954.

The 1954 President's Conference produced a "How To Do It" guide for community safety conferences which the Department of the Army distributed to safety directors in major commands all over the world. A large railroad gave the guide to its superintendents in towns all along its route. These are typical examples of the determination of the President's Conference to reach small workplaces where the great majority of work injuries occur.

The President's Conference, embracing all segments of our national economy concerned with the prevention of on-the-job accidents, continues to be a vital force in stimulating action on the part of state and local officials and private agencies.

President Eisenhower has requested the Department of Labor to organize a nationwide conference next year to concentrate on other areas which need the attention of the safety movement. The next conference will again stress promotional and educational activities which can be taken to workplaces where the accidents occur.

Any program must continually move forward with new devices and new ideas. It must be dynamic—not static. And the Bureau has not lagged in pushing into new fields.

A brand new Hazardous Occupations Order Number 12 became effective in September, 1954, following an investigation of the hazards to minors employed in the paper products industry. The order sets an 18-year minimum age for operating certain machines used in this industry. And, as evidence of more progress, one other hazardous occupation order was amended and an amendment proposed to still another, in recognition of changing industrial conditions. Bureau safety engineers are working in these areas constantly.

Another pioneering project, completed in cooperation with the Office of Education of the Department of Health, Education and Welfare was the publication of a booklet on school shop safety. Intended as a safety guide for pre-employment training, it aims

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the hard way, by being injured.

To summarize this discussion, we believe
the safety services of the Bureau of Labor
Standards contribute to the giving of more
effective safety service by states through:

1. Training state personnel in safety.
2. Providing technical safety materials and aids for states to use.
3. Giving personal safety consultation service on all phases of safety activities.
4. Pioneering and research work in new areas of safety and new techniques in safety promotion and control.

Private industry benefits from the safety

services of the Bureau because the Bureau:

1. Helps cover segments of industry that are not reached by others—the small business.
2. Helps improve the industry-wide frequency and severity rates.
3. Helps preserve industrial skilled manpower.

The worker benefits from the safety services of the Bureau because the Bureau:

1. Helps improve the safety of the machines and equipment he uses.
2. Helps improve the environment he works in.
3. Helps improve the quality of supervision over him.
4. Helps provide physical and economic security for him in his job.

The Florida Training Program

By A. P. McINTOSH

Chief, Dept. of Industrial Safety, Florida Industrial Commission, Tallahassee, Fla.

When our Department of Industrial Safety was activated October 1, 1947, all that we had to go on was a philosophy that *Florida Problems Should Be Solved by Florida People*. To determine the pattern of industrial safety needs, a survey was made throughout Florida which contacted representative industries, including executives, supervisors, workers, associations, labor groups and members of the public in each area in the state.

The most amazing thing we found was a general feeling that occupational injuries are simply "a part of progress." Executives and managers all agreed that supervisors were the key men in industry and any program for betterment of methods and practices should include these key people, *but how?*

In order to take advantage of the knowledge and experience of the only people in Florida who, we felt, could really help, we called on eight successful safety directors in industry, each having the status of a full member in the American Society of Safety Engineers, for their advice. Out of their suggestions came Florida's Balanced Safety

Program, consisting of inspections, training, aids and materials and special services.

Our chosen safety experts insisted that inspection be not just a procedure for locating hazards, but an industrial engineering approach where accident prevention is made a part of the production schedule. In numerous instances, plant or job inspection has led to 10-hour safety classes. Management has realized that safety should be *a part of the production plan*, not something separate as it had been in the past.

Building our safety training course was both an interesting and, at times, a trying experience. When nine people with a common profession, but completely divergent experiences, try to agree on the many details involved in such a project, it takes time and patience. Results have proven, however, that these men had lots of patience and inspiration. Their work will continue to pay dividends for years to come.

We started out with five points to be considered:

1. Executive and supervisory responsibility.

2. Accident source and cause.
3. Plant or job inspection.
4. Accident investigation.
5. Program planning.

Each of the nine men selected the subject or subjects they would prefer writing or preparing material on, and then started to work—each working independently of the others. The initial material was rewritten at eighth grade vocabulary level and edited to eliminate duplication. The original five items became:

1. Safety is a part of your job.
2. Where accidents come from.
3. You can see an accident coming.
4. Now, what caused that one?
5. Plot your course and keep sailing.

After a state road department artist did the cover design, chapter headings and various key illustrations, our *Florida Foremen in Safety* booklet emerged, not as a safety manual but a handbook to be used for home work with our safety training course.

The original five subjects, as chapters in the book, suggested five daily presentations, and, in order to use both lecture and conference methods of teaching, we decided on a two-hour period for each session. Thus, the *10-Hour Safety Course* began to take shape.

We decided to use visual aids as much as possible. Charts were adopted, as they are most flexible to change, easily packaged, transported and most likely to fit the various physical situations under which the course would be presented. The charts we use are painted by a local artist on dull finish plastic cloth about 18 by 24 inches in size, using lots of color in lettering and caricatures. Experience has shown that it is desirable to diversify color schemes and make each one as simple as possible so as not to confuse class members. Parallel material is added as needed. Where the discussion warrants, a blackboard is used to record the points and permit class members to make notes.

Our *10-Hour Foremen Safety Course* is simply good foremanship with safety in its proper position and proportion. Particular stress is placed on prevention of production accidents with a resulting prevention of accidents to workmen. The course is given in five successive daily meetings of two hours each, at hours during the day most

convenient to the class members. Class sizes are from a minimum of 10 to a maximum of 25 pupils.

The first hour of each meeting is used in presenting principle, by use of hand art work, "Flip Charts" and blackboard illustrations. After a 10-minute rest period, conference methods are used, and various devices get class members on their feet talking about the principles presented in each of the lessons. All material presented is in shop language. *Under no condition do we ever discuss company policy.*

Briefly, our outlines are as follows:

Monday—

- Class rules.
- Accident-definition.
- Plant accident experience.
- Accident costs.
- Business organization.
- Foreman-Definition.
- Duties of a foreman.
- Teaching.
- Training.

Tuesday—

- Accident sources (production and employee accidents).
- Unsafe conditions.
- Unsafe practices.
- Control of unsafe conditions.
- Control of unsafe practices.

Wednesday—

- Planning.
- Operating plans.
- Safety plans (a part of operating plans).
- Inspection—production and safety.
- Safety methods.
- Production and safety training.

Thursday—

- Production accident study.
- Employee accident study.
- Accident reporting illustrative cases.
- Accident records.

Friday—(Fitting safety to location or job).

- Production program.
- Safety program (as a part of production program).
- 1. Training.
- 2. First aid.
- 3. Safety inspection (for production and personnel hazards).
- 4. Accident investigation (production and personnel accidents).
- 5. Publicity.

At the close of each class, we pass out foremanship circulars paralleling the class

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work; *Monday*—Qualifications of a foreman; *Tuesday*—Handling people; *Wednesday*—Self improvement; *Thursday*—Waste control, and *Friday*—Leadership.

The class instructor devotes from two to four hours per day on the second, third, fourth and fifth days to on-the-job visits with various class members, accompanied by the safety director or some other person designated by the executive. These visits are arranged so that there will be no interference with the supervisor's production duties.

The purpose of this activity is to establish a closer relationship between the pupil and instructor, and to aid the supervisor on individual problems in connection with the basic principles of the course. The commission furnishes the instructor, class materials and visual aids without cost or obligation to Florida employers.

We believe that the success of this course lies in the fact that it is basically simple, of "homespun" origin, and our instructors have been thoroughly trained in public speaking, salesmanship and conference methods of teaching in addition to their usual

safety training. The University of Florida has been most helpful in developing and conducting training seminars to help make our field force an instruction group as well as safety people.

A survey of locations that have had the *10-Hour Safety Course*, comparing the year prior to the class to the year following, was made in 1953. This survey showed that 85 per cent of the companies had reduced their accident frequency 22 per cent, a reduction in days lost of 44 per cent, and an accident cost reduction of 36 per cent.

From the date this course was initiated, July, 1949, to October 1, 1955, we have conducted 373 classes in 107 Florida cities for 523 companies, with 6,892 supervisors completing of a total enrollment of 7,841, or an enrollment mortality of about 12 per cent.

As of October 1, 1955, we have our available class instruction service scheduled full time until January, 1956, and have had to postpone a number of requests until next year. This has contributed more to Florida occupational safety progress and good will toward our Department of Industrial Safety than any other service we render.

British Columbia's Complete Safety Service

By ARTHUR FRANCIS

Chief Inspector, Workmen's Compensation Board, Vancouver, B. C., Canada

The development of British Columbia's safety program closely follows the industrial development of the province, and, as British Columbia is the most rapidly expanding province in Canada, our program is constantly changing to meet the new conditions not only of our industrial development but also of the rapidly growing safety movement within our industries.

The design of our safety program was laid down in a report made to our provincial legislature in March, 1916, by a committee which had been appointed the previous year to investigate compensation laws, in order to ascertain the best system of attaining the principles of social justice which underlie much legislation.

The report stated: "The best system as we conceive it [is] one which will not only

eliminate so far as possible the economic waste attendant on the present system in force in the Province, but which, while protecting the employer against personal injury claims and ensuring the employee an enlarged and better measure of compensation, will in their common interest exercise a constant and direct force tending to improved personal relations between employers and their employees, and to the creation of better working conditions and the reduction of the opportunities for accident."

With respect to accident prevention the committee reported: "Another matter to which the committee devoted considerable attention, and one which we think should be given a very prominent place as an essential element in an adequate compensation system is that of making provision for the

bringing about of conditions which tend to the reduction of industrial accidents. Laws which provide for the taxing of industry to furnish compensation for the victims of industrial accidents, irrespective of fault, are commendable and desirable, but laws which will prevent the happening of such accidents are of more vital importance. In dealing with this subject every consideration should be given to the fostering of conditions which will prevent or minimize the evils which give rise to the necessity for compensation."

On industrial diseases, the committee reported: "The provisions of the Bill relating to industrial diseases adopt the principle of considering such diseases for the purpose of compensation as the equivalent of personal injury by accident. . . . It would appear necessary, in the interests of the workman as well as employers, that the duty should be imposed on the Board of seeing that no workman is retained in any such employment a sufficient length of time for him to become a chronic sufferer from the disease."

The report ended as follows: "In concluding this Report, we have only to add that, with the passing of such an Act as here outlined covering adequate medical-aid and accident-prevention features, with a system of insurance entirely exclusive of the expensive and wholly unnecessary competition of casualty insurance companies, with a competent Board composed of members holding office for a considerable term of years and thus freed from immediate political influence, and with a fair degree of cooperation on the part of both employers and workmen, the success of the proposed system is, in our opinion, assured in such a way that it will undoubtedly develop to be a strong contributing element in the upbuilding of the industrial life of the Province."

The humane views and constructive ideas expressed by this committee were reflected in the provisions of the Act and have shaped the policy of the Compensation Board ever since. The principles adopted have not only lent weight to our efforts but have imposed challenging demands to take positive and forceful action against any condition that constitutes a threat to workmen.

The System

The Act gives authorized persons the right to enter into the establishment of any

employer to ascertain whether all proper precautions are taken for the prevention of accidents to workmen and to determine what suitable devices or requirements shall be adopted or followed. The Board may order the installation or adoption of safety devices and appliances and may fix a reasonable time within which they shall be installed or adopted.

Immediately after each visit, the authorized person shall cause to be posted in a conspicuous place a statement showing the portion of the premises inspected and the condition found to prevail therein.

Such visits include the investigation of accidents, circumstances of which indicate the need for corrective action.

The Act provides for the making of regulations of either general or special application but requires that before such regulations are adopted a public hearing shall be held for the purpose of considering same.

Accident Prevention Regulations and First Aid Service Requirements were first adopted in 1918 and have been revised periodically to keep them in line with changing conditions.

Provision is also made in the Act for publishing and distributing bulletins on any phase of the subject of accident prevention and to cause lectures to be delivered to employers, employees and the general public about first aid, the causes and prevention of industrial accidents and industrial diseases and related subjects. Employers are required to maintain such first aid appliances and services as the Board may direct, and, when the employer fails to comply, the Board may install such appliances and service and charge the cost to the employer.

The Board was also given broad powers of enforcement.

When an employer fails, neglects or refuses to install devices ordered by the Board or required by regulation or where, in the opinion of the Board, conditions of immediate danger exist which would be likely to result in loss of life or serious injury to workmen, the Board may order the employer to forthwith close down the whole or any part of the establishment.

Where any particular plant is shown to be so circumstanced or conducted that the accident cost or hazard differs from the average of his class, the Board can confer or impose a special rate, differential or assess-

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Where an accident causing injury to a workman was due entirely to the gross negligence of the employer or to his failure to adopt reasonable means for the prevention of accidents or to comply with the directions of the Board or with the regulations, the Board may levy and collect from the employer the amount of compensation payable, in respect of the injury and not exceeding in any case 300 dollars.

Where the injury is attributable to the serious or wilful misconduct of the workman, no compensation shall be payable unless the injury results in death or serious or permanent disability.

Every person who contravenes any regulation is liable to a penalty not exceeding 300 dollars, recoverable under the "Summary Convictions Act" or by an action in any court of competent jurisdiction.

The Organization

When the Compensation Act became effective, on January 1, 1917, there were already in effect, acts governing safety in coal mines and metalliferous mines—safety with respect to boilers and pressure vessels, electrical wiring and equipment, provincial railway operation, prevention of fires, under the Fire Marshalls Act, and the Factories Act, which covered elevators and safety, health and welfare in factories. In addition there were Federal laws covering explosives, shipping and interprovincial transportation.

The inspectors appointed under the various provincial acts were authorized to perform the duties of inspectors under the Compensation Act.

The territory was new and undeveloped. One hundred years before 1917, the Hudson Bay trading posts had been practically the only establishments in the area. The territory was made a Crown Colony in 1858 and joined the Confederacy as a Province in 1871. Communication by railway to the rest of the country did not come until 1885.

The assessable payrolls for 1917 amounted to 78 million dollars and total assessments 939,000 dollars. There were 5,483 time loss cases and 124 fatal accidents, 63 of which were in mines, 34 of them in one mine explosion. Logging had 43 fatalities and saw-mills 18.

In 1954, assessable payrolls amounted to \$1,200,000,000, or 15 times greater than in 1917. As a matter of fact, payrolls were three times greater in 1954 than they were in 1945. There were 23,483 time loss cases in 1954 and 251 fatalities.

Dependence on the inspectors of other departments proved helpful but not too effective in reducing accidents. One of the commissioners took a very active interest in the guarding of power transmission equipment and similar hazards of the day. In 1932, a logging inspector was employed. This was followed by the appointment of additional inspectors, until today we have 22 safety inspectors, one industrial hygienist, four men concerned with the silicosis problems, three first aid inspectors, an artist and 15 office employees.

All inspectors are chosen first for their knowledge and experience for the particular industry in which they are to be engaged, and secondly for their ability to earn the respect and confidence of both labor and management.

For more effective coverage, for closer contact with industry and for more economical operations, inspectors are located at seven different points about the province. Three field offices are maintained at convenient points.

The safety department has the whole-hearted support of all other departments, so that detailed statistical information is always available regarding accident occurrence and the experience of a firm or of an entire industry.

With such a strong and broad foundation of authority coupled with responsibility, with the imposing of police powers and educational duties, with an organized system of plant inspection and accident investigation and the means to have unsafe conditions corrected, with records to show the nature and circumstances of accident occurrence, regulations to provide a guide for safe operation, means to secure employer cooperation, methods for gaining the participation of labor and devices to arouse interest and enthusiasm, we have the structure and machinery to carry out an effective safety program.

The Problem

It is necessary to have a mental picture of our province in order to understand some of our difficulties in carrying out the program.

The province is 366,255 square miles in area, roughly 400 miles east and west and 800 miles north and south. It is equivalent to the area of California, Oregon, Washington and part of Idaho.

The 700 miles of coast line has 7,000 miles of shore line, exclusive of hundreds of islands. Vancouver Island extends like a giant breakwater nearly 300 miles north from below the 49th parallel, while the Queen Charlotte Islands, a little farther north and west, form another barrier to the ocean.

The inland sea, sheltered behind these islands, is an important factor in our economy, for communication along the coast is only by boat and plane.

The eastern boundary of the province is the Great Divide formed by the crest of the Rockies. The Coast range rises from the sea along the mainland coast. The area between these two ranges is a plateau and more mountains. The extremes of topography lead to extremes of temperature which vary from the mildness of the Mediterranean to the coldness of the polar regions.

Only three per cent of the land is arable but 38 per cent is rich forest land. The balance is mountains, lakes and rivers. The mountains are valuable for their mineral deposits, and the lakes and rivers are the source of the tremendous hydro-electric power to which our industrial development is partly due, and which has helped to give us the highest standard of living in Canada.

The size and nature of the province makes transportation a problem of some significance. While we have 6,000 miles of railroad and 25,000 miles of roads, many industries are reached only by water and to others the airplane is the most convenient means of travelling.

We recently purchased a four-wheel drive one-half-ton panel truck equipped with a power winch, for travelling to lumber camps and oil drilling operations in the north country. We also provided for our inspector a sleeping bag and air mattress because habitations are few and far between in that area.

There are only 1,080,000 people in our province, 65 per cent of whom live in the south west corner. The population of Vancouver accounts for over half of the total population.

While lumbering, mining and fishing are the basic industries, the province ranks third in Canada in value of manufactured products. The smelter of Trail is said to be the world's largest producer of lead and zinc and the world's largest cold storage fish plant is located in Prince Rupert.

But, on the whole, the industries in British Columbia are small in size and hazardous in nature, thus making accident prevention both important and difficult.

Program

Our program has been built around an inspection service, and we are absolutely convinced that such a service is essential to a government safety program. Only a small percentage of operators require the full weight of authority to force them into reluctant compliance. The majority of employers are cooperative, but need to be informed of unsafe conditions and often require some gentle nudging to get them moving.

Even those operations which are sincerely interested in safety and are well organized and doing all in their power to prevent accidents, welcome and appreciate the guidance and encouragement of an inspector.

We have always provided a line of official placards giving notices, warnings and rules regarding faulty conditions or unsafe behavior.

One of the earliest educational efforts of the Board was the regular mailing of circulars to employers, giving factual information on accident causes and methods of prevention. A monthly analysis of accidents in the various branches of the lumbering industry is in such demand that when we attempted to discontinue it as being of little interest we received strong requests for its continuance.

Another popular line of literature is sketches and drawings of items such as scaffolds, ladders, strengths of structures and rigging and similar items of what could be called an engineering nature.

Various booklets and pamphlets have been issued since the inception of the Board and besides regulations, include information for workmen and for employers and recommended safe practices concerning specific hazards, of operations or entire industries. Several such pamphlets are now being pre-

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pared. Recently we published the first issue of a new effort entitled "Gleanings," which contains ideas, devices and similar items that can help make equipment safer or programs more effective.

Two types of posters are issued, one of the two- and three-color lithographed type in two sizes, of inspirational or educational nature. The other type we reproduce on our own multilith machine. These might be on any phase of safety from illustrations of accidents to items of public safety. Sometimes they are black and white and sometimes two-color on white paper, or black on colored paper.

Members of the staff participate in all types of conventions and are in demand as speakers for safety committees, company campaigns, schools and service clubs.

Moving picture projectors and film libraries are located in each field office. We feel that the effectiveness of this service and the broad use made of the equipment make it a "must" for a government safety program.

Safety graphs are used by the inspectors on suitable occasions and are available to industry from our office.

We take a very active part in organizations and programs dealing with traffic safety. On November 1 we are starting a six months' traffic safety campaign in cooperation with the Automotive Transport Association, Teamsters Union, Taxicab Owners Association and similar groups.

Frequency Records and Awards

The Board maintains accident frequency records for all the branches of the lumber industry and keeps firms informed of their standing. Annual awards are presented each year by nature of industry and size of operations. Whenever the occasions warrant, we make awards to any type of industry or present trophies for competition. Keeping a score sheet undoubtedly has a very definite influence in improving performance.

Blasters

In the last revision of the Accident Prevention Regulations in 1950 we included a provision for the examination and certification of blasters in industries other than mining. We felt this move necessary because of the widespread use of explosives,

with attending hazards, and because employers were not always in a position to determine a blaster's qualifications, or were not informed enough to train one in the safe and proper procedure. We are satisfied that the results have justified this step, and employers and blasters appear happy about our action.

First Aid

The pattern of development of First Aid services in British Columbia has been somewhat unique because of the hazardous nature of our industries, the isolation and remoteness of the operations and the difficulties of transportation.

In the beginning we depended entirely on the training services of the established St. John's Ambulance Association, but experience indicated that a more intensive training was necessary to meet the serious problems confronted by our First Aid attendants.

While St. John's Ambulance instructors still do some of the training, other organizations are active. Training has to meet Board specifications and examinations are under Board supervision. Training consists of 25 two-hour sessions of both theory and practice. Four grades of certificates are issued, renewable in from one to four years. There are at present about 3,000 certified men and women in the field, and they are doing a marvelous job both in preventing accidents and in treating injuries.

The use of professional First Aid attendants is not intended to prevent the widespread training of workmen in basic First Aid and the Board participates in and encourages the training of as many people as possible, the general public as well as workmen. The Board also supports First Aid competitions as a means of fostering interest in this training.

In 1953, a further development took place when the Board conducted an experimental course in oxygen therapy for First Aid attendants.

This knowledge proved so successful in saving lives and lessening the effects of shock that after January 1, 1956, all First Aid rooms in hazardous industries will be required to have oxygen therapy equipment and an attendant qualified to use the equipment. The Board is carrying out the necessary training of these men.

Accomplishments

From the foregoing it can be seen that our program has followed standard practice in the accident prevention field, but results do not come from organization and system alone. Accomplishment is most definitely in proportion to effort. Our entire staff is dedicated to its task of preventing accidents and each member gives generously of his time and energy.

Our statistics indicate that there has been a declining frequency rate throughout all types of industry since 1946, and that in spite of increased benefits and higher cost of medical services there has been a general trend to lower assessment rates. However, the real measure of success does not show immediately in the statistics but is revealed by the increased activities in industrial safety and a much higher level of both interest in and understanding of accident prevention philosophy.

It should be pointed out that our Act is compulsory and monopolistic, without any numerical exemptions and covering all types of work but domestic and farm labor, with the latter covered under optional protection.

Benefits are liberal and medical attention is unlimited. The worker gets compensation of 75 per cent of \$4,000, free of income tax.

A claim can amount to \$75,000. Maybe this makes accident prevention an economic necessity.

A great deal of the success in reducing accidents in our province is due to the increased activities of an increasing number of employers, the greater interest being taken by employers' associations and the greater awareness by organized labor of the importance to labor of the need for an active and constructive participation in the safety program.

I think, too, that the interest the public is showing in all phases of safety is reacting beneficially on the industrial safety movement.

I have given you some of the things we have done in British Columbia. The future to us is a constantly enlarging workforce with more and different problems, but we have a team that is alert and eager, and I am confident that we will be digging up newer and more effective plans to hold up our end in the program against accidents.

I would like to express to the National Safety Council our appreciation and my personal gratitude for the service being rendered in the field of safety. Their efforts are applying a constant force to guide society into more sensible and ethical ways of behavior.

Safety Training — Down the Line

Green Hands—What Training Should Be Given to New Employees?

By WILLIAM E. STUFFING
Safety Dir., Carrier Corp., Syracuse, N. Y.

First of all, I would like to substitute the term "Education" for "Training" in the title of my talk today. I agree with several people in the field that the term "education" is the over-all process of conveying and receiving knowledge, while "training" is a more restrictive process whereby "instructions" are crystallized or converted into manual skills. New employees should receive the benefits of over-all safety education, as opposed to the more restrictive term, "training."

In thinking about the benefits of safety education, the thought occurred to me that many of the 14,000 men and women killed and 1,850,000 injured last year in industrial accidents would still be hale and hearty today if they had been subjected to some form of industrial safety education, or if greater emphasis had been placed on the safety education they received.

I don't think there is a single one in the audience who will disagree with me that some form of safety education would have prevented many of the industrial accidents which occurred last year. I'm sure, however, that I could expect violent disagreement if I were to predict the number or percentage of disabling injuries which could have been prevented, had the victims been exposed to the proper amount and type of safety education. Unfortunately, there is no one "magic formula" by which we can crank out such an answer.

Perhaps the first opportunity a company has to educate an applicant in safety is the employment interview. After the applicant has filled out the company's application blank and sits down with the employment interviewer, safety education should start. A good interviewer will be conversant with the machinery, processes and hazards in

each shop and department. He, therefore, is in an enviable position to determine the applicant's abilities and safe attitudes.

The skilled interviewer will eliminate many undesirable applicants at this time. He also can match the applicant's mental and physical capabilities against the various job requirements, to place him in the job which he can perform most safely. Additionally, the interviewer can emphasize the company's attitude towards safety.

The physical examination is the next order of business for the applicant. The industrial physician or nurse can add their recommendation as to the fitness of the applicant for the job chosen for him. If, in the opinion of the doctor or nurse, the applicant is not mentally or physically fitted for the job assigned by the employment interviewer, a recommendation should be made by the doctor to reassign the applicant to a department where the working conditions are less hazardous, or where the physical requirements are of less importance, with full recognition regarding the safety of the applicant. At this point the physician or nurse can do a fundamental safety education job by explaining to the employee his limitations and the safe way he can cope with the job.

The next step in safety education is the induction process. More good or bad can be done towards shaping the new employee's work habits or attitudes at this point than during any other phase of the educational process.

First of all, the safety education part of the induction program must be dynamic. It must be frequently reviewed to make very sure that all the material is current and that the most important points are present.

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Although the safety engineer is best qualified to prepare the safety education section of the induction program, too many times the safety portion of the induction program falls flat. One of the main reasons that programs fail is that the safety engineer has lost contact with his fellow employees and the new employee.

A program, to be effective, must be designed and placed into operation with the employee constantly in mind. Your presentation will definitely improve if you consult him. You can flip a coin in the air 100 times, and the coin will give you the right answer at least half the time. A broken watch or clock will be right twice a day.

When we ask the advice of others, we immediately accomplish two separate and distinct things—

First, we increase our knowledge, regardless of past experience, and

Second, we automatically gain their support of the safety program. When we seek the advice of others, they immediately feel that they are an integral part of the safety program.

Naturally, the safety education portion of the induction process must be tailored to fit our own company and operating conditions. The program which has produced outstanding results in one company may fail miserably in ours. It should not be complex, nor should it be too technical. It must be simple and have sincerity woven into its every phase.

Any safety induction program designed in a half-hearted manner, or in which the employee detects a "tongue-in-cheek" or "talking down" attitude will be an absolute waste of time.

Remember, too, in designing our program we must compete with subjects which initially are of more interest to the new employee than safety. Subjects like pay-rates, pay-dates, procedure for obtaining pay, promotions, grievances, lunches, vacation plan, pension plan, hospitalization benefits, and so forth, are all going to be competing against the safety presentation. For this reason, the safety presentation must be "top-drawer." I don't need to tell you that a great deal of inspiration, plus a lot of perspiration, will be needed to get our message across.

Now that we've planned our safety induction program, we, as safety engineers, must

sit down with the person who is going to present our program and "sell" him on the importance of our program. Usually the induction class is handled by a member of the personnel department, so his natural inclinations would be to emphasize the personnel programs of the company.

There are, of course, a variety of ways that we can sell the instructor on the value of our program. I won't attempt to enumerate them; it would take too much time. I do think that our own selling job will depend upon the particular circumstances in our plant, as well as the personality of the instructor and ourselves. One thing is basic though, we'll never sell the instructor on the value of the safety program unless we are thoroughly sold ourselves.

The selling of safety is one of the most important, and one of the most difficult jobs to do. It is comparatively easy to sell a product, because the company's prospects and customers have a need for products. But when we sell safety, we find continued sales resistance.

That is why anyone who is educating others on safety principles must be, primarily, a salesman. It's our responsibility to talk to our employee customers in the same way as the men in our sales department talk to the company's customers; and certainly it is up to us to know how to handle our safety education, so that every employee knows absolutely what he gets and how he benefits by working safely.

A salesman friend of mine once told me that a good salesman never tells his prospect just what he wants him to do. Instead, he tells the prospect just what he will get by doing certain things. When the prospect realizes how he is going to benefit, he will want to do the things the salesman tells him to do.

Most successful safety engineers have discovered this technique. But all of us fail to keep the other fellow's viewpoint constantly in mind. The reason for this is that we are so close to this matter of safety, we realize its importance.

I realize that it is difficult to maintain the employees' viewpoint, but if we want to do a thorough educational job, we must make each man and woman feel that we are talking directly to him, and, in all situations show him exactly how he benefits by following safety policies and procedures.

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Points to be covered in the induction pro-
gram will vary according to such things as
size of the plant, geographical location, type
of industry, and so forth.

Perhaps I should list some points that
should be considered for inclusion in the
safety induction program. I think that any
or all of the following might very well fit
into the programs of most companies:

1. Showing of sound or silent safety films.
2. Issuance of safety rule books and other important safety information.
3. The use and care of existing safety guards and material could be described.
4. Stressing the necessity for reporting even minor injuries.
5. Description of typical plant hazards and some previous accidents.
6. Stressing the need for each employee to carry out the entire safety program.
7. The concern of the company in having the new employee learn how to do his job the right way.
8. Demonstrating the practice of clear thinking under any circumstance.
9. Pointing out that the forming of good working habits, which are just as easy to form as bad habits, and once formed are just as hard to break, is a correct approach to working safely.

After the induction program, the new em-
ployee should be escorted to the safety
store, where he should be fitted with safety
shoes, safety glasses, gloves, protective
clothing or any other protective equipment
needed for his job. This procedure gives
the safety department another opportunity
in which to convince the employee of the
need for personal protective equipment and
the proper manner in which to use it and
care for it.

After being fitted out with the equipment
needed to protect himself from injury, the
new employee meets his immediate super-
visor. In the department where the em-
ployee is to work the supervisor points out
the specific hazards to be encountered and
does a short intensive job demonstration to
be sure the employee is aware of these
hazards.

If the new employee is inexperienced at
his new job or has not performed the job
for some time, sometimes a "buddy" is se-

lected to watch over him. If the department
has a job trainer, the job trainer will see
that he learns to do his job in a safe manner.

In some cases where the type of work
warrants, vestibule schools are set up to
teach the new man or woman the skills nec-
essary before he or she is allowed to work at
the normal operating speed. Vestibule schools
are those in which space has been set aside
for educational and training purposes. Ac-
tual working conditions are duplicated as
closely as possible and the new employee
learns at a rate of speed comparable with
his ability. When he reaches the degree of
skill which is required in actual operations,
he is transferred to his permanent job.

Certainly, one of the primary duties of
the shop or department safety committee-
men is to keep a close watch on the new
employee and see that he has all the safety
equipment he needs, is using it and perform-
ing his job in a safe manner.

Another form of safety education for new
employees is performed by many companies.
After the employee is firmly established in
his job, a member of the safety staff drops
by to check on the employee. In many in-
stances the safety engineer or inspector can
clear up some safety problem or policy that
has been troubling the employee. Even if
no service for the employee is performed,
he is made aware of the company's attitude
towards safety and their interest in his
welfare.

Another form of employee education is
the five-minute safety talk. Usually, at the
beginning of a shift, the foreman will call
his men together for a short safety talk.
Experience has shown that these talks do
much to keep safe practices fresh in the
minds of the employees.

Apprenticeship is an almost ideal method
of safety education for new employees. The
apprentice realizes that he is in a training
program and is very receptive to sugges-
tions, thus making it much less difficult to
teach him the safe and efficient way to do
his job.

In order for this type of training to be
effective, however, the jobs must have been
analyzed, hazards known and clearly indi-
cated so that the boys in learning the proper
sequence will also learn to avoid the hazards.

The training of a boy by turning him
over to an "old timer" is not enough. This

method could easily result in the apprentice learning the bad habits of the older employee.

Naturally, new employees who are selected for jobs in which they can do severe damage to themselves and others through their own mishaps should receive specialized training. I'm talking now about employees who have been selected for jobs as crane operators, industrial truck operators, motor vehicle operators, work-saver operators, elevator operators, etc.

The specialized training for these men should include all the safety rules and regulations that have to do with their particular job. Before these men are allowed to perform their jobs as regular employees, they should be tested and satisfactorily pass a proficiency and safety rule test.

In conclusion, I would like to review some of the types of safety education that a new employee could or should be subjected to. There are many types I have not covered, but if the majority of methods I have discussed are utilized, the new employee will become a much safer employee. Briefly, I mentioned the following methods of safety education.

1. Employment interview.
2. Review of physical conditions at time of physical examination by examining physician or nurse.

3. The induction process.
4. Visit to safety store.
5. Interview with new employee's immediate supervisor.
6. Buddy system.
7. Vestibule schools.
8. Instruction by shop or department safety committeemen.
9. Contacts by members of safety staff.
10. Five-minute safety talks.
11. Apprentice training.
12. Specialized safety training for new employees selected for extra hazardous jobs.

Finally, I urge you to inject enthusiasm into any and all of your safety education endeavors. All of you will agree with me that Al Jolson really did not possess a great voice. If he didn't have a great voice, what made him the great singing success he was? In my humble opinion, it was the "enthusiasm" that he projected into his singing. His enthusiasm really sold his song and at the same time, himself.

By the same token, enthusiasm will help us sell our safety story to the new employee, to all other employees, supervision, and general management. Enthusiasm is the mightiest asset in the world! It shatters gloom, laughs at rebuffs and conquers the unconquerable.

Supervision Needs Special Training in Job Safety Instruction Methods

By JOHN D. GALLAGHER

Senior Consulting Eng., Industrial Department, National Safety Council

As a means of preventing accidents, many organizations have set up safety programs which include, among other things:

1. Safety indoctrination of employees;
2. Safety contests;
3. Employee safety meetings;
4. Safety articles in the house organ;
5. And other projects of that kind.

Each of these, of course, when constructively carried out, makes its own contribu-

tion to the effectiveness of the over-all safety effort.

However, experience also shows that employees can be talked to, or talked at, and can read pages of printed matter, and yet fail to apply the safety message to the details of their own individual jobs. When educational efforts are applied to groups of employees, it is oftentimes hard to be specific enough about the safety problems of individual jobs to teach a man (1) what

things to avoid, (2) how to avoid them, and (3) how to do his particular job safely.

There are inherent accident hazards involved in the performance of a great many industrial jobs. Unless the man working on one of these jobs recognizes the existence of these hazards, and understands and follows the specific safe work practices that will help him to avoid them, he is very apt to become an accident casualty.

When a new employee takes up his work, it should be under the supervision of a man who believes in safety, who practices it, and who can lead other men; because it is from this man that the new employee must learn the specific job application of the general safety principles that have been taught to him during indoctrination. This is often the point where the system of safety instruction fails, because the supervisor has probably been advanced to his present job on qualifications other than his ability to teach safety. He may believe thoroughly in safety himself, and practice it, and still not be effective in instilling his own knowledge and interest into other people.

All skills and work habits must be learned, and so all the thoughts and the skills which we want a man to have about his job must be taught to him. Many plants never check into the supervisor's job instruction technique, to determine its character or even whether it exists; and, as a result, the employee is often instructed in a very haphazard way, if he is at all. In many cases a new man's statements about his own ability and experience are taken pretty much at their face value, and he is simply "tried out"; that is, he is put on the job and left to prove whether he can stay out of trouble or not.

For example, in one plant an elderly man was hired on the strength of his own statement that he had been a woodworker all his life. Without any particular instruction or supervision, in this case, the foreman tried this man out by letting him operate a circular saw. Within a few hours, the man cut four fingers and his thumb off of one hand, at a cost to the company of some thousands of dollars, which would, of course, have paid for a lot of job safety instruction.

The best logical insurance for preventing any man from becoming an accident casualty is to give him job safety instruction,

with supervisory follow-up; so that he will know just what his specific job hazards are, and will understand the specific safe work practices that will help him avoid these hazards.

Since the supervisor's responsibilities require him to be familiar with the operations, processes, equipment, materials and people under his supervision, he should also be reasonably familiar with the various job hazards and accident exposures that they might involve. The supervisor, of course, has long been recognized as being responsible for giving proper attention on the job to (1) maintaining a safe work environment, (2) educating his workers in safe job habits, and (3) enforcing his men's day-to-day safe work practices.

Specific safety educational work, therefore, is really, and primarily, a responsibility for supervisors, who, because of their authority and also their close daily contact with employees, are in a pretty good position to translate safety generalities into the everyday safe-practice procedures that apply to specific tasks, machines, tools, processes and so on. So the supervisor is logically the one who should give job safety instruction.

Of course, that presumes, in turn, that the supervisor is well qualified to give this kind of instruction to his men. As safety men, we ought to be objective in considering whether the average supervisor is well qualified to give effective job safety instruction, unless he has some special training to help him do this.

A great many supervisors have grown the hard way, which is up from the ranks. This means that the supervisor must acquire his knowledge and skill of supervisory techniques, either by picking them up as he goes along, through the "cut and try" method; or, preferably, that his supervisory skill and knowledge must be given to him in a complete, well-organized form by special training.

A few years ago one large industrial organization, in a survey of its superintendents and foremen, found that 39 per cent of the supervisors listed "How to instruct" among the top three topics they felt should be included in their supervisory training program. There were undoubtedly a good many additional supervisors in that same organiza-

tion who were in equal need of training in "How to instruct," but simply failed to recognize their own need for it; so that the 39 per cent figure would actually be rather substantially higher if it was based on the actual need for this training among the supervisors. It is just not reasonable for us to expect that the average supervisor is going to use an effective method of job safety instruction unless he is given some training in how to do this effectively.

The need for training of supervisors in safety was recognized during World War II and was met then by providing nationwide training courses in what was called "JIT," or Job Instruction Training. Also, at that time, the Ordnance Department provided a special job safety training course for supervisors in its own plants; and this course was one which would be equally applicable in any normal industrial operation. More than a million supervisors were trained in "JIT," and it is generally recognized in the training field that both these courses did a tremendously effective job of improving war production efficiency, and also of preventing accidents.

I would like to say something about the details of these courses; because if we think a little bit about the techniques necessary for getting good results through job safety instruction, I feel that it should be fairly apparent that the average supervisor just cannot be expected to use these special techniques unless he has some training to help him understand and use them effectively.

The "JIT" and Ordnance courses were both based upon the recognition:

1. That safety is vital to efficient production;
2. That workers who are not well trained in safe and efficient job methods are apt to make mistakes, and that these mistakes in turn result in:
 - a. Accidents;
 - b. Scrap and rework;
 - c. Damage to equipment;
 - d. Production delays;
 - e. And other warts on the wheels of progress;
3. And also upon the recognition that approximately 80 per cent of all accidents result, at least to some extent, from human failures, and that these can largely

be prevented through the right kind of job safety instruction:

- a. By getting workers to know the hazards of each job operation;
- b. By instructing them in safe job methods; and also
- c. By making sure that they do follow their job safety instructions.

It was estimated then that if every worker knew his job thoroughly, and did his work to the best of his ability, about 80 per cent of the supervisor's problems would either be eliminated or at least greatly minimized, including the problem of accidents. So that on that basis, getting each man to do each job safely as well as correctly, when multiplied by all of the men in a plant, would certainly seem to represent a great deal of the answer to getting out safe production.

What does a supervisor need to know in order to give effective job safety instruction? Well, it is generally recognized that he must have some understanding of the training process, and also some knowledge of effective training methods, in order to be a good instructor.

The basis of the Ordnance course was JIT. Therefore, let's take a quick look at JIT first, and later we can consider the strong emphasis on safety that was added in order to create the Ordnance Job Safety Instruction course; because the techniques involved in both of these courses do have an important bearing on our subject.

The JIT method consists primarily of two parts:

1. Planning the instruction; and
2. Presenting the instruction to the worker.

Let's briefly consider planning the instruction first.

Assuming that the one best method of performing any specific job has already been established through job studies, the principal feature in planning the job instruction is to make a breakdown of the job, which can then be used as an instruction guide by the supervisor whenever a man is given instruction in that job. Making a breakdown enables the supervisor to determine in advance just what he is going to tell the learner about the job so that the man will learn it correctly and do it safely. Making a breakdown is not a complicated process and ought not to take the experienced

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A good breakdown is really essential for good job instruction. For example, the new man on the job has to pay attention to such things as what to do with his hands, where to look with his eyes, what part of the operation to do first, how hard to push on a lever, what safety instructions to take on each step of the operation, and so on.

A lot of poor instruction, which results in accidents and other production inefficiencies, is really the result of the instructor failing to organize all the important points of the job clearly in his own mind, before he actually gives the instruction. As a result, then, he overlooks mentioning certain of the safety features, or other important points about the job, and also, he tends oftentimes to jump around from one point to another during the instruction, in such a way that he confuses the learner, rather than helping the man to learn the job quickly, safely and properly.

In analyzing a job for instruction purposes, the supervisor needs somehow to get back to the simple and elementary points of the job, where the learner will have to begin. A good job breakdown will include all of these points, and also it will enable the supervisor to give his instructions clearly, in their proper sequence, and not to overlook any of the safety points when he instructs the man.

One common way of making a job breakdown is to list, in the left-hand column of the breakdown sheet, in their proper sequence, the principal steps the man would normally go through in performing the job. The next step would be to list in the right-hand column of the sheet the so-called "key points" important in performing each of these steps safely and properly.

With reference to the importance of "key points," I would like to mention the anecdote about "Pop" Peters, who went to work on a railroad when he was 15 years old. He retired after 50 years of service, and the company gave him a banquet, and presented him with a gold watch. The president of the company was there to make the presentation, and in his speech he told how, for the last 20 years or more, "Pop" had had the very important job of going around and tapping the wheels on their

rolling stock to be sure they were in good, safe condition.

Then he said "Pop, I'd like to ask you a question I've always wondered about, before I hand you this watch. Just what do you listen for when you tap a wheel?"

Well, Pop was one of those ingenuous, simple souls, and he blurted out the truth without stopping to think about it. "By golly, Mr. President," he said, "In the last 20 years, many's the time I've wondered about that myself."

Well, there was Pop going around every day tapping all these wheels, and not knowing exactly what it was he was supposed to be listening for; which, of course, in this case was the vital key point of the job, that his job instructor of 20 years or more before, had apparently neglected to get across to him.

I mention this only to try to illustrate how important a key point can be; not only from the standpoint of doing the job right, but also as experience shows, equally so from the standpoint of doing the job safely.

In making a breakdown for instruction purposes, the job should be carefully analyzed for accident hazards, and the safe practices for avoiding these hazards should be built into the breakdown as key points. This is where the Ordnance course goes a step farther than the basic JIT method; it does provide the supervisor with a specific guide for analyzing the safety hazards of the job, so that these will all be incorporated into the instruction breakdown as key points, and none of them will be overlooked when instruction is actually given. In other words, it insures that job instruction becomes job safety instruction.

Briefly, this guide in the Ordnance program gives the supervisor five specific job factors to consider from the safety standpoint, in making his instruction breakdown:

1. The work area;
2. Materials handling;
3. Machines;
4. Tools; and
5. Improper clothing.

It also breaks each of these down further. For example, with respect to machines, it calls attention to:

1. Pinchpoints;

2. Projections;
3. The point of operation;
4. Flying pieces;
5. Power transmission, including
 - a. Line shafts,
 - b. Other shafting,
 - c. Belts,
 - d. Gears, and so on.

Planning the instruction along these lines is important for good job safety instruction, and we ought to ask ourselves whether the average supervisor will actually do a thorough job of analyzing all the safety hazards of the job, and will make an instruction breakdown that covers all of the safe practices that should be followed, unless he does have some special training to help him do this. If he fails to do it, all of the safe practices are not going to be taught to each man who learns the job; and the result is that we will have a potential accident-producing situation.

So far we have talked about planning the instruction. Now let's briefly consider presenting the job instruction to the worker.

The basic, four-step JIT pattern of giving job instruction, although it is used with some variations, is now pretty generally accepted as about the most effective method for the supervisor to use in transmitting his knowledge, skills and attitude about the job to the worker. Its steps are: *Step One*, prepare the worker; *Step Two*, present the instruction to the learner; *Step Three*, try out the worker's job performance; and *Step Four*, follow up.

In Step One: The purpose of preparing the worker is to get his mind focused on what he is going to learn. This can usually be accomplished by:

- a. Putting him at ease;
- b. Describing the job to him, and finding out what he may already know about it;
- c. Arousing his interest in learning the job; and
- d. Putting him in a position where he will see the work from the same angle he will see it from when he actually does the job, so that he will not see the motions backwards; which would confuse him in trying to learn the job safely and properly.

In Step Two: Presenting the operation combines:

- a. Explaining, showing and illustrating the details of the job to the learner;
- b. Cautioning against common errors;
- c. Calling his attention to safety points he might not notice for himself; and then
- d. Repeating the job presentation, step-by-step clearly, completely and patiently, a sufficient number of times so that the learner will understand all of the steps and safety points involved.

In Step Three: Trying out the worker's job performance gives the man an opportunity actually to "learn by doing," while the instructor is still with him to correct mistakes and to guide him in establishing safe and proper habits of job performance. In this step, the instructor has the learner explain each key point as he does the job, to be sure that the man really understands just what he has been taught. If this step is not carried out in just this way, experience shows that the learner can still lack knowledge of the safety precautions, after the instruction is thought to be completed, with the result that we will again have a potential accident-producing situation, if this Step Three is not carried out properly.

In Step Four: The instructor follows up the instruction by watching the learner regularly to be sure he does continue to use the safe and proper job methods he has been taught.

An instruction technique of this kind is important for good job safety instruction, and, again, when we consider whether "Supervision Needs Special Training in Job Safety Instruction Methods," we ought to consider whether the average supervisor will actually plan and give the kind of job safety instruction I have tried briefly to describe, unless he does have special training to help him do this. We could hardly expect him to do this without special training, because a special technique is necessary that he can understand and use effectively only if it is taught to him.

The practical question then arises as to what we can do as safety engineers to see to it that supervisors do get this kind of special training. The answer to this will naturally vary according to the position and relationships of the safety man within his

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own company organization, and also accord-
ing to the facilities that may be available
to him.

For example, if there is a training de-
partment in his organization, he can prob-
ably get them to present job instruction
training to his supervisors, and then he can
participate in that training himself, at least
to the extent of being sure that there is
enough emphasis on safety in its presenta-
tion. If there is no training department, the
safety man will either have to do the train-
ing job himself, or get someone else in from
the outside to do it for him.

If he needs outside help, he may be able
to make arrangements with his State De-
partment of Vocational Education to send
a man to the plant to give the training to
the supervisors. Many of these State de-
partments will do this upon request.

Another source of outside help would be
the Training Within Industry Foundation,
which is a non-profit organization located
at Summit, New Jersey. Arrangements can
be made with them to send a man from the
plant to attend one of their five-day insti-
tutes, which are held periodically at various
locations throughout the country; and upon
his return to the plant this man would then
be qualified to train the plant supervisors in
job instruction methods. If it is not feasible
to send a man to one of these institutes,
arrangements can be made with the Founda-
tion to send one of their trainers to the
plant, and he will give this training directly
to in-plant supervisory groups.

If the plant is located in a well-indus-
trialized area, it may be possible for the
safety man to locate some individual in
either the training or the safety department
of another near-by plant, who is or has been
a qualified trainer in JIT. It may be pos-
sible to have this man come into the plant
and present the training to in-plant super-
visory groups. If this is not feasible, the
safety man can very likely learn enough
from this other individual about the basic
principles and effective presentation of job
instruction so that he can at least indoc-
trinate his own supervisors with these prin-
ciples to the extent that they will be able
to give effective job safety instruction.

Also, if the safety engineer is going to
have to rely upon doing this training job
himself, possibly through individual contacts

with supervisors, or in supervisory meet-
ings, in many cases he can acquire addi-
tional personal knowledge regarding the
principles of effective job instruction and
how to present it to his supervisors, by
writing to the extension division of his state
university. Many of them have such infor-
mation available and will provide it upon
request.

Also, there are various films available
which outline the basic principles of effec-
tive job instruction, and which can be used,
with discussions, at supervisory meetings
for indoctrinating supervisors with these
principles for their effective use in giving
job safety instruction.

For example, there is a sound-slide film
entitled, *Teaching Safety on the Job*, which
is put out by the National Safety Council.
Also, there are two sound-slide films avail-
able from United World Films, in New
York City. One of these is an 11-minute
film entitled *The Job Breakdown*, which
covers planning the instruction, and the
other is a 15-minute film entitled *The Four
Steps*, which covers presenting the instruc-
tion to the worker.

There is also a 16mm sound movie en-
titled *Instructing the Worker on the Job*,
distributed by Castle Films through their
offices in New York, Chicago and San Fran-
cisco. There are also other films available
from various sources on this subject.

In actual practice, a good many foremen
turn new employees over to their group
leaders for job instruction, and therefore
feel there is no real need for their own
training in job instruction techniques. It is
generally felt, however, that foremen should
have this training, preferably before their
group leaders do.

The fact that this training is given to
the foreman first usually makes the group
leaders feel it is important for them to
learn and use this technique effectively
when they do give job instruction to new
or transferred workers. Also, a knowledge
of this technique will enable the foreman
himself (1) to see to it that his group
leaders and other subordinate supervisors
use this training method consistently and
effectively, (2) periodically to evaluate the
effectiveness of its use by his subordinates,
and also (3) to spot-check periodically on
just how well his own workers are being

instructed in safe and correct job performance.

Before a supervisory training program of this kind might be instituted, the safety man can stimulate the interest of his foremen in taking the training themselves as well as having their group leaders and other subordinate supervisors take it. I have seen a good many plants, for example, where the safety man, as a result of building up a strong, friendly relationship with each individual foreman, has been able to get their real personal cooperation all the way down the line on safety. In a situation like this, the safety man can sit down with an individual foreman, and, by demonstrating to him the effectiveness of the four-step instruction method as contrasted with the poor instruction results of merely "telling" or "showing" a man how to do a job, he can oftentimes stimulate the foreman's interest in the instruction technique to the point where he will want to take the training himself.

Usually, when the foreman takes this training himself and becomes sold on the value of using an effective method of job safety instruction, he will then follow through to the point of insuring that his supervisors make continuing and consistent use of effective job safety instruction; so that, instead of being a spasmodic effort which quickly dies out, the result of the

supervisory training program will be the permanent use of effective job safety instruction methods.

If a safety engineer is not able to sell his management on group supervisory training, he can at least indoctrinate his individual supervisors with the principles of good job safety instruction through individual conversations and demonstrations of the kind I have just mentioned; also by the use of films and discussions on job safety instruction in supervisory meetings; and by helping supervisors to make job breakdowns, and giving them occasional follow-up help when they do give job safety instruction to new or transferred employees.

In closing, I would like to repeat two of the points I have tried to bring out during this discussion:

1. If we do not use an effective method of job safety instruction similar to the general methods of the JIT and Ordnance Department programs I have briefly outlined, we cannot expect to get good safety instruction on the job; and also
2. We cannot expect the average supervisor to use an effective job safety instruction technique unless he does have special training to help him do this, because a special technique is necessary that he can understand and use effectively only if it is taught to him.

What Shall We Teach the Safety Engineer of Tomorrow?

By WILLIAM D. RENNER

Safety Supvr., Schering Corp., Bloomfield, N. J.

The safety profession is no longer an infant. It is, however, still growing by leaps and bounds. We can now look back over more than 40 years of hard-gained experience in organized accident prevention work and count the benefits in impressive terms. It is more important, however, that we look to the future, where the best safety work is yet to be done.

We cannot predict all of the problems which will face the accident prevention

expert of 1980, but we have a pretty good idea of what some of them will be. We must make our experience available as a guide for tomorrow's men in meeting their problems, just as we today are using the experience and knowledge which has been passed along to us by those who pioneered the movement in 1912 and 1913.

The accident prevention field is always changing. When one type of hazard is brought under fairly good control, such as

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machinery guarding, another, such as radiation, arises. To meet these changing situations, we must have trained and qualified men.

In the state of New Jersey, this need has been recognized by state labor department officials and they have requested legislation pertaining to the registration of qualified safety personnel for New Jersey industry.

Tomorrow's problems may be complex. They will be best met through the practical application of safety theory. This is our great need, today and tomorrow. This we must teach. There is no time to sit and dream where safety progress is concerned. We've made a start. Let's keep rolling. Let's help the "new man" stay ahead of his accident problems, as we like to stay ahead today.

What shall we teach? Fundamentals! Basic knowledge is a foundation, a framework upon which the finished structure is applied through practical experience. It is recommended, therefore, that we teach the following:

1. Basic principles of the individual engineering sciences.
2. A concept of the science of the preservation of industrial health.
3. Accident costs and how to estimate their true value.
4. Safety philosophy and safety psychology.
5. How to educate, how to train in regard to safety.
6. Pride in the dignity and stature of the safety profession.
7. How to get along with people—and vice versa!

A brief discussion of each of these points will illustrate their importance in the education of a safety engineer.

Engineering principles. The safety of any facility or piece of equipment has its roots in the engineer's drafting board. It has often been found that when safety features are incorporated in the original design of facilities and equipment, a large obstacle to accident prevention is removed. To assist in such matters, the safety engineer must be an engineering jack-of-all-trades. His knowledge of principles must include the following:

Electrical. The whys and wherefores, and methods of grounding. The basic phenomena of voltage, current, circuit wiring, transforming and distribution of

electricity and the necessary precautions against accidents and injury of an electrical nature. This information is readily obtained from the handbooks and codes on the subject.

Chemical. The corrosive, toxic and flammable properties of all chemicals and how to safeguard against them. Once again, fundamental knowledge of chemistry, plus recourse to handbooks, National Safety Council data sheets, trade publications and so on, will provide the necessary information for practical application in the field.

Mechanical. A knowledge of machinery guarding principles is indispensable to the safety engineer. Also included in this field are the fundamentals of ventilation, which will always be an industrial problem. The steady advance of automation brings new matters of mechanical safety to be properly controlled.

Civil. An idea of construction safety features, such as fire resistive properties of materials, floor loads, stresses and strains, adequate access, entry and exit facilities, is important for intelligent scanning of blueprints. The safety-man-to-be must be taught to read plans and to find the answers to his questions in the N.F.P.A., state labor department, American Standards Association, M.C.A. codes and publications.

Industrial Engineering. The movement of materials through all phases of processing creates many safety problems. The safety engineer will do well to maintain close liaison with industrial engineering people, who are constantly devising newer, more efficient and usually safer ways to move materials.

Radiation. Finally, there is the work of the physicist, with all of the problems of radiation. How extensive this will be in industry in the future, we cannot say. The control of radiation is prescribed. The safety engineer must master this prescription and apply it daily. There is an ever growing file of literature on the subject, and numerous public agencies are equipped to give answers to radiation problems.

All of the above sounds like a big order, and so it is. Such a wide knowledge is not easily or quickly gained. By teaching the

young safety man *where to find the answer*, we will do much to further his education and equip him in the never-ending fight against accidents.

The young safety engineer can be equipped with a degree in any of the above engineering science fields, or from an arts or business college, but he will soon discover the need for basic knowledge in all of the science fields.

Industrial Health. Although this field is a profession in itself, it is closely allied with the industrial safety effort. In many instances, it is the safety engineer who is called upon to deal with industrial health problems from a preventive standpoint. New sciences make this aspect of accident prevention extremely important.

Knowledge is necessary about the forms and types of air contaminants, dermatitis causatives and preventive measures, the manner in which industrial poisons can attack the human system and the mechanical and physiological controls necessary to protect health against them.

Safety Philosophy. In the matter of a safety philosophy and psychology, we must teach the concept of safe individuals, rather than safe workers. We must point out that human actions are dictated from the mind and, therefore, the mind must be directed in its thinking along safe channels.

Through elementary psychology, such as the use of accident experience, and the play upon the various basic drives of a person, we can exercise a *safety influence* on the average person's mind. Here, too, the use of promotive efforts, advertising techniques and continuous propaganda can get an individual to adopt his own safety psychology.

A sound safety philosophy will teach that we must realize that we will always have accidents, but we must also constantly direct our efforts toward the irreducible minimum of such occurrences and the best possible control of their *consequences*.

Accident Costs. A true knowledge of accident costs will be very helpful to the young engineer. These costs must be interpreted not only in monetary terms, in chargeable accident statistics and in the language of direct and indirect costs. They must also be understood in terms of their effect on productive capacity and of their effect upon the individual and society.

How to use accident costs is very important. When shown in their true light, they are a powerful argument for the entire safety movement. Knowledge of the right way to display these costs and make them into an effective tool will help the safety man in his ceaseless battle to apply preventive controls on the onrushing accident problem.

Education and Training. We must teach the safety engineer of tomorrow how to teach. True recognition of the part played in accidents by the human factor has been ours for many years. Here, perhaps, is the biggest part of the safety job. The man who does this job must know how to train, how to educate.

Industrial safety training is an art. It utilizes tried and successful teaching techniques, the best and most ingenious of visual aids. It calls for lively imagination and a repetitive effort. The safety engineer must realize that his training and education work is like an inoculation, but an inoculation that is not permanent, because here we are dealing with *minds of people*, which are *always* alive.

A major part of the safety engineer's education work is directed at supervisors. They must be well grounded in safety principles so that they can do the bulk of the safety education *in the field*, where it counts the most.

Roast beef today, beef pie tomorrow and hash on Wednesday. That is safety. The same dish, constantly served, in many forms.

Pride in Profession. Let us also teach the coming safety engineer the value of safety work, so that he may have justifiable pride in his profession. Let us help him enhance and dignify his stature so that he is always respected for what he is trying to do—prevent accidents, save lives, alleviate suffering and protect property.

We shall teach him to recognize the rewards that come from the knowledge of a safety job well done. If these rewards are not always material in nature, they can certainly many times have a spiritual value that can balance the occasional frustrations of any hard working safety engineer.

How to Get Along. Finally, and of utmost importance, we must teach the men who will follow us the necessity of *getting*

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along with people. A good part of the safety job is getting people to do for you. Tact, firmness, diplomacy, humor, understanding . . . Dale Carnegie stuff perhaps, but indispensable for this type of work.

The entire success of a safety engineer's efforts depend upon his ability to get people to do things for him, and to do things his way, the safe way.

Summary. As we put all of the foregoing thoughts into a final two paragraphs, we reach again the following conclusion: The major items we are to teach the 1980 safety engineer are the fundamentals of the various engineering sciences, a concept of safety

philosophy, how to present accident costs so they help in reducing further costs, how to educate and train and influence the formation of safety habits, and how to get along well with people and keep them on the right side.

By this type of teaching, which will be based on the nearly 50 years of experience in the field of organized safety, we must create a desire and demand for careers in the safety profession. Then we can be assured that all of the good work already done in the interest of accident prevention will continue to be fruitful and will be further cultivated by competent hands.

The Human Element in Industrial Accident Prevention

The Human Element in Industrial Accident Prevention

(Panel Discussion)

Discussion Leader: Walter A. Cutter, Ph.D., Assistant Director, Center for Safety Education, Div. of General Education, New York University.

Participants:

Leon Brody, Ph.D., Director of Research and Publications, Center for Safety Education, New York University.

John C. Larson, Research Associate, Center for Safety Education, New York University.

Hugh M. Jackson, Manager, Industrial Health Program, Johns-Manville Corp., New York.

H. J. Spoerer, Director, Industrial Relations, The Youngstown Sheet & Tube Company, Youngstown, Ohio.

DR. CUTTER:

The subject of this meeting is the same as the title of a book based on research conducted by the Center for Safety Education of New York University and published this year.

The book contains much material not usually found in safety papers. Except for incidental treatment, details of safety engineering procedure have not been reviewed. This was not to minimize the importance of safety engineering but rather to draw more attention to behavioral factors.

The only constant in the human factor is its variability. In dealing with this human factor, we must take into account not only basic human similarities which permit group controls to function but also individual differences which make special control measures necessary.

There is a segment of opinion which discounts research, preferring common sense, which really is quite uncommon. It is much

better to study a question than merely to hold opinions.

Inevitably, some of the material is rather elementary. The book, of course, does not answer all questions ultimately. But nowhere in the whole field of human activity have all questions been answered ultimately.

DR. BRODY:

The Center for Safety Education has received numerous complimentary remarks concerning its publication, *The Human Element in Industrial Accident Prevention*. Few letters and reviews, however, have really evaluated the publication and pointed out omissions or weaknesses in content. The complimentary remarks are welcome, of course, but it would have been helpful to us and to the cause of industrial safety if more specific possibilities for improvement could have been identified. After all, 100 pages cannot tell the whole story of the human element in industrial accident prevention, although we do feel that the publication tells a great deal.

The reviews appeared in periodical literature of management, medicine, psychology and safety. There is not a single critical comment of specific suggestion. The discussion this morning will provide opportunity to correct this situation. A small number of individuals did make specific comments in letters. These included a vice president, a medical director, a director of training, a director of personnel, a director of safety, a public relations manager and a mechanical engineer, among others. The comments of this small but obviously representative group fell into four categories: 1. Application of findings 2. Labor market considerations 3. Level of writing and 4. Topics omitted.

Application of Findings. Most of the reviewers said they wished that ways of ap-

plying the findings had been discussed. The value of such discussion cannot be questioned. However, it might have been confusing to include applications in a volume devoted essentially to research considerations. It may be well to undertake a companion volume for this purpose.

Labor Market Considerations. A majority of the reviewers pointed out that a shortage of labor supply often prevented organizations from carrying out the research implications for hiring procedures, although, in general, they subscribe to these implications.

One must agree that selective hiring is limited by the labor market, but only to a certain degree. Much can be accomplished to help offset this limitation by adequate training and by supervision based on the psychology of motivation and the principles of human relations.

Level of Writing. About half of the reviewers felt that the publication was entirely digestible. The rest had mixed opinions and felt that it made "tough" reading in sections.

Topics Omitted. "Application of findings" has already been discussed as a topic that did not receive coverage. A few reviewers wished more information had been provided on accident investigation. Some desired more information on rest periods, employee benefits, and so forth.

One comment deserves special recognition: The mechanical engineer thought there should have been more coverage of the engineering aspects of the problem. He was not convinced by the explanation in the preface: "Except for incidental treatment . . . matters of safety engineering have not been reviewed; this was not to minimize the importance of safety engineering, but rather to draw more attention to behavioral considerations."

MR. LARSON:

The book which provides the basis for this discussion was born almost of desperation. Like many of you, we found it almost impossible to absorb or keep up with the literature in industrial safety. And nowhere, to our knowledge, was there any anthology of research. Accordingly, we decided to consolidate the findings pertinent to the human aspects of industrial safety. These findings were culled from many fields, since many fields have to do with human beings.

Since safety engineering was doing a much better job of informing itself, and since its findings were pretty specific and up to date, the medical and behavioral sciences received the most attention. Except for general treatment, matters of safety engineering were not reviewed.

We examined nearly 1,000 references to safety which appeared in medical psychiatric, ophthalmological, optometric, psychophysical, psychological and sociological journals, periodicals and texts. About 500 of them were abstracted and over 100 were summarized in the book; the remainder were eliminated either because they were unsound or because they duplicated better studies.

Projects which didn't mention safety but which had considerable relevance were referred to in the bibliography. In addition, we set up a glossary of technical terms and tests for the convenience of our readers.

As a result of these labors, we reached the following general conclusions:

1. The majority of potential accident risks can be detected before they are hired by dint of a careful analysis of their job histories, references, their injury and accident records in all walks of life, their hospitalization records, and their civil, federal and court martial offenses. You will note that all of these factors indicate a person's stability, and they can be obtained easily from thorough application forms and skillful interviews. This is not to say, however, that prediction can be 100 per cent.
2. Psychological tests, well chosen and carefully administered, can suggest signs of instability if their results are supplemented by the data described above. Prediction is commensurately increased here.
3. Medical screening also is very helpful. Many obvious illnesses make a man a poor risk, but it is equally true that many illnesses are not necessarily portents of a bad accident and injury rate. In fact, under the proper circumstances, people with certain disorders and/or physical disabilities perform as well as (or better than) workers who enjoy good health.

These were the general findings as far as pre-employment safety efforts were concerned. Our research also showed that there

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are a number of post-employment practices which are of great help in reducing accident tendencies, accident rates and injury rates:

1. Thoroughly briefing and generally assisting the new worker to adjust himself to his job have proven valuable. However, mere token efforts along these lines can, on occasion, be worse than letting him shift for himself.

2. Putting the new worker in the job for which he is best fitted and then training him thoroughly for that job are essential aspects of a good safety program. Again, token training can be disastrous, nor is it wise to harp on safety too much. Efficiency and safety are almost one and the same.

3. Physical working conditions should be as attractive and efficient as possible. In addition to machine design, guards, plant layout, lighting and protective equipment, certain other aspects seem significant, such as five-meal eating schedules to counter fatigue (many physicians, as a matter of fact, recommend this over the normal three-meal schedule), careful sound-proofing and the like.

4. Though rather intangible, the social and psychological elements of the work environment seem to play more important roles in causing accidents and injuries than do physical working conditions. Low morale and a dissatisfied work force generally are associated with high accident and injury rates, lowered production, high breakage and waste rates, and impaired efficiency; they also breed cliques, factions, personal enmity and personal competition. A co-operative atmosphere, on the other hand, usually is associated with the opposites of all these things: a number of studies underlined this point directly.

The research on this type of bad situation indicates that the main problem is to improve morale and decrease dissatisfaction. Financial incentives alone, award programs, poster contests, more recreational facilities, and other more or less superficial approaches often have been found to meet with little or temporary success. However, profit-sharing plans, joint group conferences with employees on ways of solving plant problems, and similar techniques of gaining the cooperation of workers by allowing them to participate in the company's affairs and contribute to its progress and welfare, have proven valuable.

Safety committees are an obvious means of accomplishing these aims, although, theoretically, they are concerned only with accident and injury prevention, they have the added advantage of allying workers with a management in the joint solution of mutual problems.

5. Management also has at its disposal another way of cutting down accidents and injuries. Studies have shown that accidents and/or injuries often are preceded or accompanied by certain behavior—certain hints of trouble. Among them are absenteeism, chronic visits to the medical department, a series of minor injuries and accidents, frequent complaints and evidence of poor performance on the job. In combination, these things often can predict who is likely to have an accident, and, thus, where it is likely to occur. It is very important, therefore, that accident reports and reports from foremen, supervisors and the medical department be collated and *carefully examined* at some central point so that maximum use of them can be made.

Although there were a number of specific and detailed findings, these were the major findings of fact. To most of you, they may be rather obvious. But we feel that we have provided a concrete basis for these measures. No longer need a safety man rely on hunches, opinions, and so forth. Perhaps some misconceptions were brought to light.

We were appalled at the number of poorly-conducted studies—so much so that an entire chapter was added spelling out deficiencies and recommending research practices. As above, many of these deficiencies were obvious, most of them constituted nothing more than standard operating procedures in research, but we felt that they had to be put in writing.

MR. JACKSON:

The book prepared by the research staff of the New York University Center for Safety Education is an excellent approach to that all-important phase of accident prevention—the human element. Statistics have led us to believe that 85 per cent of our accident experience have causes directly related to human failure or operators' errors in judgment.

The findings and observations contained in this book are a challenge to our present concepts of employment, medical, training

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and job safety programs. The data indicate that a close scrutiny of our present activities and techniques in these fields should be made. While there are vast areas of research yet to be embraced, the information summarized in this book provides many thought starters toward making our in-plant practices more effective in the control of the human element.

The complexity of the "human element" demands a much more complete integration of the activities of employment, medical training, methods engineering and line supervision.

The fields of discussion covered in the book are relatively new and require a preciseness in terminology. This problem has been recognized by the authors, and an excellent glossary has been included.

The New York University Center for Safety Education is to be highly commended for this summary of research. It is an excellent inquiry into the current status of our knowledge of human behavior and its relationship to accident prevention.

There are a few areas, however, in which my remarks concerning this publication cannot be so complimentary. In an early portion of the book, there is the inferred philosophy that selection methods, tests, interviews, and so forth, should be used as a means of discarding the unfit, of rejecting those of high accident liability. This attitude is reminiscent of the early function of the physical examination. However, we have come to recognize that the purpose of the physical examination is to know the limitations of the individual in order that proper job placement may be made. Similarly, I would recommend that the evaluation methods discussed be used for appropriate placement of the individual, rather than total rejection for employment.

Although Dr. Brody has already commented on the omission of the field of safety engineering, I still believe that coverage of this field would enhance the value of the text. Certainly, the recent developments in engineering design which minimize the opportunity for human error in judgment should be given some attention. Recognizing the many factors that make up human behavior, it appears logical that anything that can be done from an engineering standpoint to keep that behavior within acceptable limits is desirable.

Another area for consideration is that of changes in our labor relation concepts that should be made according to research completed to date. In most labor contracts, seniority plays an important part in the matter of job assignment. The research findings indicate that for purposes of accident prevention, job placement must be made on the basis of physical, mental and emotional capacities.

The much maligned word "automation" suggests another problem area. The maintenance of motivation and morale in a work situation which demands a minimum of physical effort and an upgrading of mental acuity may be much more difficult than today's morale problems. Further research toward the development of a simple and practicable technique of morale measurement would be of inestimable value to industry.

MR. SPOERER:

Let me quote from the synopsis of Section II of the book, *Psychological and Sociological Characteristics*:

"According to research, intelligence tests do not identify accident-free workers from accident repeaters, except at the extremes. The same thing is true of tests of general coordination, hand-finger skill, and arm-hand facility, as well as of knowledge of mechanical operations. However, where exceptional ability along these lines is needed to perform the job safely, these tests are of some help.

"An interest in mechanical things seems to be associated with safe workers to a certain extent—apparently because workers with such an interest tend to recognize dangerous situations more readily than those who do not.

"Several studies have shown that personality has a lot to do with accidents. Specifically, how well a worker adjusts himself to everyday living seems to be important, as is his ability to get along with other persons. Such things, of course, are reflected in his past record, so a careful check of references, banking habits, home ownership, indebtedness, arrests and other indexes of stability or instability are very helpful to the personnel department."

There is a wealth of information bound in this book of less than 100 pages which, if properly analyzed, may furnish the cues to some problems or suggest new avenues,

and in some instances confirm what you already thought.

The tests generally seem to be too small a sampling to carry the proper weight. It is indicated that psychophysical tests (visual acuity, reaction time, hearing, and so forth) still outnumber all other categories of accident research but are on the wane. Psychosocial tests (social factors related to psychological factors) are getting greater emphasis.

One test made by Harris concluded that accident proneness, implying a psychological predisposition to get hurt, may have been greatly over-rated. The Purdue University pegboard test findings were found to vary in a work situation involving more mechanical operations. The finding that mechanical interest was correlated with a good accident record must be examined more closely. Mechanical interest, which often goes hand in hand with mechanical ability, differentiated the "accident prone" from the "accident free" group approximately 95 per cent of the time.

The authors emphasize situational factors in their conclusions. They imply that a person lacking psychological predisposition toward accidents is unlikely to have an accident, even when an accident-producing situation develops. The inference seems to be that, despite an inability to predict "accident proneness" from the results of the study, the investigators believe personality characteristics have something to do with accidents. More information is needed.

One test by Whitlock and Cramell, comparing 100 "major accident" cases with 200 accident-free cases, disclosed that neither mechanical comprehension test scores nor intelligence test scores had any significant relationship to the occurrence of accidents.

The accident-free group appeared less "neurotic," less introverted and more self-confident than the accident group.

This research report indicates that so far we have only scratched the surface of the problem.

We shall be obliged to develop some technique that is simple to learn and apply to determine what social factors are related.

SUMMARY OF DISCUSSION

Mr. Jackson: We must have something reasonably simple to interpret and use. The doctor can discover much in his contacts.

Psychological tests and interpretations must be regarded in terms of practical considerations.

Dr. Cutter: We must distinguish between original research and the problems of applying the findings. There is need for a book which will indicate where findings can be applied and what compensating devices can be used.

Dr. Brody: Some possibilities of application have been indicated briefly in the text. In most instances, there has been nothing new in practical applications.

Mr. Spoerer: We want to hear things to help us in our work. There is no substitute for prompt investigation of accidents. Too often there is a waiting period of hours which gives those involved a chance to think up alibis and cover up the facts. Many persons enter the field without adequate training or experience. More material is needed for their guidance.

Dr. Brody: We should also consider investigation of near-accidents, which outnumber personal injury accidents but are due to the same causes.

Mr. Spoerer: This is being done on a large scale.

Dr. Cutter: Another subject to consider is automation and its possible effect on boredom fatigue, the most common type of fatigue.

Mr. Jackson: Another area for research is morale, to evaluate such morale builders as pensions, recreation and other fringe benefits.

Mr. Spoerer: Morale is a fundamental. In addition to the familiar "Three E's," we need a fourth—Enthusiasm. It means more than words; it must come from the heart, or the other "Three E's" won't do much good.

Question: Is the 85-per-cent-of-accidents attributed to human causes high or low?

Answer: We are too inclined to blame everything on human failure. That doesn't tell what really happens. We fail to engineer properly for human beings. Boredom fatigue is one of the problems.

Question: What about accidents to the experienced worker? I refer particularly to the man who doesn't use all his abilities on a job.

Answer: It is sometimes just as bad to

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place a Class A man on a Class C job as
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for his abilities. The experience of many
companies is that the more hazardous jobs,
which require closer attention, often show a
better accident record than easier and ap-
parently safer jobs.

Question: Is there any relationship be-
tween safety on the job and off the job?

Answer: Research by General Electric
showed that employees who received safety
training on the job were six times as safe
in traffic as the average for the community.

Question: Do medical studies indicate
noise as a contributing cause to accidents?

Answer: Every accident is the result of
a number of contributing factors. Present
knowledge indicates that noise is one of
them.

Dr. Cutter: Any man can be employed
if we know enough about him and compen-
sate for his defects. Indiscriminate use of
the word "unemployable" is unfortunate.
Much could be accomplished if we paid as
much attention to men as we do to machines.
Large industries must do more training.

"Z16.1" The Yardstick of Safety Performance

The Origin of the Standard and Recent Revision

By H. GENE MILLER

Dir., Statistics and Library Div., National Safety Council, Chicago, Ill.

The search for a way to make comparisons of accident statistics started in 1914 when the U. S. Bureau of Labor Statistics initiated a meeting in New York of Workmen's Compensation officials. In 1915, the Committee on Statistics of the IAIABC (International Association of Industrial Accident Boards and Commissions) also began a study of the problem.

In the beginning, injuries were expressed as so many per 1,000 workers. This was not sufficiently precise because numbers of workers varied from day to day, there were differences in the hours worked, number of days worked per year, and so forth. This led to the development of a unit of hours which at first was set at 3,000, then 2,400, and 2,000.

All of these units had disadvantages; so finally, in 1919, a complete break was made with the odd units and the 1,000 hour unit was adopted. Frequency rates were expressed in terms of 1,000 hours. The severity rate was expressed in a single 1,000 hour unit.

A system of assigning time losses for computation of severity rates was worked out by the U. S. Bureau of Labor Statistics in the early part of 1914. As first used, the time allowances as fixed by the Wisconsin Workmen's Compensation Act for Specific Injuries were applied. Later, these time allowances were changed, death being based on life expectancy, and permanent disabilities on the New York scale increased by 50 per cent.

It is interesting to note that the time charges as developed in the first table of such charges continued unchanged until the 1955 revision of the Standard, when the charges for fingers and toes were revised. During all those years, the charges were reviewed several times, but each review in-

dicated that they still represented proper values.

In 1926, the American Engineering Standards Committee (now the American Standards Association) was officially requested to initiate a project on accident statistics. This was done in that year, but the first Standard was not approved until 1937. Since then there have been two changes in the Standard. One occurred in 1945 and the latest one in 1954.

Regarding the recent changes, the first one I will mention is the title of the Standard itself. It is now titled the *American Standard Method of Recording and Measuring Work Injury Experience*.

Next, the new Standard includes a section on "Definitions," in which all of the terms used throughout the Standard are defined. An Appendix to the Standard is new, where interpretations are presented covering certain common situations.

For the specific changes, I will discuss these in the order in which the items appear in the Standard.

Medical treatment injury. This classification in the new Standard covers all non-disabling injuries and combines two separate classifications which had been set up in the previous Standard: (1) temporary partial disability, and (2) medical treatment injury.

Disabling Injury. The new Standard states specifically that the injury used in calculating the standard injury frequency and severity rates is identified as a "disabling injury." In the old Standard, this was loosely referred to in many ways, with the term "lost-time injury" developing importance through usage. Some injuries used in developing injury rates may not result in lost time (permanent partial disabilities), and the term "lost time," therefore, is not entirely accurate.

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Charge for finger and toe amputations. As mentioned earlier, the scheduled charges for fingers and toes were changed in the latest revision. Previously, each finger had the same charge—300 days. In the new Standard, each finger has its own charge, with the little finger, for example, having a charge of 200 days, and the more important index finger a charge of 400 days.

It is difficult to set down all the specific charges in a written report, so I will cover them briefly and suggest that each of you obtain a copy of the Standard itself for reference use. (It may be obtained from the American Standards Association, 70 E. 45th St., New York 17, New York).

In addition to each finger having a separate charge, each joint of each finger has a separate charge, and for the various fingers these are as follows: Little finger, distal phalange—50 days, middle phalange—100 days, proximal phalange (entire finger)—200 days.

For the other fingers, the respective charges are: Ring finger—60, 120, 240; middle finger—75, 150, 300; and index finger—100, 200, 400. The charge for a thumb remains unchanged at 300 days for the distal phalange and 600 days for the proximal phalange.

Each toe except the great toe has the same charge, but these are different than in the previous Standard. Distal phalange—35 days, middle phalange—75 days, and proximal phalange—150 days. For the great toe, the distal phalange has a charge of 150 days and the proximal phalange a charge of 300 days.

In evaluating finger and toe losses, the charge for each digit is the charge assigned to the highest valued bone involved.

The charges are not cumulative; only one charge is used, and that is the one assigned to the highest valued bone involved. To get the charge for two or more fingers, merely add together the charges for each finger. This is a much simpler method than that used in the previous Standard, where percentage losses had to be averaged and then applied to total charges, which varied disproportionately depending on the number of fingers involved.

Disabling Injury Severity Rate. The injury severity rate in the new Standard is on the same basis as the frequency rate—

1,000,000 man-hours of exposure. The method of calculating the rate is unchanged, and in fact rates calculated on the new basis will be the same as those calculated on the old basis except that the decimal point will be moved three places to the right. A severity rate which would have appeared as .25 previously will now appear as 250. In calculating rates, it is recommended the decimals not be used, but that the rate be rounded to the nearest whole number.

Average days charged per injury. In addition to the injury frequency and severity rates, a third measure has been included in the new Standard. It is the Average Days Charged per Injury.

The severity rate has frequently been misinterpreted as indicating the severity of the injuries. It does not do this, but merely indicates the rate of loss from injuries. The new rate, average days charged per injury, will tell how severe injuries are on the average. It is determined by dividing the total number of disabling injuries into the total days charged as a result of these injuries. It may also be determined by dividing the frequency rate into the severity rate.

Injuries charged to date of occurrence. This is not really a change in the Standard, but merely sets down in writing an important point of procedure. It is of particular importance today with the increasing emphasis being given to no-injury records. It states that a no-injury record terminates on the day an accident happens, regardless of the delay which may result before the injured person begins to lose time.

Back Injury. An attempt has been made in the new Standard to obtain more uniformity in the handling of back cases, and to avoid charging as injuries back conditions which do not arise out of and in the course of employment. The procedure set forth is not very precise. It is generally recognized as a starting point from which further refinements can be made.

The Standard says that a back injury or strain shall be considered a work injury only if it meets both of the following conditions: (a) There is a clear record of an accident, or an incident such as a slip, trip or fall, sudden effort, over-exertion, or blow on the back; and (b) the physician authorized to treat the case is satisfied, after a complete review of the circumstances of

the accident or incident, that the injury could have arisen out of said accident or incident.

Disability arising solely out of physical deficiency. The new Standard provides that injuries which arise solely out of physical deficiencies shall not be charged as disabling cases. The purpose of this change was to avoid penalizing a company for hiring a physically handicapped person should the physical handicap give rise to an injury. For example, if a worker with an artificial foot suffered an injury in a fall which resulted when his impairment caused him to lose his balance, this injury would be determined as having arisen solely out of the pre-existing physical deficiency, and would not be considered a work injury.

However, if an injury arises out of and in the course of employment, it shall be considered a work injury even though the employee had a pre-existing physical deficiency. Suppose the same situation existed as in the previous example, except that the worker lost his balance and fell when he stepped on an object on the floor. Since this injury did not arise *solely* out of his pre-existing physical deficiency, it would be considered a work injury.

Aggravation of Minor Injury. This is another point which does not really represent a change in the new Standard, but again merely represents stating specifically an interpretation that was followed even under the previous Standard. The Standard now states that if a minor injury is aggravated because of improper diagnosis or improper treatment, either professional or non-professional, or if infection develops later, either on the job or off the job, the injury shall be classified according to the ultimate extent of the disability.

The above points cover the principal changes that were made in the Standard. All of us may not agree with the changes that were made; in fact, we may not all agree with the Standard itself. When as many people are involved and interested as there are in connection with standard injury reporting, it would be a miracle if everyone was in agreement on every point.

However, much more will be gained if all companies will record and classify injuries in accordance with the Standard procedure, so that valid comparisons can be made among companies, than if each person records and measures his injury experience according to his own preference.

Its Application

By HENRY B. DUFFUS

Administrator, Accident Prevention, Westinghouse Electric Corp., Pittsburgh, Pa.

As the Daily Stock Control Sheet is to the stockbroker, the Daily Racing Form to the bookie, the Weekly Market Price List to the farmer, so also is the *Monthly Injury Report Form* to the management of a plant.

Modern management must be kept informed of their progress in injury control through a measure that can be applied nationally, permitting them to compare their operating experience against competitors and against other types of industries. "The American Standard Method of Recording and Measuring Work Injury Experience" is the national medium that makes this possible. Whether you are interested in the textile or steel industry, quarrying

or canning, electrical equipment, manufacturing, construction or lamp manufacturing, the same measure for performance can be applied. Whether you are in New York, California, Maine or Mississippi, the same method is applied in measuring experience, if you use the Standard Method for compiling your experience.

This is possible because the Standard is an American standard developed on the consensus principle and on the principle that groups having a substantial interest in the standard have an inherent right to representation. In other words, any agency with a substantial interest in or affected by the standard was permitted a voice in its development. The standard

Injury. This is not only a standard, but a standard specifically followed even in the Standard. The Standard of injury is a proper diagnosis or professional or technical development off the job, the according to the ability.

For the principal of the Standard, with the changes we may not all be interested as the standard in a miracle if on every point. It will be gained if and classify in the Standard. Provisions can be made if each person has injury experience.

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of comparison that meets with uniform acceptance is provided.

In essence, Z16.1 is the bookkeeping manual of accident prevention. It spells out the method of recording and measuring the gains and losses in the safety program. Whether it be the U. S. Bureau of Labor Statistics, the National Safety Council Statistical division, a multiplant company, or a small plant of 20 or 30 employees, the same measure for performance is applicable. It outlines the method to use for comparing your short or long periods of injury experience against other longer periods, or your plant experience against other plant experiences. Let me give you an example.

While Westinghouse Electric Corporation is basically a manufacturer of electrical equipment, we are in reality a multi-industry company. We have plants that manufacture ceramics, jet engines, glass, steam turbines, television sets, thermoplastics and electronic tubes. We also have major construction projects and broadcasting stations. Because of these widely diversified operations, in many instances it is not too practical to measure one of our operating plants against another. Therefore, to get a proper measure of their disabling injury experience, we take advantage of the national measure and look to the National Safety Council Accident Rates pamphlets for comparisons. There we can relate the experience of each Westinghouse plant to plants in the same industry of a similar size.

Keep in mind that the Standard Z16.1 is the only national measure of comparison of disabling injury experience of plants in different industries and plants of different sizes. There are one or two exceptions to this. The railroads, I believe, measure their experience by a casualty rate, using the frequency of non-fatals and a frequency of fatalities. This, naturally, precludes the possibility of developing a severity rate for railroad operations.

Since there are a few exceptions, and since some companies apply only part of the National Standard in the compilation of their experience, it is good practice when publishing your injury experience to include the statement "Compiled in accordance with American Standard Z16.1-1954" When so stated, it tells the reader that the report was compiled in line with the Standard and can be used for comparison purposes.

Let's take a look at the application of the Standard when comparing disabling injury experiences between states. As pointed out, the 1945 revision was divorced from rulings by the Workmen's Compensation Acts of the several states. The 1954 revision carries through with this because there is no measure of national comparability or disability injuries under the acts applied within the 48 states.

Take a plant in New York state, for example. Over 50 per cent of the cases compensated under the act might involve no loss of time from work because of the injury or alleged permanent partial disability. To compare the experience of this plant against one in Pennsylvania, Maryland, or many other states, we must revert to the American Standard which spells out the degree and types of permanent disabilities and gives a uniform measure of disability.

Without such a standard we could not have meaningful comparisons between industries and industrial averages as listed in the National Safety Council *Accident Facts*. Through this medium, it is possible to point up low-hazard industries, such as the communications and the printing and publishing industries, and industries with low-frequency rates, such as the communications and electrical equipment industries.

Since the Standard is a national means of comparison, it is important that it measure only that part of the injury experience which can be uniformly recorded by all plants in all industries. Therefore, in setting up the several degrees of injury, it was necessary to cut off at a point where it could be most uniformly applied using only the top four degrees—fatal, permanent total disability, permanent partial disability, and temporary total disability.

This limitation need apply only when making national comparisons between industries. It does not preclude the recording of other lesser degrees of injury within a plant or within a company or industry group. For example, we, as well as an ever-increasing number of companies, do compile frequency rates for all injuries, including medical treatment injuries. Management now appreciates that the causes of large numbers of minor injuries become the breeding ground for the more serious injuries. In recording these medical treat-

ment cases we build up frequencies of three or 400.

Such frequency rates, however, cannot be used for national comparison at this time because of the wide variation in methods of collecting these data. For uniform rate comparisons, therefore, we have to cut off at a level that permits uniform comparability.

Another application of the frequency rates common within several companies is the recording of frequency by the several degrees of injury, somewhat similar to the railroads. These companies list the frequency of deaths, frequency of permanent total disability, frequency of permanent partial disability, frequency of temporary total disability, and frequency of medical treatment injuries. Such a method points up clearly the frequencies of the more serious types of injuries. I believe this method is more applicable in the high-hazard industries. Here the number of deaths and permanent partial disabilities provide a meaningful frequency measure.

It should be noted here that you cannot use the Standard to determine the facts surrounding an injury. All the Standard is intended to do is permit a proper measure of recording these facts and a weighted

measure of the seriousness of the injury. It permits you to pigeonhole each industrial injury with the several degrees of injury, and sets a uniform measure for recording the seriousness of permanent disabilities. It does not spell out whether an alleged loss of function of a finger is or is not reportable, nor does it set the degree of injury. These facts must be provided by the plant personnel and by the medical profession. When established, it is easy to assess the proper time charge and classification of injury.

It is rather interesting to get the reactions of different groups and industries relative to the use of severity. Some feel that the severity rate has no meaning, that injury occurrences are all that matter, the seriousness being simply a matter of chance. In essence, I disagree with this concept and would like to convince you of the need for some measure of difference between an injury involving a stubbed toe, with one-day loss, and a death. The question of chance may be present to some extent in the degree of injury, but the fact remains that a person was killed. Therefore, some measure is necessary to set the incident apart statistically from a mere one-day case, since both carry equal weight in compiling the frequency rate of injuries.

Making Interpretations

By HENRY G. LAMB

Safety Engineer, American Standards Assn., New York, N. Y.

The original American Standard Method of Compiling Industrial Injury rates, Z16.1-1937, was rather short and to the point. On the question of which injuries to include and which to exclude from the frequency and severity rates, it simply stated that in case of doubt on any case the ruling of the local Workmen's Compensation Authority should be used as a guide. In other words, if the Workmen's Compensation Authority included the case for medical treatment and compensation payments, then it should be included in the rates. If the Workmen's Compensation Authority threw out the case, then it should not be included in the rates.

This was changed in the 1945 revision. The standard was divorced from Workmen's Compensation rulings, and the Z16 Sectional Committee was faced with the tremendous decision, how could they write into the American Standard just which injuries should be included in the rates and which should be excluded?

In general, they provided that injuries arising out of and in the course of employment should be included, but they made certain specific exceptions to this ruling. All members of the Committee realized that, through Workmen's Compensation referees and court decisions, books upon books had been written upon this one subject of what

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constitutes "arising out of and in the course of employment." The Committee made a fast decision and established a Committee of Judges to decide which cases should be included and which should be excluded from the Z16 frequency and severity rates.

It was, of course, the idea that this group would simply interpret which cases did arise out of and in the course of employment and which cases did not come under this classification, but it soon became evident that some people were taking this "Committee of Judges" quite literally.

One case was submitted, for instance, where the employer stated, "The employee claims that as he passed through the bulkhead of this ship he struck his shoulder on the edge of the steel plate and received injuries which have resulted in lost time." The employer could not find any witnesses to this incident and claimed that the employee was faking. They wished the Committee of Judges to decide the question of fact—did this employee, or did he not, strike his shoulder on the steel plate? As a result of this and similar cases, the Committee of Judges adopted a policy that they would be happy to try to interpret any vague or obscure meanings or intentions with regard to the American Standard Z16.1, but they did not believe that they were in a position to judge questions of fact as to whether the employee was telling the truth or not.

During the nine years that this standard was in existence, 255 cases were judged, and the decisions were published for distribution. To start with, groups of from 20 to 30 of these decisions were published in the *Magazine of Standards*, published by the American Standards Association. Then the cases were put on multilith plates, and copies were made available to all interested parties. For instance, we now have a list of 150 individuals who desire one or two copies. We also have a few companies who are so interested that they have standing orders for from 25 to several hundred copies of the decisions, which we duplicate and mail to them at a cost which just covers our duplicating and mailing expenses.

In the 1954 revision, the Committee very definitely changed the name from Committee of Judges to Committee on Interpretations. Because of other cases which have been received concerning the old standard, it was

decided to start cases based on the new standard with the serial number 400, and already the Committee has received 55 cases for decision. Some of these are definitely of a borderline nature, but already decisions have been reached on 40 of them.

Here are some typical cases: An employee reported to work a half-hour early, and, instead of reporting directly to his work area, he first visited a friend in another department. This was approximately 150 feet from his work area, and, in going to his friend's department, he fell into an open pit at the tail pulley of a belt conveyor. It was admitted that someone had failed to replace the guard over this pit, but the employer believed that the injured employee had taken himself outside his employment by going to see his friend. In this case, the Committee interpreted the standard as arising out of and in the course of employment.

Back Injuries. The 1954 revision for the first time made special provisions for back injuries, and, as can well be anticipated, several safety engineers have submitted borderline cases for interpretation as to whether they did or did not meet the special provisions of paragraph 5.2.

An employee was regularly engaged in handling and piling 100-pound bags. Two men were engaged on this operation so that the lifting of each man should have been about 50 pounds. During his normal operations one day, while stooping down to pick up one end of the next bag, he felt a catch in his back. There was a momentary pain that left within a few seconds. He continued working without any stoppage or making any comment to his fellow worker. Two days later his back was very sore. He reported to the company doctor, and the doctor diagnosed it as a sprained back and gave him some heat treatments. This employee lost about two weeks from work before his back returned to normal.

In accordance with the provisions of paragraph 5.2, the Committee decided that this injury should not be included in the industrial injury rates on the basis that this employee had not slipped, tripped, fallen or had any other incident or accident as called for in the standard.

The Committee still receives many case histories concerning hernias. The special requirements concerning hernias shown in

paragraph 5.1 have been changed slightly from the provisions in 1945, but apparently there will always be borderline cases concerning hernias.

The provisions for hospitalization for observation have been slightly relaxed in paragraph 5.13. The Committee received a case where an employee jumped or fell and landed on his heels. There was a crushing injury of one heel. The doctor immediately took this employee to the hospital, and, by the use of ice packs for the first 24 hours, was able to reduce the swelling so that with a walking cast this employee was actually able to return to work in 48 hours. The Committee called attention to the statements in paragraph 5.13 that this is only an observation period for injuries which are known to have a delayed effect, and where the physician determines that the injury was in reality slight, and that the injured person could have returned to work without any permanent impairment or temporary total disability. In this case the Committee decided that whether or not there had been any observation, this employee would have had to be in the hospital 24 hours for the ice pack treatment, and that the case should be included as a temporary total disability.

Arrangements are now being made to continue the former practice of publishing decisions of the Committee on Interpretations in the *Magazine of Standards*, and reprinting copies to be distributed widely for the information of all parties concerned. Some of the members of the Committee on Interpretations believe that an index of these cases would be very valuable in helping to find previous decisions in connection with any particular paragraph or with regard to certain situations which may come up from time to time. Mr. H. Gene Miller, director

of the statistics and research division of the National Safety Council, is secretary of the Z16 Committee, and a member of the Committees on Interpretations. He has already started work on such an index, and as soon as details can be worked out, arrangements will be made to have copies available for those who are interested.

May I take a moment at this time for a special message to those of you who have sent in cases or who may send in some question in the future. We hope you all realize that the members of the Committee on Interpretations are voluntary workers. They are not being paid for the job, and I hope that everyone appreciates all of the time and effort that the members have devoted to this undertaking.

The Committee tries to do as much of its work as it can by correspondence. This, of course, takes a certain amount of time, and we hope that you will be patient in waiting for a decision by the Committee.

As you can easily guess, there are differences of opinion between members of the Committee, and, when a case is of a real borderline nature, it is held for discussion at a meeting of the Committee. In such cases, it may take an even longer time to get you a decision.

In the 1945 revision it was requested that three copies of a case be sent in. Since there are seven members of the Committee, this did not help us too much. Now the standard respectfully requests that you send us nine copies of your request. When we can receive these copies, it saves a tremendous amount of duplication work in the offices of the ASA. May I take this opportunity to express our thanks to those of you who have sent in the required number of copies.

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Noise — What You Can Do About It

Measuring the Noise Exposure

By HAROLD W. CROUCH

Eng., Eastman Kodak Co., Rochester, N. Y.

Noise has been defined as unwanted sound. I think this is a good definition. For example, the sirens on the fire apparatus coming down the street might be considered noise. But if it is your house that is on fire, it would not be noise—at least by the above definition.

The reasons for measuring noise vary. We may be concerned with whether the level is high enough to cause loss of hearing. Or we may be interested in its annoyance value in the office or conference room, or its interference in communication in the work room. The problem may be its neighborhood annoyance value.

The measurements that are made differ in each case. However, the instruments used are the same and the units are the same.

Frequency-Level-Continuity

Sound has three main attributes—frequency, level and continuity.

Sound is wave motion in air. It consists of small pressure and rarification areas travelling out from the source at a definite speed. In air at normal temperatures, it is approximately 1,100 feet per second, or a mile in five seconds.

Musical Sounds

The ear is sensitive to these pressure waves when they follow each other at rates from about 20 a second to 15,000 a second. The rate at which these arrive at the ear is called the "frequency" of the sound. We express it as "cycles per second."

The sound pressure level or db level of the noise—is a measure of its loudness. It depends on the pressure difference—in the travelling pressure waves which we said caused sound. The higher the pressure the louder the sound. We measure this pressure with a microphone.

To express the level of a sound we use a unit called a decibel.

This is a very convenient unit—it is the log of the ratio of the average pressure in the sound wave to a reference pressure. It indicates the amount of energy in the sound.

Increasing the energy 10 times raises the db level by 10. Doubling the energy increases the level three db. When the energy is doubled, the ratio of the energies is two. The log of two is three-tenths, and 10 times this equals three. The reference level is taken as the threshold of hearing, or the weakest sound that can be heard by the average good ear.

Various Noise Levels: Loud sounds are made with a very small amount of energy. One watt of sound energy in this room would raise the level to over 100 db.

Cutting the noise in half is not very much reduction, but reducing it to one-tenth is a real improvement. A large magnitude of noise reduction is necessary to "quiet" a noisy operation. Cutting the noise in half will probably not be satisfactory.

The third factor—continuity, or intermittency—is much harder to evaluate or express as a value. There is no question that it is important in loss of hearing, or in annoyance studies. I have built an instrument that measures the time the noise is above various levels.

Instruments

Now let us look at some of the instruments used to measure noise.

Survey Meter: The survey meter is the simplest and most convenient instrument to use. One of the various makes of survey type meters consists of a microphone mounted in the top, an electronic amplifier and an indicating meter. This meter will read noise levels from 40 db to 130 db. The