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IATIONAL SAFETY CONGRESS TRANSACTIONS

CONSTRUCTION INDUSTRY and PUBLIC EMPLOYEE

NATIONAL SAFETY COUNCIL
425 North Michigan Avenue
Chicago, Illinois 60611

58th NATIONAL SAFETY CONGRESS

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CONSTRUCTION SECTION

GENERAL CHAIRMAN'S REPORT TO THE SECTION

By BERNIE M. ENFIELD
Safety and Training Director, Chicago Bridge & Iron Co., Oak Brook, Ill.

This past year has been a whirlwind of activities by our various divisions and standing committees. The results of these activities are evidence in the fact that the Construction Section completed the year in third place for the Cameron Award. Just two short years ago the Section finished seventeenth.

This has been a great year of progress for your general chairman. New doors in safety were opened to me and many new acquaintances were made. The year has been both an enjoyable and valuable experience for me. This Section has been very concerned during the past year about current and impending Federal legislation. The Construction Safety Act of 1969 is already a reality, and soon there will be the Occupational Health & Safety Act. Our Section made much progress in exchanging information to keep all interested parties informed of the current status of this Federal legislation. Excellent liaison was maintained between the Construction Section and the Department of Labor. All Construction Section members were kept informed on present progress of those agencies who will be responsible for implementing the Construction Safety Act of 1969.

The Construction Section was active in the co-sponsoring of a one-day training seminar along with the Steel Plate Fabricators Association. This seminar was titled "Communications for Safety" and was conducted in St. Louis, Missouri. Other training activities included films and lectures at both the Construction Section Executive Committee meetings and the first production of a training cassette tape, which was titled "Attitudinal Training." A film directory for construction films was completed and more than 300 requests for this directory have been received.

Two research projects, titled "Wind Hazards on Construction Projects" and "Highway Safety Standards," were completed during this year. Numerous other activities included the production and revision of data sheets, safety releases, and visual aids for safety.

The officers of the Construction Section watched the progress of all divisions and all standing committee activities very closely.

We have four charming nurses who contributed most of the technical publications during the year on health of construction workmen.

I could not complete this report of progress without making some predictions for the future. Our future plans include:

1. An expansion of training for both the supervisor and the workmen.

2. Accident trends will be dissected and analyzed to decide where the major problems exist. It is regretful that many in our industry truthfully don't know all the problems of today.

Our future Congress programs will attempt to zero in on common problems related to the Construction Industry. Therefore, each day of our Congress program will be directed toward certain areas and/or divisions of the Construction Industry that will be of interest to all.

Our Construction Section has made great progress during 1970 and I sense or feel that the members have an honest desire to lead the safety efforts of the construction industry to new levels of accomplishments. I know these leaders well enough to recognize the sincere desire they have to further decrease the frequency and severity rates in our industry.

This Section is capable and willing to accept that responsibility.

EARTHMOVING EQUIPMENT SAFETY STANDARDS

By J. B. CODLIN
Safety Dir., Allis Chalmers Mfg. Co., Springfield, Ill.

Government is a big construction customer in roads, dams, airfields, defense projects, and others. Government activity in safety lies in the area of safety regulations. This is either in the form of direct laws or contractual requirements for work to be done for the government. In the United States, the State of California has been a leader in the effort to develop regulatory safety laws for the construction industry. Other government bodies who have been very active are the Corps of Engineers, Bureau of Reclamation, and Forestry Service. In addition, many other countries are developing safety regulations and standards.

With these regulations are beginning to come a crescendo of requirements good and bad, conflicting and complimentary, strict and lax and, above all, confusing. In getting something on the books, regulations are being written that are too general to be enforceable, or too specific to be practical.

In order to alleviate this problem, we believe it must be approached on three fronts: on the basis of individual engineers through societies such as SAE; through industry associations such as CIMA; and as individual companies.

First, I would like to tell you about the approach that SAE is taking. The Society of Automotive Engineers is an organization of engineering oriented people, particularly to mobile type equipment. It is an organization of individuals, not company representatives. Each member serving SAE does so as an individual professional engineer. The society is organized by industries that have common interests. For example, activities are related to aeronautics, construction machinery, farm equipment, etc.

Within the construction machinery segment of SAE we have an organization called the Construction and Industrial Machinery Technical Committee (CIMTC). This committee is composed of a number of subcommittees that are technically oriented toward specific phases of engineering and whose projects fall in two areas—safety activities and technical activities. Among these committees are a Brake Committee, a Test Codes Committee, and a Human Engineering Committee.

The subcommittees act not only as technical committees developing and writing standards, they also serve as a consulting service for various government bodies. SAE has reviewed and suggested changes to various proposed standards being written by government groups; examples include a safety standard for the Bureau of Reclamation. This standard was reviewed in rough draft form and a number of changes suggested by SAE have been adopted into the document. Some other examples of their work are:

1. Subcommittee X—Vehicle Brakes. This committee has submitted a vehicle brake test code and also reviewed and made recommendations for the State of California's "Design Criteria for Brake Systems for Heavy Off-Highway Earthmoving Equipment."

2. Subcommittee XVI—Ease of Maintenance. This committee has developed a check list for determining the condition of the vehicle from an operational standpoint. Systems to be checked are those whose proper functioning are vital to the safety of the operator, such as braking and steering. Consideration is also being given to a checking routine to be followed before the vehicle is to be put into motion.

3. Subcommittee XVIII—Human Engineering. This committee has organized and developed standards relating to safety signs, seat belts, warning devices, heat shields, and fenders and machine access.

4. Subcommittee XIX — Remote and Automatic Controls. This committee is currently developing a standard for the performance requirements for emergency steering systems for earthmoving vehicles.

The second approach to safety by the construction machinery industry has been through CIMA, the Construction Industry Manufacturers Association. Membership is made up of companies in the industry. Personnel sent to its meetings go as representatives of the companies involved.

Last year Mr. Larmore outlined some of CIMA's activities, particularly relating to safety. Some of his comments were, "CIMA's activities in this area are governed by a written policy which sets forth the philosophy that the industry itself, through its association, would seldom, if ever, write any actual standards. Such creations in its own interest by a commercial organization might be considered suspect by others outside the industry despite the immense dedication which would accompany the give and take necessary to the creation of any standards by the total industry or a segment thereof.

"In lieu of writing our own standards, CIMA has approached several of the outstanding professional and technical societies to discover if they would assume responsibility for writing performance standards in areas where our members are able to point out the existence of important needs."

For example, in 1965, the State of California, Department of Industrial Relations, issued safety orders relating to construction machinery. Paragraph 1591, subparagraph (H), from these orders stated, "All self-propelled pneumatic tired earthmoving equipment whose primary purpose is rapid movement of large quantities of material shall be provided with fenders and an approved emergency braking system, and approved seat belts. Roll-over bars or approved equivalent shall be installed on all equipment operated in California within one year from the effective date of these orders."

The problem with this order, recognized by all including California's Safety Department people, was: what vehicles were in this class, what equipment could be approved, and on what basis would approval be given? In order to answer these questions, an advisory body including industrial trade representatives and citizens of the state was formed by the Industrial Relations Department.

The approach of the committee to this problem was to consider specific vehicles and specific conditions and situations and write into the standards where roll bars are required and what loads are to be sustained under what conditions for a specific type of machine.

The problem was then taken to CIMA, who defined the need and submitted it to SAE. This particular task was then assigned by SAE to Subcommittee XII—Test Methods, of the Construction and Industrial Machinery Technical Committee.

The task of writing roll-over standards has now been completed for five standards relating to roll-over protective systems for construction machines. All five have been endorsed by the CIMA performance standards committee and all five have been used in the revision of the California safety code, to be effective in 1971. Currently, there are over 100 requests for standards in this area of safety, based on need established by CIMA through its segment committees. All of them are being developed by technical societies, including SAE.

After the standards have been completed and endorsement made, CIMA has accepted the job of promulgating the standards. The seven standards endorsed by CIMA have been sent to over 800 people in local, state, and federal agencies and to Canada and countries overseas. It is our desire, as an industry, that these standards, developed by knowledgeable engineers serving on SAE committees as individual professional people, will be accepted by the many different regulatory bodies for use in their safety codes and regulations. If they will do this, future machinery can be designed and built against consistent requirements. The results will be greater safety for the operator, the user, and the public.

What are we doing as individual companies about this matter? To give examples, I will speak from the viewpoint of my own company.

First, I would like to quote from our safety policy: "It is the policy of Allis-Chalmers to promote safe living by an effective accident preventive program in all phases of our operation—manufacturing, design, sales, research, and employee and community relations. This program utilizes the best principles of safety engineering and education to reduce industrial and off the job accidents and generally to advance the well being of our people, the company, and its customers."

Based on this policy, there have been many things done that are represented by actual safety hardware. For instance, in the Construction Machinery Division we have over 60 specific items that are either standard equipment or can be purchased as special equipment to make our construction machinery safer.

So far, I have only made mention of two other areas—the user and the operator involved in this problem. These two elements also have a vital part in this whole picture. Accident data published by the National Safety Council show that the greatest cause of accidents among "unsafe acts" is the unsafe use of equipment. The official manual of the International Union of Operating Engineers, Local 115, Vancouver, B. C. says, "Machines Don't Think." They go on to state: "About 80 per cent of all injuries which occur around weight handling equipment are caused by some failure on the part of workmen. Long familiarity with a piece of equipment develops an indifference to danger."

Twelve major causes of accidents with weight handling equipment are listed in the book:

1. The backing or turning of machines, the swinging of booms, the lowering of buckets and similar operations, done without direction from a signalman, or without due regard for safety of any personnel in the way.

2. Unauthorized boarding, leaving, or riding of equipment in motion or in operation.

3. The operation of equipment with defective brakes, clutches, cables, or with other defective parts; the existence of the defects being either known or detectable by proper inspection.

4. Working or walking over a skip, bucket, crane load, or other suspended hazard, or in the path of a traveling piece of equipment.

5. Failure to set brakes and other controls before starting engines.

6. Oiling, adjusting, or repairing equipment while it is in operation.

7. Using equipment with unguarded [illegible] inadequately guarded engine fans, roc[illegible] arms, or other dangerous moving parts.

8. Failure to use personal protectir[illegible] vices and clothing such as goggles, shoes, gloves, and hard hats.

9. Failure to block or otherwise secure equipment or parts of equipment during repair and operation.

10. Careless operations in dangerous vicinities, such as running a piece of heavy equipment too close to the edge of an excavator or bringing a steel crane boom into contact with a high voltage line.

11. Poor housekeeping, either on equipment itself or in the operating area.

12. Overloading the equipment.

Further, they suggest under the heading "General Accident Prevention for Operating Engineers": Don't take changes—Be serious about your work—Keep your work area clean—Use the right equipment for the right job—Inspect your equipment often—Stop moving parts—Use protective equipment.

These recognized facts are known to all people in the business. In Mr. Larmore's talk last year, he spoke of a development of machinery operators safety manuals by CIMA. Since that time, four safety manuals have been completed. These cover crawler tractors; front end loaders; off-highway trucks; power cranes and excavators. Two other manuals will be completed this year, one for graders and one for motor scrapers. These are available from CIMA and can be purchased at a very nominal cost. We at Allis-Chalmers include one of these safety manuals with each crawler tractor and front end loader bei[illegible] [illegible]hipped. We also make them availa[illegible] [illegible]ur dealers to operators and c[illegible]

CIMA [illegible] [illegible]entation consisti[illegible] [illegible]ade from [illegible] tiona[illegible] at [illegible]

This is a goal that probably can never be reached, but it is one that can and will always be approached closer and closer.

Safety is something we all must continue to promote, to design for, to teach, to train for, and to practice. It is a people job. It takes all the elements—the manufacturer, the legislator, the operator, and the user—to do the job.

Safety is everybody's responsibility!

MANAGEMENT SAFETY RESPONSIBILITIES AS A CONTRACTOR SEES THEM

By JACQUE FRANTZ
Vice Pres., Frantz Bros. Inc., Sidney, Ohio

At the President's Conference on Occupational Safety in 1964, at the time when the labor unions were talking about appointing the steward on the job as the safety man on the project, one of the speakers, who was a contractor, made the statement that labor had nothing to do with safety. That remark ended the meeting, or at least whatever else was said was not heard. Whenever you think labor has nothing to say about safety, you are entirely wrong. It is their men's lives you are risking. In 1968 I went to the National Safety Conference in Washington, D.C. sponsored by the Associated General Contractors. Everybody there was interested in safety. This was at the time the Labor Department was going to do something about the death rate in construction. We got word at the meeting that the Secretary of Labor was going to hire the Hard Core unemployed to be safety inspectors.

These things have not happened yet, but believe me, they will if management and labor don't take their responsibility or show that they are taking their responsibility for safety. Remember, the government is trying to take it by passing safety legislation. They're going to pass laws to hinder us in our operation, or more red tape to get the same job done that we can do ourselves. When safety legislation comes up and everybody but us are writing bills for the congressmen and senators to pass, that's all they can do. If you don't like the bills or they would hinder your industry, you should assist your associations in writing a bill that would help your industry. This is what happened to the Construction Safety Act of 1969, which President Nixon signed. I'm not saying the bill is bad; I'm saying it would not have been necessary if management and labor had taken the responsibility first. The bill is better than it was when first presented; one of our associations wrote amendments to the bill and presented it to the Congress, and this is the bill the President signed. The way the bill read first was: if a contractor was found guilty of a regulation, he could be black listed from bidding any public works job for three years, there would be cancellation of contract and entering into other contracts for the completion of the contract work, charging any additional cost to the original contractor, he had no hearing or trial as to who was guilty—was it a company fault, a laborer's fault, or human error. In the bill that was signed, the contractor at least has the right to a hearing before an administrative body, to determine if a violation did occur, before cancellation of contract.

I have read that the construction industry is a $91 billion industry, with fully one-third of the labor force of this country either directly in construction or dependent on the construction industry. We are talking about a very significant segment in the economy. We certainly do not want to create another great gigantic ever-burgeoning bureau in Washington to oversee the safety of the construction industry. We do not want hundreds or thousands of additional people on the federal payroll. There is also talk that a project of $100,000 or more shall have a safety engineer. This is unrealistic and would just raise the cost of construction. Also, where are we going to find 50 thousand safety engineers?

The thing that confuses me is all this talk about federal safety legislation. What is the

reason for it now? There is definitely a big improvement. Do we want to turn our responsibility over to the government? I don't. If the government wants the people to feel that the government is doing a humanitarian act to save the lives of the working people by taking the responsibility away from the employer, and causing penalities and red tape, why don't we pass a law that the government will assist us? Pass a law saying every company will have an organized safety program and, if the government wants to hire more people, instead of hiring inspectors to find fault, hire people who can assist the employer in a safety program. I'm not talking about passing a law concerning the contractor who bids on federal work using federal money. I mean every contractor, every company, every manufacturing company, every gravel pit, every block plant, every concrete plant. The village plumber who digs a ditch, every town electrician, every county government, every city government, every state government.

One thing that irks me is the fact that I am tied with specifications that I have to abide by, and the government, whether city or county or state, can do whatever they want. If my men have to wear hard hats, I want to see the city, county, state, and federal people wear hard hats. If I have to put shoring in a ditch, I want to see the city, county, and state forces do the same.

I am not saying that management is doing their share; I think they should do more. But they are doing as much as labor, city, county, and state government agencies. House rule 10946 requires the contractor or subcontractor contracting for any part of the work assure that any laborer or mechanic or other employee shall not be required, in the performance of a contract, to work in any place or under any working conditions which are unsanitary, hazardous, or dangerous to his health and safety.

The construction industry is a very dangerous industry. You always have something swinging or moving (like heavy equipment). You're up in the air, you're under the ground—we know it is dangerous. In 1968, 2,800 construction workers were killed on the job, which is the highest annual death rate for any one industry in the United States. During the last ten years, in each year there has never been less than 2,300 construction workers killed per year. In the last ten years, there has never been less than 200,000 construction workers disabled per year. Yet, it is estimated that 85 to 90 per cent of all accidents are caused by human error. When the contractor calls the union for an operator, does the operator know the dangers involved with the piece of equipment? He should. When a laborer is called to put pipe in the ground, does he know what dangers are involved? He should. Does a carpenter know the dangers of handling tools or wearing loose clothing? He should. Does a teamster know never to back up without signals from someone who can see behind him? I say they don't. Only the man with experience knows. The new member does not; many a time I have pulled them out of the way, or stopped them from doing a dangerous act. I feel the unions could and should do a great deal more to train their members in safe work practices. They should continuously educate their members, especially the new members, in the dangers of a job and encourage cooperation with company safety efforts. We as contractors expect a more skilled man when we go to the labor organizations for our employees. If they're not more qualified than the man on the bank, who needs the union? I don't think labor puts enough emphasis on safety in the apprenticeship program. They should demand that he does every job in the safest possible manner.

If we are a team we must work together in safety. The federal government is going to penalize us. What is the union going to do to the man who committed an unsafe act? Management does not want reckless people on their projects. It is said that the hidden cost is four times as great as the direct cost, and I don't believe that. I believe it is more like forty times the direct cost in damaged equipment, damaged property, down time with equipment, and loss of schedule. When we call a man from the union hall, we expect him to perform his work in the most efficient and safe way. Men are our most valuable assets. Without them we cannot perform our contracts. We don't want them to be injured and off the job, slowing up production. We need every one of them. We expect every man to be concerned for his own safety and his fellow worker's safety. Also, he should point out unsafe conditions and acts to management.

I feel management has the authority and the responsibility to establish and enforce its own safety program. Management also has the responsibility to its employees and the public to provide a job with as much safety planned into it, with as much production and least cost as possible. It is a well known fact that the conditions which cause personal injuries are also responsible for many operating losses. In other words, personal injuries and operating inefficiencies stem from the same source. It is management's responsibility to properly select, place, train, and supervise people. Full consideration to these important production factors through good supervision will assure management of a smooth efficient job and at the same time insure employees freedom from personal injuries.

Because mine is a small company, we felt that we did not have the time or know how to start a safety program, so we explored the source where we might get the type of help we needed. Fortunately, in Ohio our contractors association had the foresight to realize the benefits an association sponsored safety program would have to the individual company and to the industry. The saying that an association cannot do service for an individual member has got to be changed. I won't say in every phase, but especially in the safety field. If the association can get safety programs started in the member companies, this will help the overall industry. If your executive director or chapter manager isn't interested, it is your responsibility to get him behind it. I have heard them say, "Hell, I'm the only one in the office. I have other programs to worry about," and he does. But, see where he puts safety—behind the other problems. I'm not knocking the manager; he does have other problems. Maybe his staff is too small.

Our association has had a safety program for over 12 years. Here are some of the factors we have found important for implementation. First, you have to have someone on the staff responsible for the safety program of your association. When you have a man responsible for your association's safety program, here is where and how your association can help you. Our association appointed a safety committee of from nine to sixteen men representing every phase of industry, seven from contractors, three from the public agencies, and four from the labor organizations. These people, or our committee, tells the staff what we want them to do. Remember, we are the employer—they work for us. Too many people expect the staff to do as they please, hoping they will come up with some kind of a program for us. They need our help, as they are not contractors and they don't know all the dangers of construction. They're good men, but they need our support and advice. They need fresh ideas, that is why a committeeman should be moved around. If he stays on one committee too long, no new or fresh ideas.

The staff man responsible for the safety program is not just a man who writes articles about safety. His and the committee's job is to write and publish guides, instructions, and safety rules to help get their members interested in a safety program for their company. One of the best ways is to explain to the member that it is not an expensive proposition to have a formal safety program. The main objective is to make a better utilization of time on the part of management and employees. Speaking for myself, when our company got started on a safety program, we had a 10 per cent penalty rating over basic rate. We went to a 35 per cent credit rating after we initiated a safety program. We have just a small company and we saved $3,000 in insurance the first year. That will buy a lot of safety equipment, or one can put it on the profit side.

A small company can have a formal safety program just as easily as a large firm. You can show management how they can save money. Maybe we should ask them not how much can you save, but how much it is costing your company by not having a safety program in constant operation? The amount of money involved as a result of the benefits occurring from the safety program are substantial and are often unrealized by those who most directly benefit. To illustrate, contractors A, B, and C decide to bid a $2 million project, all of them estimating their payroll cost at $500,000 for work performed under the Ohio industrial compensation code 6102, street and road construction operation. At the present time, contractor A's workmen's compensation rate is the basic rate of $23.60 per $1,000 of annual payroll. He has no safety program and has been reasonably fortunate, mainly due to good luck. Contractor B, who has had a safety program in effect for some time, has a 60 per cent experience credit, which makes him eligible for a net rate of $9.44 per $1,000 of annual payroll. Contractor C, who also has no safety program and has been plagued with several job accidents, currently is subject to a penalty rate of 70 per cent over and above the basic rate, producing an annual rate of $40.12 per $1,000 of annual payroll. This means that contractor A must include chargeable payroll premiums of $11,800 into his bidding operation to recover his cost on the project. Contractor B would only be liable to include premiums of $4,720 on the same job. However, contractor C must charge $20,060 into his figures to cover his cost. As a result of this, contractor B automatically enjoys a $7,080 advantage over all base rated competitors, not withstanding his advantage of $15,340 over contractor C. Many contractors have not been aware of this common occurrence. Many contractors think industrial insurance is just a necessary evil. Show them that this is not necessarily so and I think you can get management behind the safety program.

So, you have told them it is not expensive and how they can stop losing money. Many times they respond. How do we establish and operate a safety program? This is the job of the staff man responsible for safety. If a contractor wants assistance in setting up a safety program I think it should be available to him. What good is an association if it doesn't help the member? The staff man for safety should call on the member at the member's office and try to get him set up with a safety program. He also goes out on the projects and checks for hazards on the job that maybe you don't know exist. He brings them to your attention; he has no policing authority, but he is looking out for your interest as a member of the association. Remember, that is his first and only job.

Other things that the association and committee can do to assist its members is write guides for setting up safety programs, safety rules, safety talks for foremen and superintendents, safety posters, accident reports and instructions on how to make accident reports, assist in safety awards or give safety awards.

Now, what can you do to help the association? You can back the safety program of the association by having a safety program in your company and by being a member of the safety committee, if you feel strongly enough that you can help the association's safety program. Don't wait until you are asked to be on the safety committee. Tell them you are interested in safety and safety legislation and would like to help. Again, don't ask if you don't intend to participate.

Speaking as a contractor, and as a member of a contractor's association, we are not going to give up our responsibility for proper safety on our projects. We are going to make a better effort and urge the government and labor organizations to help and cooperate with us to have a dedicated industry for safety.

SAFE HANDLING OF COMPRESSED GAS AND CRYOGENIC LIQUID CYLINDERS

By F. CARL SAACKE
Safety Director, Air Reduction Co., Inc., New York, N. Y.

The safe handling of compressed gases and cryogenic liquids has been thoroughly covered by the gas industries, who work increasingly through trade associations and national societies to provide the public with a consensus of the most informed and safety-minded specialists in these fields. I have listed the best sources of such pamphlets in the bibliography.

Unfortunately, the personnel preparing a safe practices pamphlet are faced with the problem of keeping it brief and compact so it will be read and followed. And in doing this the decision must be made to omit the

historical background, experiences, and reasons for establishing each specific safe work practice recommendation. The alternative would be to publish a book instead of a pamphlet, and thus limit its distribution. So here I will try to emphasize the reasons behind many of these recommendations.

In presenting the reasons behind these safety recommendations, I will be citing the most serious accident that can happen under each safe practice violation, and there is a tendency when repeating troubles, to make the subject sound gloomy and dangerous.

In 1949 I visited the metallurgical laboratory of the largest supplier of compressed and cryogenic gases in the United Kingdom. Although a mechanical engineer by education, I had been a practicing metallurgist as well as a materials and test engineer for 18 years, responsible for the investigation of all engineering and material failures in my company. The UK metallurgist had held the identical responsibility in his company for the previous 30 years. Between us we represented 48 years of industrial experience regarding cylinder service and accidents, but had neither met nor corresponded before this meeting.

In the four hours that we spent together, we raced through all of our more serious accidents, describing their nature, the existing conditions, and our analysis of the cause and preventive measures. As fast as the listener grasped and agreed with the analysis, the other skipped to the next subject. After four hours of this emphasis on failures, my counterpart in England looked up with a deep sigh and said, "Carl! Do you know what I would do if *I* owned these cylinders?" Before I could answer, he burst out with, "I'd scrap them all!"

Now it is true that we are always learning and that we have improved our products tremendously over the years. But I hope you do not infer, from what I am about to say, that with all the possible hazards involved in welded construction, this work is dangerous. It is not, unless you make it so. Records indicate a man is safer working at his profession than he is off the job. And if you want to be completely safe, and I mean 100 per cent sure of yourself, just follow the safe practices recommended. They are there for a good reason. If you question any practice—ask! But don't try to find out by experimenting.

Lifting Cylinders

If you are interested in handling cylinders safely, your first concern may be with their weight. The larger gas and the liquid cylinders are the heavier, and nothing I can say will make them any lighter. So take a moment to be sure that they are being handled safely. Some of the methods of weight handling to avoid accidents are: Large cylinders are awkward as well as heavy. And lifting them improperly can cause back and foot injuries as well as a strained groin. There are techniques of lifting such as those which emphasize keeping your back upright and using your legs to lift, which will reduce the strain on your back and help you to avoid injury. But I have no pearls of wisdom that will enable a cylinder handler to lift 150 lb. gas cylinders with ease. There is nothing quite like a mechanical device for lifting, or an extra pair of hands to help ease the burden.

Liquid Cylinders

ICC4L or DOT4L cylinders are charged with gas in the liquid phase so that 3,000 cubic feet of gas can be furnished in a single package that a man can move (please note that I did not say "lift"). Nevertheless, these cylinders deliver the oxygen as a gas under medium pressure to the user, the same as a pipeline supply.

However, the "liquid" cylinder is also heavy (over 200 lbs.) and should be moved by mechanical means rather than lifted or rolled by hand. The main problem in utilizing these cylinders is their relative fragility in relation to their weight. I dislike calling them fragile, but they cannot be dropped from the tailgate of a truck, they cannot be rolled against a sharp edge or corner, and they cannot be dropped on end without the user incurring a costly bill for damages. The central tube on top is not a handle, it is a level gauge. The outer shell is not built to retain internal pressure, only to resist atmospheric pressure externally with a vacuum inside. The disc-like base is centrally supported and is easy to bend.

But what is far more serious is the way these cylinders have been modified by careless users. Gauges, relief valves, and fittings are removed and, in many cases, changed in position. Consider that such cylinders hold 3,000 cubic feet of gas in a 3½ cubic foot space by virtue of a temperature 290° to 320° below zero. Puncture the shell and, without an insulating vacuum, the cylinder will vent oxygen or nitrogen rapidly. Block the relief valve and the boiling liquid can cause the container to explode. So handle the cylinder reasonably and don't permit tampering with or damage to the control piping or fittings.

Shrink Fitting with Liquid Nitrogen

Occasionally, construction personnel use cryogenic liquids such as liquid nitrogen to assemble pulleys, gear drives, bearings, and other cylindrical members which are to be assembled to journals and drive shafts with interference fits. Because liquid nitrogen may be needed in large quantities to shrink the shafting, four cautions should be emphasized:

1. Liquid nitrogen is cold, 320° below zero. Painful burns will result if this cold liquid is allowed to come in contact with the skin or other parts of the body. To avoid injury, use rubberized aprons, wool and leather gloves, and full face protection.

2. The liquid phase is 700 times as dense as the gas phase. Closing two or more valves in a line filled with liquid can create a dangerous condition. The pressure will increase with extreme rapidity and cause an explosion unless the section of the pipe between valves is fitted with a cryogenic (long stem) pressure-relief valve.

3. Carbon steel is brittle at low temperatures. I have seen a low-pressure carbon steel pipe break when exposed to cold gas, fall to the ground, and break further from a 15-foot drop. Use copper, aluminum, or stainless steel if you have to handle cryogenic liquids.

4. Cold nitrogen is denser than air and rapidly dilutes the oxygen in the air. When one suddenly breathes air that is low in oxygen, below 12 per cent, unconsciousness can come without warning. Avoid breathing over containers holding or evaporating liquid nitrogen. One should never rely upon finding 21 per cent oxygen in clear air, irregardless of its proximity to moisture clouds over evaporating liquid nitrogen.

Rocketing Cylinders

One hazard which cannot be overlooked but which must not be overemphasized is the possibility of a high-pressure gas cylinder rocketing in the event the cylinder is dropped and the valve is broken off. The great majority of all high-pressure cylinder valves are made with an inlet opening of approximately ¼-inch. Because a valve that breaks off will leave the stub end of the valve in the cylinder neck, the opening in the cylinder neck will be limited to ¼-inch, in most cases.

Since a cylinder cannot rocket unless its acceleration $(a = \frac{F}{m})$ due to its mass and propelling force exceeds 1g (where $F = pA$ and $m = \frac{w}{g}$ where w is the weight in pounds and g is the acceleration of gravity in feet per second^2), this valve opening effectively prevents the larger high-pressure cylinders (over 100 lbs.) from lifting themselves into the air. The lighter cylinders can theoretically rocket but they are relatively easy to lift and carry, and are too light to break off the valve when toppled over.

Of course, a broken valve will cause a full cylinder on a flat surface to pick up speed, depending upon the freedom from obstructions—and leg injuries are not painless—but the hazard has been overrated.

It is still important to keep valve caps in position to protect cylinder valves except when the cylinder is in use. We encourage the securing of cylinders in the vertical position so that a falling cylinder cannot injure a man's foot or leg. But if a cylinder being moved starts to fall, it is far better to let the cylinder fall and step back, rather than to risk a back injury by trying to regain control of a falling weight.

Valve Protection Caps

The cylinder cap provides a dual service. It not only protects the cylinder valve from breakage in case the cylinder tips over or is dropped, but it protects the valve to a considerable extent from contamination by oil or grease. However, while the gas supplier encourages the cylinder handler to keep the cylinder valve protected by its cap when the cylinder is not in use, a new hazard is being introduced. Caps are usually interchangeable, and metal threads corrode and wear. So it is not possible for a gas supplier to guarantee that the cylinder valve cap thread fit is sufficient to hold the weight of the cylinder. Persist in lifting cylinders off the ground by their caps, and sooner or later

you will suffer a painful mouth or eye injury when the cap slips off and strikes you in the face.

Always check to see that a cylinder cap fits firmly. But remember that a loose cap thread can jam and feel tight. Restrict your lifting to standing a cylinder upright but never try to lift the cylinder off the ground using the cap as the grip.

Color Coding Cylinders

Occasionally someone will use a hydrogen cylinder to purge air or oxygen from a vessel instead of nitrogen, or he wi l introduce hydrogen, nitrogen, or carbon dioxide into a breathing oxygen line, or will use oxygen to clear the atmosphere in a tank instead of using compressed air. There are other interchanges of gas cylinders that can be equally dangerous, and to the average safety engineer not too familiar with the gas industry but anxious to prevent such interchanges, the idea of color coding cylinders seems like an ideal solution—particularly from the point of view of an individual who may use only two cylinder gases.

However, over the years the compressed gas industry has learned to recognize the complexity of the problem and strongly recommends that the gas content of any cylinder must be identified by the written word. If the welder or cutter cannot read and cannot learn to recognize the printed name of the gases he must use, then he should not be permitted to weld or to cut.

With hundreds of gases and gas mixtures in commercial usage, there aren't enough colors to permit the use of single colors for each gas. Consequently (and the U.S. Army has tried color coding) a barber pole assortment of color bands must be used. Unfortunately, the user must carry a chart with him to identify the color code—providing the colors are recognizable. And in between the difficulties in matching paint colors; in using painted cylinders in chemical atmospheres that change colors radically; in viewing colors in sunlight and in shade, under tungsten, ultraviolet, or fluorescent lamps that provide their own color scheme; and with a considerable part of our population who are color blind, it is considered unsafe to use color to identify the cylinder gas content. We have not even mentioned foreign cylinders, with their own various reasons for coloring cylinders, which enter this country for refilling not only through all seaports but also through inland ports along waterways like the St. Lawrence river and the Great Lakes, which have been opened seagoing ships.

It seems to be most necessary that construction personnel, like other industrial users, identify all gases to be used by actually reading the decal or label on each cylinder and refuse to use any cylinder or gas that is not legibly labelled, no matter how much it may seem to resemble the gas they are accustomed to using.

Do Not Transfill Cylinders

Unless you are operating under transfilling procedures established or approved by an experienced organization, and unless your transfilling personnel are experienced by years of practice or have been trained by skilled personnel, *it is not safe to transfill cylinders,* that is, to fill smaller cylinders from a source of larger gas capacity. Peculiarly enough, the more the unauthorized transfiller knows, the more dangerous the operation can become—because of the increased chances he is liable to take.

When should a transfiller recognize that one of his oxygen cylinders returned as "empty" may actually contain 100 cubic feet or more of hydrogen, about one-half a pound? Because "empty" cylinders have a residual pressure of three to five per cent of their original pressure, he may think that he can save three to five per cent of his gas product by not blowing down returned cylinders, and recharging them to full pressure with oxygen. One such omission took four lives, injured 30 men, and cost millions of dollars.

How can a transfiller learn to use soap safely for leak testing oxygen cylinders, if all soaps are combustible in oxygen?

Why should a transfiller anticipate that because his cylinder would not accept five pounds of propane by cooling in iced brine, his filler would use liquid nitrogen to obtain his five pound charge, not realizing that instead of a standard five pound cylinder, he had a three pound cylinder and a cylinder steel which is as brittle as glass at liquid nitrogen temperatures?

The list is long, and amply justifies the recommendation not to transfill. Don't be misled by the apparent simplicity of an operation run by trained personnel. The visual examination of returned cylinders is an art to be practiced only by personnel trained by experienced and responsible individuals.

Welding Equipment

1. Do not call oxygen "Air."
2. Do not call acetylene "Gas."
3. Do not leave torches in confined spaces (tanks, small rooms).
4. Do not bring cylinders into confined spaces.
5. Do not store cylinders in airtight cabinets.
6. Leak test connections regularly.
7. Keep equipment in good condition.
8. Do not work in oxygen-enriched atmospheres.
9. Do not work in explosive atmospheres.

Atmospheres containing fuel gases should be avoided at all costs. Precaution 1, 2, 3, 4, 5, 6 and 8 are designed to either avoid explosive atmospheres or avoid working in them.

1, 2. We insist on calling our fuel gases by name so that instructions will never be misunderstood.

3. We do not leave torches in tanks because a small leak over lunchtime, overnight, or over the weekend can develop a highly-explosive atmosphere.

4. We do not bring fuel gas cylinders into confined spaces; first, because they do not have to be present and second, because we introduce more points for possible leakage such as valve stems, packings, seats, safety devices, regulator connections, etc.

5. We do not store gas cylinders in airtight cabinets for the same reason that we do not leave torches in tanks. The tiniest leak can create a deadly atmosphere that can be ignited by a cigarette, a static spark, or friction at a lock or latch. One fatality occurred when a workman tried to thaw out a frozen cabinet lock with a match. The cabinet opened, explosively!

6. We leak test connections regularly, since the movements in handling torch, hose, and equipment and the presence of dirt in the shop or field make it difficult to ensure that connections and packings are leak tight. The effect of a leak, in addition to its size, is determined by the space into which the leak flows and the length of time it persists.

7. Keep equipment in good repair whenever leak tests indicate the need for cleaning and retightening or repair.

Remember also that fresh air is the best friend that fuel gas equipment can have. The possibility of a fuel gas leak creating an explosive atmosphere is usually recognized by the construction worker, since his tools are strong igniters; whereas a similar explosive atmosphere at a service station dispensing gasoline is frequently overlooked by the attendant carrying a lighted cigarette while he works.

Exactly why the general public is so disrespectful of oxygen-enriched atmospheres, I do not know. I suspect it is conditioned by their attitude towards air or oxygen as a supporter of life. Lately, acc.dents involving doctors working in hyperbaric chambers and astronauts in Apollo missiles have made a greater number of people more conscious of the hazard. But the effect is likely to be temporary, short-lived.

Each year a patient will suffer critical burns in a hospital oxygen tent which provides an oxygen-enriched atmosphere for therapeutic purposes and despite large warning signs in his room, and on the inside of his canopy reading "Do Not Smoke." Probably, he thinks the caution is to protect the hospital blankets from having holes burned in them. At any rate, it must be obvious that there is a serious lack of information concerning the nature of the hazard faced.

Most people, including hospital patients, think of a spark on clothing as creating a glowing ember that will slowly enlarge in size until it either goes out of its own accord or is extinguished by brushing with almost anything, including one's hand. In an oxygen-enriched atmosphere, such as enrichment of from 21 per cent to 29 per cent oxygen, the touch of a spark to a brushed fabric will cause the entire fabric exposed to the oxygen-enriched atmosphere to burst immediately into flame (within several seconds at the slowest).

It is entirely possible that this lack of appreciation for the quickness of spark ignition of solid combustibles in oxygen is the basic cause of the casualness with which an employee would call oxygen "air" until the day he worked in a pit and, as it was getting somewhat stuffy, asked a buddy to blow some air into the pit where he had been working. When he lit his torch later or

struck his arc, he learned the hard way that the "air" he received was actually oxygen. Last year, three men burned to death when an air grinder was used in a deep pit that had been aired out with oxygen almost three hours before.

Of course, a loose valve stem can cause an equally serious situation unless the equipment is periodically checked and promptly repaired. The respect that your personnel show for atmospheric mixtures with oxygen or fuel gases can frequently be directly measured by the regularity with which they leak test their equipment before beginning work. Keep them leak testing, and they will be more apt to recognize the wisdom in the nine precautions listed.

Purge Hoses Before Lighting Up

It always surprises me on making inquiries of welding shop personnel *and* welding engineers to find how few people know that they are risking fire and explosion by failing to purge hoses before lighting up.

An element of safety is built into oxy-fuel gas equipment by using a mixer near the welding or cutting tip so that the individual gases are kept separate before use. Consequently, flash backs which can occur in mixed gases are prevented from burning back into the torch equipment any further than the mixer.

We have a class of accidents called the Monday morning hose fire or explosion. Invariably, the fire occurs on lighting the torch without first purging the lines. Either the hose and torch has been left with the torch valves open so that air can be drawn into the acetylene hose, or the equipment has been misoperated, with one gas being forced into the other hose through the mixer. In either case, failure to purge the hoses before lighting up in the morning can cause a flashback that will burn back into the hose and regulator as far as a mixture of a flammable gas with air or oxygen can be found.

Check valves can help a great deal to prevent feedback but are not 100 per cent reliable and can create a false sense of security, although, where workmen are careless, they are better than nothing.

Open Valve Slowly

Drain Oxygen Regulator Before Opening Cylinder Valve

Because a cylinder may contain oxygen at pressures up to 3,000 psi, the user is cautioned to "open valves slowly" to permit the heating effect from friction and fr gas compression to be absorbed by t tal fittings and tubing and prevent ex ly high temperatures from developing. The p caution is a sound one but is not as important as the precaution to "Drain the oxygen regulator before opening the oxygen cylinder valve."

To understand these precautions, it is necessary to understand the effect of adiabatic compression; that is, the heat developed by compressing a pocket of gas without any heat being absorbed by the sidewalls of the gas passage. Whenever the valve on a full high-pressure cylinder is opened, temperatures should be developed in excess of 1,700°F, temperatures which exceed the ignition temperatures in oxygen of all the materials involved, including steel. However, ignition can only occur if there is enough total energy in the hot compressed gases to heat any combustible present to its autoignition temperature before the temperature of the hot gases drops below this autoignition temperature.

If an oxygen regulator is left with oxygen under pressure within the inner stage, the high-pressure inlet seat will remain shut when the cylinder valve is opened. In this condition, the air or oxygen when compressed against the high-pressure inlet seat of the regulator can cause a violent fire if the seat is seriously abraded or contaminated.

When a cylinder valve is opened, two temperature changes occur:

1. If the regulator inlet seat stays closed while repressurizing the regulator, this gas will be heated from ambient temperature to its final adiabatic temperature, which can be over 1,700°F at 2,000 psi.

2. If the regulator inlet seat opens while repressurizing the regulator, most of the gas compressed from ambient temperature will be swept into the intermediate stage of the regulator at a relatively low pressure (the interstage pressure). And the gas that is finally compressed against the regulator (high-pressure) inlet seat will have been cooled initially by the reduction of its pressure through the cylinder valve.

When a regulator is not drained of gas, therefore, the inlet seat will be held shut, during repressurization, by the intermediate stage gas pressure and the highest temperature of condition (1) will develop. To prevent the relatively remote chance of a regulator seat fire on opening a cylinder valve, it is wise to be sure that the oxygen regulator has been drained of gas before the oxygen cylinder valve is opened. This is done normally by getting used to draining the regulator when shutting down the equipment—by first closing the cylinder valve and draining the regulator, hose, and torch by opening the torch valve until oxygen stops flowing—and then closing the torch valve.

Segregate Cylinder From Combustibles

Cylinders are equipped wi h safety devices designed to prevent full ders from rupturing in fire. But a p tial full cylinder can explode before the safety device releases. In general, high-pressure cylinders that are 50 per cent full or more will be prevented from rupturing in a fire by their bursting discs. Of course, if a localized flame plays against the base of a high-pressure cylinder, even a full cylinder can rupture. In the case of low-pressure liquefied gas cylinders protected by relief valves, the relief valve will protect the cylinder from rupturing until the cylinder is almost empty of liquid; but more often than not, the shell of the cylinder, when no longer cooled by internal liquid, will heat up and fail under the pressure setting of the relief valve unless the relief valve burns out and allows the cylinder to empty completely.

For these reasons, it is quite important to segregate cylinders from combustibles to minimize damage in the event of fire and to protect nearby personnel and firemen from exploding cylinders.

Fire Prevention

Space will not permit an adequate discussion of this subject. But it may help to remember that welders and burners are wearing blinders and cannot see where the hot slag, sparks, and flames are traveling. NFPA 51B points out that management and welding supervisors have a joint responsibility with the welder or burner to see that the work is done under intelligent supervision, that the area is cleared of combustibles, that combustibles that cannot be removed are protected, that fire extinguishers or water hose are on hand, and that a watcher is provided during or after the hotwork when needed.[4] For your own protection as safety or construction engineers, you should be thoroughly familiar with that NFPA standard.

Keep Fuel Gas Cylinders Upright

This precaution is usually phrased "Acetylene & liquefied fuel gas cylinders should be stored and used upright, and not allowed to be on their sides." However, while the precaution as I have phrased it differs somewhat from the present standard caution, it is simple and easier to remember.

The great majority of flammable gases used in the construction industry are liquefied gases such as acetylene, propane, butane, and ammonia. And while there are flammable gases that are not liquefied in the cylinder, such as hydrogen, carbon monoxide, methane & ethylene, these gases do not constitute an important segment of the construction industry's fuel gases. The nature of the gas in the cylinder is important because safety devices such as relief valves are sized to relieve pressure adequately when connected to the gas phase. If connected to the liquid phase due to the position of the cylinder, the cylinder in a fire might rupture before the relief valve vents enough liquid. Consequently, it is most important to store and to use these gas cylinders in the vertical position with the valve on top.

Second, the acetone in an acetylene cylinder does not diffuse completely throughout the cylinder filler. When the cylinder is placed in one position for several hours, many cylinders will eventually form a liquid level in this position. Thus, an acetylene cylinder, after having been stored horizontally and then positioned upright for use, may act for several hours as if the outlet valve was still submerged under liquid acetone. Under this condition, the cylinder will release liquid acetone with the acetylene and this can be expelled through the welding or cutting tip for a considerable distance, to create a fire hazard. In addition, the escaping acetone can develop a static charge of tens of thousands of volts in several seconds, which can cause self ignition.

Many years ago, one of our customers had several acetylene cylinders catch fire when they opened the cylinder valve. Fortunately, no one and no equipment was burned. As soon as we heard of the fires, we asked the customer to hold the cylinders for our investigation. Several days later when we looked for the cylinders to study, we couldn't

find them. It took a while before the customer would admit that acetylene cylinders were in such short supply that they couldn't hold up the cylinder shipment for our study. And since only the first three cylinders gave trouble, they used up the entire rail shipment after the remaining cylinders gave no further trouble. It was quite a while before we determined that the railroad had been shipping our acetylene cylinders horizontally because they stacked better. They had been forming liquid levels in most of the cylinders which covered the valves and which took hours to eliminate after standing the cylinders upright.

For these reasons, it is best to store and use all fuel gases in the vertical position to avoid inadequate pressure relieving capacity or to avoid acetylene cylinders that will spit acetone.

Acetone Spitters

Because an acetylene cylinder might release acetone with the acetylene when full, some workmen have the habit of checking each full cylinder for its tendency to release acetone by opening the cylinder valve momentarily and holding their hand in front of it. Since entrained liquid action can generate a 20,000-volt charge in a few seconds by impinging on an insulated body, there is a strong tendency to self-ignite under these conditions. The difference between a fire with personal injury and only a bit of liquid in the palm of one's hand may be simply the wearing of a glove (which is an insulator) on the hand that turns the cylinder valve. When testing without gloves, the charge will drain off as fast as it is generated.

We hope this habit will disappear as we point out that not only is a fire hazard involved but the test itself is meaningless. Without a regulator, the opening of a cylinder valve places a flow rate demand on the cylinder for which it is not designed and that it should not be called upon to deliver. If any question arises about an acetylene cylinder releasing acetone when full, a single piece of equipment is available to check this phenomenon which limits the flow rate, separates the acetone, and prevents a static charge from building up.

Maximum Acetylene Pressure

Acetylene equipment is designed to operate at 15 psig. At this pressure, and in the hoses, regulators, and torches provided, acetylene is stable.

You may know that safety with the oxy-acetylene process is achieved by keeping the gases separate until they are mixed at the welding or cutting tip where they are to be used. When, due possibly to an obstruction at the tip, the gas flow is reduced until the flame velocity exceeds the gas velocity, the flame will flash back through the mixed gases until it reaches the mixer where the flammable mixture of gases start. Because acetylene under 15 psig is stable, the flame will stop when it reaches the passage carrying pure acetylene to the mixer and will go out or can easily be extinguished.

Now! Gauge pressures represent the difference between the pressure inside the Bourdon tube of the gauge and the outside or atmospheric pressure. So when we say acetylene is stable at 15 psig, we are actually saying acetylene is stable at 30 psia, since the absolute pressure determines the true density of acetylene.

In a caisson, however, where you work under pressure, the external or atmospheric pressure increases but the regulator can still provide only a 15 psi discharge pressure above atmospheric (15 psig). Thus, while acetylene equipment is designed for 15 psig, the equipment when used under pressure will be operating at 30 psia plus the caisson pressure.

For example, in a caisson under 70 feet of water, the atmospheric pressure will be 45 psi instead of 15 and the absolute pressure will be 60 psia or the equivalent of operating at 45 psig under atmospheric pressure. Remember, the regulated delivery pressure of the acetylene will not change, but the density of the acetylene and its instability will increase in direct proportion to the caisson pressure.

There is a tendency in the construction industry to adjust the regulator delivery pressure to higher than allowable pressures (the gauge scale above 15 psi is colored red for "danger"), or to insert a longer adjusting screw into an acetylene regulator to secure acetylene discharge pressures above 15 psi. This permits higher gas consumption from a single cylinder and the use of two torches from a single pair of cylinders with apparent financial savings. What the user doesn't realize is that he is saving money

at the risk of his neck, of the surrounding property, and of a much greater expense due to a fire or explosion later on.

Flashback tests have indicated that while 15 psi acetylene will not propagate a dissociation through a ¾ in. hose, a 30 psi delivery pressure will flash back through the hose. Since the stability of acetylene is affected by a number of other variables, the 15 psi pressure was chosen by the industry as a practical limit and the equipment designed for this limit. When acetylene is used at pressures above 15 psig without redesigning the equipment (smaller passages and greater cooling surface areas) the possibility of an explosive flashback increases rapidly. Such operations should be searched out and eliminated.

There are many other precautions that I cannot cover in this presentation such as "Do not drop cylinders," "Do not use cylinders as supports," "Do not arc burn cylinders," "Do not heat cylinders with a torch," "Do not move cylinders with regulators attached," etc. You'd be surprised how many people forget when they are using cylinders as equipment supports and cut into them. We have had people cut into cylinders while removing jammed caps with a torch. Others lift cylinders with magnets or choke straps until they bump the lift and the cylinders fall.

Precautions are established because the hazard which would otherwise be involved will eventually cause an injury. All of the present precautions are the direct result of past serious accidents. The Welding and Cutting Safe Practices Standard Z49.1—1967 (1) includes the Construction Industry under Part 1 of Section 9 on Industrial Applications. Please! Let me repeat—please do not make the mistake of thinking that the precautions in Part 1 of Section 9 covering the Construction Industry are the only precautions needed. The precautions of all nine sections should be your guide. Be thoroughly familiar with Z49.1 and it will pay off in safe operations and freedom from wrong or injury.

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6. CGA G-4, *Oxygen.*
7. CGA G-5, *Hydrogen.*
8. CGA G-6, *Carbon Dioxide.*
9. CGA P-1, *Safe Handling of Compressed Gases.*
10. CGA SB-2, *Oxygen Deficient Atmospheres.*

ANSI—American National Standards Institute, New York, N. Y.

AWS—American Welding Society, New York, N. Y.

NFPA—National Fire Protection Association, Boston Mass.

CGA—Compressed Gas Association, New York, N. Y.

FEDERAL CONSTRUCTION SAFETY ACT

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Why a construction safety act? The statistics speaks for themselves. The National Safety Council 1970 *Accident Facts* reports that in 1969 the construction industry had four million workers, of a 79 million employed work force (five per cent), 2,800 of 14,200 deaths (20 per cent), and 240,000 of 2,200,000 disabling injuries (11 per cent). The construction industry had more fatalities than any other major industry group while employing the third smallest number of workers in all eight major industry groups. Frequency was 14.07 versus 8.08 all-industry average. Severity (man days lost and charged per million man hours worked) was 1715 versus 640 all-industry. Congress took note of these statistics and, in the wake of the Farmington, West Virginia, mine disaster late in 1968, made the Construction Safety Act the first substantive bill passed in the 91st Congress.

Exactly what and who are covered by the Construction Safety Act?

1. Each Federal government contract exceeding $2,000.

2. All Federal and Federally financed construction contracts.

It is estimated that coverage under this act will amount to 40 to 50 per cent of all construction work in the country: 2⅕ million workers; 250,000 work sites; $50 billion worth of construction by contract. The act does not cover anything in the nature of a Federal loan guarantee or insurance, including loan guarantees, or as issued by the FHA or VA for individual home ownership.

A second question most often directed to us is: What will the Federal standards be like? Before going into that question, let me outline briefly how the standards are being written.

The law called for the establishment of an advisory committee to be made up of three representatives each from labor, management, and the public. Their function is to advise and consult with the secretary in the formulation of the construction safety standards. After the advisory committe was established, I was chosen as coordinator to form a task force to write the standards and put the package together.

The task force is made up of engineers, safety officers, and an industrial hygienist. They hail from all over the country. We had many, many inquiries for these positions, which illustrates to me the importance attached to these standards and the great interest of all construction safety people in this task. It is anticipated that we shall have need for additional staffing when the standards are publicized in the *Federal Register* and they become applicable to field operations or Federal contracts.

The first thing the task force had to do was decide what hazards the standards should cover and what guides, rules, regulations, or consensus standards had been written against those hazards. We collected all those materials in order to judge the latest, the best, or the most effective rules to apply. We had listed every possible hazard we could think of, gathered together in what we called a hazard category guide. We didn't know, until we started the actual researching, exactly what would be included, what left out, or even what final form the standard would take. The format would necessarily depend on the contents. The guidelines derived from what we considered representative of and applicable to the construction industry, formulated by the best of expertise and basically developed by what is considered general consensus input.

The advisory committee kept an eye on each step of the way and made suggestions and comments as needed. When a first rough draft was completed, they took each section piece by piece, individually reviewed it, and in a later meeting discussed it part by part, again giving us the benefit of their expertise, experience, and knowledge, with suggestions for changes, additions, or more acceptable basic guides and reference documents.

In addition to the advisory committee, the task force was helped immeasurably by the Office of Standards Development of the Bureau of Labor Standards. It has been a joint effort. We are working together to put out a good document. Each team gave the standards subparts a good scrub-down, then as a single team we are melding in the valued inputs of each.

A contract was entered into in 1970 to aid and augment the task force work of collecting, cataloging, indexing, and evaluating all construction safety standards on a hazard category basis. This contractor's input or periodic reporting basis has been considered along with the research work of the task force.

While we were gathering all that background material, the construction industry associations and those who would otherwise in some way be affected by our standards were aiding in many cooperative ways. They offered their information, data, materials, and their help in the task we had to do.

What will the Federal regulations be like?

We are trying to compose a set of standards that will be practical, workable, and applicable on the job site. By that, I mean that we will spell out exactly what we mean in each section. The boil down of standards subparts (to 23) is based on construction phases; e.g., excavations; concrete, masonry, and asphalt; personal protective and life saving equipment; material handling, storage, use, and disposal. We feel that all employees in such operations are subject to the same relative hazard exposures. This is being followed in preference to citing craft hazards.

We don't want to require anyone to carry a nine-foot shelf of reference books on his back as he supervises a job, but we believe that every safety director and engineering department should always have at hand the latest complete reference material available.

The advantage to you will be very great:

1. Uniformity of requirements throughout the country. There should be only relative minor differences between state and Federal regulations.

2. You will have clear directions for the writing of your own company or organizational manuals in which you spell out the safe practices you require of all your employees to accomplish the fulfillment of your charge of responsibility under the Act.

Remember: It is management's responsibility to furnish a safe place to work. It is the employee's responsibility to work safely.

We have tried to be practical. Obviously, a regulation that would result in stoppage of an operation or unnecessary delay in some phase of a project is self-defeating. That type of rule could, conceivably, result in just the opposite effect we are trying to accomplish.

Public Review and Endorsement

We are planning to hold informal review and discussion meetings in five locations throughout the country early next year. At that time, written or oral comments will be collected, studied, and evaluated by our team. We feel that the knowledge and expertise from people in the field is both desirable and necessary. You can be sure that what you have to say about the proposed standards will be definitely considered.

Later, of course, after the notice of standards promulgation has been published in the *Federal Register*, there will be formal hearings in which witnesses will again have a chance to enter written comments on final development of the construction safety and health standards.

Inspection and Compliance

Coordination meetings are being held with other Federal agencies, and state agreement plans are being considered. The President's 1971 budget proposes 45 positions for the addition of field staff—inspections, training, and field liaison. House action reduced the number to 26. There has been no action by the Senate to date, and no appropriation to date.

Training

In June 1970 the Office of Training contracted for development of a training course for first line construction supervisors: a 30 hour basic course, a 10 hour condensed course, and a 40 hour instructors course. The contract calls for 25 classes of 25 men to be conducted nationwide in 1971.

POST-TENSIONING AT THE JOB SITE

By FRED BRASELTON
General Manager, The Prescon Corp., Corpus Christi, Texas

One of the fastest growing and most interesting new fields in the construction industry today is that of prestressed concrete. This youngster emerged on the American building scene in the early 1950's and since then has enjoyed an amazingly fast growth. My objective today is to better acquaint you with this versatile construction tool.

First, there are a few definitions and industry vernacular with which we should become familiar before we can get into a discussion of prestressed concrete and, more specifically, post-tensioning. In order to talk about prestressed concrete, we must first know the meaning of prestressing. Here is one definition for your consideration:

Prestressing: The development within a structure of stresses, capable of resisting, within prescribed limits, other stresses induced through loading of the structure.

In an attempt to further clarify, let me paint this word picture: Design engineers can compute with accuracy the loads that a structural member must carry. In most

structural systems, the engineer designs the structural members strong enough to carry the worst loading condition (with the proper safety factor built in) with a minimum of deflection. However, in prestressed concrete design, the engineer, knowing the load-carrying requirements of the member, can offset the heaviest loads by introducing prestressing into the structural member and thereby take full advantage of the component materials of the member.

I like to think that a prestressed concrete member is not forever laboring under the strain of just barely being able to carry the loads, but instead is sort of "floating" between the columns or support points. Most of the downward gravity and service loads are counteracted by the upward prestress force; therefore, the concrete is under relatively uniform stress between the support points. In fact, the concrete beam thinks it is a column, not a horizontal load-carrying member since prestressing has, in fact, changed the flow of gravity from vertical to horizontal within that member.

Another word we need to understand is:

Tendon: This is the prestressing steel element (wire, strand, or bar) which, when tensioned, imparts prestressing to the concrete. Tendons are made of high-strength steel which has a high degree of elasticity and the ability to withstand high stresses over long periods of time.

Concrete can be prestressed by two separate methods; pretensioning or post-tensioning. In pretensioning, the steel tendon is placed in the form and is tensioned prior to the placing of the concrete. When the concrete is placed, the concrete develops bond with the tendon. When the concrete reaches the proper strength, the tension on the steel tendon is released and the bond, which had previously developed between the steel and concrete, compresses the concrete to the desired degree.

In post-tensioning, the steel is encased in a sheathing to prevent initial bond between the steel and the concrete. The tendon is then placed in the form and concrete is placed around the tendon. After the concrete reaches the proper strength, the tendon is tensioned and anchored. The force necessary to tension the steel tendon exerts a compressive force on the member, thus prestressing the concrete.

Let me emphasize that either method produces the same result: Prestressed concrete. The prefix "pre" or "post" refers only to whether the steel tendon is tensioned before or after the concrete is placed.

Although both methods result in prestressed concrete, the procedures involved in attaining prestressed concrete are very dissimilar. The pretensioning method is built around a precast concrete operation and its product is a finished precast, prestressed concrete member. The prestressing is accomplished in a "pre-tension bed" which is specially constructed for this purpose. Pre-tensioning results in precast members which are then transported to the job site and erected much like structural steel.

In post-tensioning, the suppliers fabricate only the prestressing steel tendons which are later incorporated into a concrete member or frame at the job site. Most often, post-tensioning is used with cast-in-place concrete since its prestressing operations are portable; however, post-tensioning can also be incorporated into precast concrete if desired.

Which method is best? Well, it depends on who you're talking to, I guess. Actually, both methods have their place and quite often will be used on the same job. Pre-tensioning offers speed of construction, economy through mass production and factory built quality control; it is, however, limited to only a few structural shapes, the distance factor in hauling from plant to jobsite and large fixed investment in plant. Post-tensioning offers flexibility in shape and design of structure, portability of stressing and versatility of application. Its disadvantages are that it is custom made for each job and requires a high degree of technical ability to engineer, produce and market.

With this for a background, let's look at the emergence of concrete as a building tool and discover the basic principle of prestressing.

Use of concrete has increased dramatically since the turn of the century until it has now become the most popular construction material throughout the world. Basically, concrete consists of cement, sand, gravel, and water. It is mixed in a liquid state, then poured into molds (or forms, as we call them) and allowed to sit until it solidifies. The forms are then removed, leaving only the solid concrete.

Structurally, concrete is strong in resisting compression but weak in resisting tension. To overcome its weakness in resisting tension, the concrete is usually reinforced with steel bars. This is commonly referred to as reinforced concrete. This product has become popular because it is fire resistant, requires relatively little maintenance, is quite strong, and can be produced economically. But, let's look for a minute at what is going on in that reinforced concrete member. It is spanning between two supports carrying a load in addition to its own weight. The natural thing for any object under these conditions is to sag under the load midway between the supports. As the concrete sags, the top of the member gets squeezed together while the bottom of the member tends to split apart.

We said concrete was strong in compression, so we don't worry about the top; however, we do have problems with the bottom part since concrete is weak in tension. To help the concrete overcome this tension, we had reinforcing steel added in the bottom of the member. Therefore, when the concrete member begins to fail under the tension load, it relies on the reinforcing steel to carry it. In other words, the concrete uses the reinforcing steel as a crutch. The reinforcing steel is of no value until the concrete reaches the point of failure. Then the concrete grabs the steel and hangs on for dear life.

It is obvious that if we could eliminate the sag in the member (thus eliminating the tension) we would further improve the characteristics of structural concrete. This is the whole purpose of prestressing. It is designed to remove all tension from the member, thus utilizing the compressive strength of concrete.

How does the tendon accomplish this objective? The tendon is parabolically draped through the member. In this way, it provides a lesser uplift force near the support and a greater force at the midpoint. Or, just what the doctor ordered. This works for a more sound structure as well as a more economical one.

The concept of prestressing is really nothing new at all. Barrel hoops and wagon wheel rims have utilized the idea for years. By heating and then cooling the steel (which causes it to shrink) the steel exerted a compressive force on the wood. Even the idea of prestressing concrete dates back to 1888. However, the lack of high strength steels and quality concrete kept prestressed concrete in the experimental stages until the 1940's when stronger steels and better concrete were developed. And, finally in 1950, the first contracts for prestressed concrete bridges in the United States were let and the infant was born. Since that time, prestressing has been established as an industry itself and is ever increasing its uses and applications.

Earlier, the differences between pre-tensioning and post-tensioning were outlined. Suffice it to say that the method used to pre-tension the steel is used practically worldwide. However, several different methods of post-tensioning have been developed. When post-tensioning, a high compressive force is exerted directly onto the concrete member. Generally, this force is much greater than the cured concrete could withstand. Therefore, all post-tensioning methods utilize a steel bearing plate cast into the end of the concrete member to distribute the prestressing force to the concrete without crushing it. However, there are at least two methods of retaining the prestressing force in the tendon: friction wedge and cold-formed buttonheads. In the friction-wedge system, the prestressing steel is stressed and then conical wedges are driven into a tapered hole in the bearing plate which wedge the steel tendon in its elongated position. In the buttonhead system, a head is formed on the steel after it has been threaded through a steel anchor member during fabrication. After the concrete is cast and cured, the tendon is tensioned and steel shims are inserted between the anchor member and the bearing plate to maintain the elongation in the steel.

Post-tensioning tendons may be either "bonded" or "unbonded." An "unbonded" tendon is one in which bond between prestressing steel and the concrete is prevented by greasing the steel and encasing it in either paper or plastic sheathing. A "bonded" tendon is one in which the prestressing steel is encased in a flexible metal hose. After stressing has taken place, the void in the metal hose is filled with cement grout. Design requirements often favor one type tendon over the other and the final decision is up to the design engineer.

The topic today is "Post-Tensioning at the Job Site." However, before we move to the

job site, let me briefly explain how post-tensioning tendons are fabricated. Depending upon the various systems and applications, post-tensioning tendons may be either pre-fabricated at a plant and delivered to the job ready for installation in the forms, or fabricated at the job site.

Plant fabrication of tendons is accomplished in a specialized shop facility where the various tendon components are made and assembled. The steel wire travels down the table to the desired length and then is sheared. At this point, the steel is threaded through the end anchors. The next step is to form the buttonheads on the ends of each wire. The tendon is then moved to the next station where rust preventive compound and paper or plastic is wrapped around the tendon. After completing the fabrication, the tendon is coiled and readied for shipment by truck.

In a set up for fabricating friction wedge type strand tendons, the wrapping is done on another line and the tendon is cut to length, placed in the end anchorages and coiled. In a Quality Assurance room, equipment and personnel inspect the product and manufacturing procedures to insure job specifications are met.

Now that we have become somewhat acquainted with prestressing concrete and what it does and how tendons are made, let's move on to the real crux of today's topic—the job site installation and stressing of tendons. As I previously mentioned, the tendons are either plant fabricated or job site fabricated. The installation of the tendons differ depending on whether they are plant or job site fabricated; however, the stressing and grouting operations are, basically, the same for either type and we will consider them as being identical.

First, let's discuss installation of job site fabricated tendons. End anchorages and empty metal hose (or duct) are shipped to the job site where they will be installed in the forms prior to concrete placement.

When the bridge deck is formed, the end anchorages are batted to end bulkheads and the ducts are assembled to the proper tendon length, in accordance with the shop drawings. After placing the tendon duct, it should be wire-tied to the rebar stirrup cage at each designated support point to insure the duct remains in the proper location during concrete placement.

Following the casting of the concrete, the strands are pulled through the empty ducts with a powered tugger, equipped with a cable line and a "Chinese finger" to fit over the bundle of strands. After pulling the strands through the duct, approximately 12 inches of strand must project from each end of the concrete to allow removal of the Chinese finger and to attach the stressing block.

The strands are threaded through the stressing block which is then secured to the end anchorage which was previously embedded in the concrete. This completes the installation operation and the job site fabricated tendon is now ready for the stressing operation.

To date, job-site fabricated tendons are most prevelant in cast-in-place bridge construction. It lends itself to the very long and complex bridges now required in our Interstate highway and freeway system.

However, the large majority of post-tensioning work utilizes the plant fabricated tendon in cast-in-place concrete so we will devote more explanation to the operations involved in placing, stressing, and grouting of these type tendons.

The same workmen who place reinforcing steel are generally employed to place post-tensioning tendons. Tendons are usually placed before reinforcing steel, electrical conduit, and other mechanical work on the formwork since tendons are the primary structural elements in the concrete and take precedent over all other embedded materials.

Tendons are generally shipped on trucks in coils approximately 5 ft. in diameter. Tendons may be off-loaded and handled either mechanically or manually. Care should be exercised in unloading and handling the tendons to prevent damage to the slippage sheathing, which is an integral part of the tendon and is not merely packaging as so many workmen assume. Belt or webbing slings are recommended.

The coil is secured by ties at intervals to prevent premature uncoiling and possible injury to workmen during the placing operation.

Each tendon is marked, corresponding to the mark shown on the shop drawings, which are carefully prepared by the prestressing supplier's engineering department and care must be taken to insure the correct tendon is placed in its proper location.

The structural engineer has determined the exact tendon location by careful calculations and close tolerances must be observed. Vertical deviations, when required, should be kept to no more than ⅛" to ¼"; horizontal deviations, though less critical, should also be maintained as required by the specifications.

In the vertical plane, slab tendons should be placed on individual supports of proper height and at specified control points along the length of the tendon. Horizontal positioning is obtained by tying No. 3 reinforcing bars at right angles to and on top of the tendons at the control points. Joists, beams, and girders usually contain supplementary reinforcing steel, such as stirrup cages, to which tendons can be secured, both vertically and horizontally.

Placing the tendons should normally precede placing reinforcing steel, However, in joists, beams, or girders, a reinforcing cage may be used with open top stirrups to allow the reinforcing to be fabricated and placed prior to the tendon placement. Tendons may then be placed down through the open stirrups and secured in final position. After the tendon is completely placed, the vertical position of the tendon should be checked at specified control points. At this time, if tendon sheathing has been damaged, repairs should be made to prevent concrete from coming in contact with the steel tendon and causing bond prior to the stressing operation.

Now, we are ready for placement of concrete. When concrete placement begins, a workman should be assigned to maintain proper vertical and horizontal alignment of the tendons slightly ahead of concrete placement since the vertical position of the tendon in concrete is most important to the performance of the structure. Care should be exercised so that concrete is placed in such a manner that tendon alignment and reinforcing steel positions remain unchanged during the pour.

Special attention must be given to vibration of concrete at tendon anchorages to insure uniform compaction at these points. Thorough and proper use of concrete vibrators is very important during the concrete placement and cannot be emphasized too strongly. Another item of importance during concrete placement is to avoid stepping on tendons as this may dislocate them from their proper positions and adversely effect the performance of the structure.

Concrete placement completes the tendon placing operation and readies us for the stressing operations. As we mentioned earlier, the stressing operations for both job site and plant fabricated tendons follows the same general procedure so we will discuss them as one operation.

All necessary stressing equipment is furnished by the prestressing supplier, although the contractor generally provides the electric power (110V) to the equipment.

When laboratory tests indicate that the concrete has reached the proper strength (usually 75-80 per cent of specified, 28-day strength) the stressing operations may begin. It is imperative that shoring be left in place until the post-tensioning operation is performed since the concrete has no structural strength until after the tendons are stressed.

After desired concrete strength is reached, inspect the concrete around all bearing plates for voids. Voids behind the bearing plate, or insufficient concrete strength will cause concrete failure which can cause injury to workmen. Careful vibration during concrete placement and proper curing of the concrete will eliminate most such difficulty. All voids behind the bearing plate must be repaired prior to the stressing operation.

Since stressing is a most important operation, it is recommended that tendons be stressed only when proper data and personnel experienced in stressing operations are present. The stressing data chart supplied by prestressing suppliers indicates the proper equipment size, stressing forces and gage readings for each specific tendon.

Before beginning stressing operations, make sure that sufficient power (110V for electrically operated pumps) is available and that the source is close enough and/or the line is large enough to insure that no appreciable power drop will occur.

After this, check to insure that all stressing equipment to be used is the proper size and type for the tendons to be stressed, as called for on the prestressing supplier's shop drawings. Many jobs require several different types of equipment which may be similar in appearance but quite different in loading capacity.

For the sake of clarity, I am going to explain the assembly and stressing of a buttonhead wire system. A friction wedge system would vary a little in some of the

detailed procedures but the basic principles are the same.

The stressing operations begin by attaching the stressing jaws to stressing washer. Then slide the retaining collar over stressing jaws. Be extremely careful to insure that the stressing jaws are the proper diameter for the washer to be stressed. Next, slide the jack base over stressing rod, making sure that the four corners of the base are firmly resting on the bearing plate and not on the concrete. If the corners are on concrete and not on the bearing plate, it is likely that the concrete will crush during the stressing operation, causing damage and possible injury.

It is also important to make sure that the stressing equipment is centered on the bearing plate; if the base is not properly centered, the stressing rod may bend slightly under application of the force and could break during stressing and cause considerable damage and injury.

Now place the center hole hydraulic ram over the stressing rod, with flat end of ram against the jack base. Thread the lock nut on the end of the stressing rod, making sure that all threaded connections are fully engaged. Partial or improper thread engagement is the most frequent cause of equipment failure.

When the stressing equipment has been properly attached, the pump switch may then be moved to "on" position which will actuate the ram and begin elongation of the tendon.

During the stressing operation, it is important that no one stand directly behind or above stressing equipment or between the equipment and the edge of the building. In the event of a failure in the equipment or steel, the ram and attached equipment will fly directly backward with a sudden, deadly force. If the concrete crushes, the equipment will move in the direction of the concrete failure with the same deadly force; also, the crushed concrete particles can cause eye damage. On high-rise jobs, an equipment failure could result in the equipment falling over the edge. Workmen should be careful that the hydraulic hoses do not become entangled around their feet which could pull them off the building edge along with the equipment.

The stressing operation continues by operating the pump until the gage reading is approximately as called for on the prestressing material supplier's shop drawings. At this point, the stress retention shims are inserted; care should be taken to see that both shims are inserted at the same time.

After shims are properly inserted and positioned, the pressure on the pump is released. Make sure that the pressure is released slowly, not suddenly, and that shims maintain proper position. This completes the stressing operation and the equipment should now be disassembled and moved to the next tendon where the stressing cycle will be repeated.

During the stressing operations, if at any time, any type of failure appears imminent, release the hydraulic pressure on the stressing system and allow the prestressing steel to slowly recede to its original position. Occasions for this action include a growing crack in the concrete behind the bearing plate, receding of the bearing plate into the concrete, bending of the bearing plate or bending of the stressing equipment, among others.

All post-tensioning equipment and procedures have been carefully designed with reasonable factors of safety incorporated. However, flaws in material can sometimes go undetected, equipment may have been misused, or proper stressing procedures can be ignored. For this reason, extreme caution should be exercised at all times as stressing is carried out at extremely high pressures. The primary safety rule is to keep personnel from standing directly behind or above the stressing equipment or between the edge of the building and the equipment. Failure during stressing operation could result in the equipment knocking workmen off the structure.

And, remember, shoring must be left in place until the stressing operation is completed.

One very important safety feature of prestressed concrete is that the structure is actually pretested before the shoring is removed. This is true in that the concrete, at time of stressing, is at only 70-80 per cent of its ultimate strength while the steel is initially overstressed 10 per cent to overcome losses due to friction and relaxation. This places the maximum prestress load on the concrete at a time when it is at its lowest strength so if it stands the stressing, you know it is safe to remove the shoring. In

reinforced concrete you don't know its strength until after you remove the shoring, at which time you hope it doesn't fall down. With prestressing, you know of failures while the formwork is intact and remedial measures are possible.

As we mentioned earlier, prestressing tendons may be either "bonded' or "unbonded." Bonded tendons require the additional step of pumping cement grout into the duct after the stressing operation is completed.

Grout ports are provided in end anchorages to receive fittings through which grout will be pumped into the tendons.

The grout pump and appurtenances are furnished by the prestressing material supplier. Before starting the grouting operations, the operator should consult the operating instructions furnished with the equipment for proper operation and maintenance procedures.

The injection of the grout is continuous from one end of the tendon. It should be allowed to flow until grout at all vents and openings is the same consistency as that being injected. Vents should then be closed progressively in the direction of the grout flow.

If grouting operation is interrupted long enough for the grout to set, or clogging occurs before the tendon is fully grouted, the partially grouted duct must be completely flushed with water to remove all grout. Therefore, it is necessary to maintain a dependable source and volume of water should this action be required.

After the vents have been closed and the conduit completely filled with grout, the pressure at the injection end should be raised to not less than 50 psi and held for a few seconds. After the grout has set, the fittings may be removed to complete the grouting operation.

Upon completion of the stressing and grouting operation, steps must be taken to prevent the end anchorage from being continuously exposed to the atmosphere.

Usually, tendon anchorages are coated with a rust preventive material and then a concrete cover is placed over them to prevent rusting. To insure neat placing of cover concrete in recesses, pockets, or edge strips, the forms should be fitted securely against the previously placed concrete.

Just like many other operations within the construction industry, post-tensioning can be a hazardous operation. It can be hazardous because it involves working with equipment capable of exerting many tons of force; because it is new and unfamiliar to the workmen, and because it requires fairly close tolerances in the field. However, it doesn't have to be hazardous. The post-tensioning industry has learned that the best prevention of accidents and problems is education.

Most companies have developed complete and thorough brochures explaining exactly how to perform each operation and the hazards to be alert for. On some jobs, the post-tensioning supplier will also supply the labor required to install, stress, and grout; however, the majority of the labor is performed by the general contractor or subcontractor's personnel. In either case, the post-tensioning supplier normally furnishes a qualified technician to supply initial instruction in placing, stressing and grouting and to be on call for any problems that develop. This well-trained technician spots many problems before they occur and assists the workmen in becoming proficient in the proper techniques of each operation.

Operating and maintenance instruction pamphlets have been developed by the post-tensioning supplier for the various post-tensioning equipment used and are available to the workmen. In many areas, post-tensioning suppliers have cooperated with trade union apprenticeship programs and have provided personnel to conduct training seminars in post-tensioning methods and techniques.

The great majority of accidents that are encountered in post-tensioning are caused by human error, not by product or equipment failure. Because of this, the post-tensioning industry, though young and small, is devoting its efforts toward education of the workmen to increase productivity per man hour and reduce accident frequency.

Now, there are some specific points in post-tensioning operations where danger is inherent. I'd like to review them with you. These are areas where a little knowledge and alertness beforehand can save considerable time, money and human suffering.

In the placing operation:

1. Exert care in uncoiling the prefabricated tendon. It will act like a coil spring when cut loose and the loose end could cause an accident. Hard hats and gloves are needed during this operation to minimize injury in the event of premature uncoiling.

2. Tendons are often deceiving in appearance—they are heavier than they look. Caution should be exercised in lifting and carrying tendons about on oil slick form material. Because of this, safety toe shoes and nonslip work boots should be a requirement for workmen in the post-tensioning operation.

In the stressing operation:

1. Always carefully scrutinize the area around the bearing plate for signs of voids in concrete before stressing begins. If there is any doubt that a void exists, chip out and repack the concrete around the plate. Chipping of concrete should only be done by persons wearing safety goggles.

2. The equipment used to stress operates at extremely high pressures. Hoses should be checked periodically for weak points or fraying and sharp bends in the hoses should be prevented. Also, the hoses are not handles and the equipment should not be moved by pulling or jerking on the hoses. Finally, the worker should avoid standing where he may become entangled in the hoses in the event of a failure and the equipment falls from the building.

3. The number one villain in stressing is not having full thread engagement or full grip on strand. This is an absolute must and the workmen must not be allowed to become lazy or laggard in checking for this.

4. Another problem is standing behind, immediately over, or between the equipment and the edge of the building. In the event of a failure, the equipment could move in any one of these directions and will demolish anything in its path.

5. Finally, use of damaged or faulty equipment is a danger that can be overcome by alertness and periodic checks. If there is ever any doubt, the stressing operation should not begin until a qualified man from the prestressing supplier has examined the equipment and approved its use.

In conclusion, post-tensioning is a young and dynamic industry. It is now growing at a 30 per cent rate each year and its number of applications are multiplying. It is going to become more and more of a factor in the construction industry in the future because it fills a need both for the designer and the owner.

Many of the problems we are now experiencing are due to unfamiliarity with the product and its use. Also, as with other new products, the rapid advancement of technology makes it difficult to stay abreast.

We are now attempting to tackle the problem of educating the workmen in the use of this new and potential-laden product. This education will come as our industry can train qualified technicians and instructors and publish current and useful instructional aids and brochures. However, the biggest need we have is exposure; exposure to apprenticeship programs, exposure to construction companies and exposure to groups such as this today.

Most post-tensioning suppliers in the United States are active members of the Prestressed Concrete Institute and work together for the betterment of our industry through its Post-tensioning Division. As a representative of this group, I welcome your suggestions and comments on how we can best serve the construction industry.

PRECAST PANEL ERECTION AND ITS HAZARDS

By DEE BROWN
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There are five basic phases to every precast operation:

1. *Subcontract Activity and Assignment of Responsibility.*

The contact administrator should, immediately after he is assigned a particular precast concrete erection project, obtain from the estimating department methods and procedures that they had planned on using to set precast, when they were bidding the job. He should issue purchase orders to the precast concrete panel supplier and/or manufacturer and instruct them to start shop drawings immediately. When issuing the purchase order, he should enumerate all items which need to be covered by shop drawings and

completely review the contract plans and specifications with the material supplier and/or manufacturer.

He should review all critical and potentially dangerous areas surrounding the precast panel anchorage design, and completely review all critical facets pertaining to the weight of panels in relation to their structure so as to ascertain the proper number and placement of insert lifting devices which are to be cast into the panel so that panels can be lifted, turned, and transferred safely.

2. *Prejob Planning, Scheduling, and Rigging.*

Determine the criterion of rigging and equipment that will be required to set the precast concrete panels in regard to the size and weight of the precast concrete structure to be lifted. Determine whether any special rigging is needed and if so, plan for same.

Completely review with the manufacturer all facets surrounding the placement and type of anchorage which is to be used in the construction of the precast concrete panels.

Completely review with the manufacturer, according to the contract plans, the placement of and the types of receiving angles or anchors which will be an integral part of the building embedded in the concrete that will receive the anchoring devices cast into the precast concrete panels.

Try to project any and all logistic problems which may occur, such as the proper sequence scheduling of the panels loaded in a manner in which the last panel loaded on the truck will be the first panel off, to eliminate the danger of panels dominoing and causing extensive damage to life, limb, and property, as well as other logistical problems pertaining to ingress, egress, etc.

Make arrangements to rent or lease the proper equipment necessary to accomplish the particular projects that you have contracted for from a reputable equipment firm if you do not own equipment which will handle the size and weight of the precast concrete panels called for on this particular project. Never cheat on rigging.

Where possible, submit your rigging operation and plans for observation and approval of the structural engineer on the job so that any equipment that you place on the project will not overload the structure.

3. *Operation Checkpoint.*

At this point and time prior to receiving any material or starting any erection operations, check all phases which you have accomplished previously, as well as re-checking all plans of the operation which have not yet been instituted.

Check all shop drawings, prior to submitting same to the general contractor for approval, for the proper size anchorage in relation to the size and weight of the precast concrete panel. This is most important, because you are the one who is going to lift this panel. If the anchor is not sufficient to carry the load under extreme stresses, it will be your operation in which the anchor will pull out, and it will be your insurance company that will have to pay for all damages caused by a 12,000 lb. precast panel falling 21 stories. Therefore, this anchorage must meet your requirements even if your requirements are excessive in the eyes of the precast manufacturer or the structural engineer.

Review the shop drawings in regard to the contract plans minutely, with the objective of locating any potentially dangerous conditions which might exist in the setting or aligning of the precast concrete panels as shown on the shop drawings.

Review shop drawings for quality and strength of anchoring devices, so as to obtain the highest grade material available in today's market, such as the use of high strength steel set screws in lieu of ordinary leveling bolts, etc.

Thoroughly review all shop drawings in regard to the general design of the anchorage and its compatibility with the actual structure as shown on the contract plans. If either show that a conflict exists, then insist that those parties necessary to work out this conflict meet and resolve differences prior to the installation of panels.

At this point, be sure that your job foreman or supervisor has been selected and that he is well-briefed on the game plan for the installation of the precast concrete panels on this particular job.

Send your job foreman or supervisor to the precast concrete panel manufacturer's plant to look at the panels which he will be required to set, so that he can determine in his own mind that the game plan is either

right or wrong and will have an opportunity to contribute to the pre-planning at this stage. Also take the general contractor's superintendent to the manufacturer's plant, when possible, so that he can actually look at the panels to be erected and will understand the nature and size of same and will have those areas in which precast panels are to be received properly shored prior to the arrival of the first shipment. This will insure that there will be no failures in structure due to overloading from the delivery of materials.

Review once again your plan for the rigging and the type and size of equipment you feel you need as well as the type and size of equipment your job foreman feels he needs after all parties concerned have looked at the actual panel size, etc.

4. *Setting Operation.*

The setting operation encompasses all functions which are actually accomplished on the jobsite. This entails the actual installation of the rigging, the hoisting of the material, and the placement of the material and the dismantling of the rigging.

Follow the game plan already established with as few variations as possible. This tends to eliminate confusion which normally causes accidents.

When installing the rigging to handle the hoisting of the material, figure in advance of actual lifting, the vertical path the stone will take. Be sure that all personnel and spectators are clear of that area directly under the vertical path of the stone.

Rig the lifting devices in a manner which will keep the material as well as the hoisting device, such as a stiff-leg derrick or a crane, clear of the building structure as well as any other obstructions around the area of installation. After the setting operation has actually started, observe the agility and skill with which the operator for the hoist works and the condition of the equipment with which he has to work; then plan your safety procedures accordingly. When lifting precast concrete panels which are laying face down on a truck, always lift this material with a two or more part line so that the material can be turned in the air after it is well away from any obstruction which it might damage or might cause damage to it.

See that all workmen are outfitted with the proper safety equipment such as shoes, hard hats, safety belts, and any other protective clothing necessary. Be sure that the job in question is provided with the proper size of hand tools in comparison to the size of the stone which is being installed. By doing this, you will insure that your workmen are using tools and equipment sufficient to move the material being handled rather than depending on their backs to move same and thus eliminating the risk of costly injuries.

Make sure all equipment is in top-notch condition prior to beginning installation of precast concrete panels. All cutting torch rigs of acetylene and oxygen should be checked each day for leakage. Proper fire-fighting equipment should be available in those areas where welding or cutting torch operations are in process, or where the raw materials for this operation are stored.

5. *Completion of Job.*

After the completion of the precast concrete panel installation, all permanent connecting points should be checked to make sure that they are properly welded in place. All rigging should be dismantled and lowered to the ground, exercising and utilizing the same safety precautions as were utilized in their erection.

In summary, the erection of precast concrete panels can be quite hazardous when the work is performed by amateurs or semi-professionals. However, the erection of precast concrete panels when installed by professionals is a very low risk type of construction. Much more so than other more traditional means of constructing multi-story buildings.

PUBLIC EMPLOYEE SECTION

THE EVOLUTION OF THE PROFESSIONAL SAFETYMAN

By HUGH M. DOUGLAS
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The role the professional safetyman should play in the attainment of safety objectives has been much discussed. Absolute conclusions have not been reached because the whole field of accident prevention has been evolving from a narrow injury prevention concept to the broad spectrum included in programming to preclude all losses. The tempo and scope for total loss control is rising rapidly.

Safetymen who do not recognize and move with the evolution will be left behind. It is not too late to take stock. The quote by Disraeli, "To be conscious you are ignorant is a great step toward knowledge," has meaning for forward thinking safetymen.

On the premise that fundamental changes are taking place in so-called safety programming, two basic questions must be answered before the professional safetyman can really determine what his role is, or should be.

The first question is: At what stage in programming are you and your firm thinking and practicing? Is the main emphasis injury prevention? Total accident or damage control? Total loss control?

Having honestly answered that question, a second and equally important question must be asked and answered: At what level are you practicing as a safetyman—if you are a manager, at what level is your safetyman practicing? First aider? Do gooder? Good doer? An accepted member of management?

Having raised these two questions, the logical objective of the presentation is to examine them with the view to helping safety personnel improve their ability to appraise the operating efficiency of an organization in terms of current industry practices and then recommend changes to minimize the number of incidents which downgrade the system, thereby assuring attainment of continuing profit goals.

To organize a logical approach in meeting the objective, the following questions will be examined: Where are we? How did we get here? Where have we failed? What must be done? How must we do it?

To fully appreciate the present, it is necessary to do two things: (1) look to the past, for "the past is prologue;" (2) have an appreciation of the standards by which measures are made. There is much truth in the statement made by Peter Drucker: "The measurement used determines what one pays attention to."

The universally accepted standard of measurement is the disabling injury frequency rate. A look at the average for industry, as reported to the National Safety Council, gives an overview of what the current experience is and where it has been. Much improvement was made between 1925 and 1941. The experience rose during the war years. A major drop occurred in the 1950's. A rising trend prevailed in the 1960's. The year 1970 must be the cross road. It will only be so if a major shift in emphasis is made.

Having examined the record, the question is asked: what programming was used to improve the record from 1925 to 1960? The following items are a synthesis of the program vehicles used. Others could be mentioned, or different titles could have been shown: machine guarding, housekeeping, rules and regulations, personal protective equipment, visual aids, five-minute safety talks, committees, and individual responsibility.

Equally important to what was done is—why was it done? Almost everyone interested in accident prevention consciously or unconsciously thought of these programs as a means of seeing that people did not get hurt. As holy as that motive is, it is a primary cause for the rising rates. Before taking exception to that statement, examine what the failures were that accounted for the rising trend in the 1960's.

The question is divided into parts: (1) where have we failed in programming efforts; and (2) where have professional safetymen failed in their personal development?

In the area of programming, six underlying failures are cited: narrow base action; etiological causes by-passed; patch prevention practiced; universal antidotes used; limited formal safety training; and too little applied research.

Having listed the causes of the deteriorating injury experience, the next question is: What must be done? The most important thing to be done is to broaden the control base. All other efforts are supportive to broadening the base and raising the standard of work excellence expected.

The broadening can be brought about in two steps: (1) by including all damage incidents to property; (2) by programming to preclude all incidents which can downgrade a system. When step 2 is achieved, safety will no longer be a satellite function. It will then be fully integrated with quality and quantity of production. Step 1 is a total accident control, or damage control program, as it may be more familiarly known to some.

The entire significance of a program can be changed by the addition of four words to the standard rule for reporting. The four words are—"or damage to property." But total accident or damage control also stops short. The ultimate step is total loss control.

Total loss control or total environmental control is a concept to improve productivity through the elimination of the errors which result in downgrading incidents. Total loss control is concerned with the control of all insured and uninsured loss arising from such business interruptions as injury, property damage, fire and explosion, industrial illness, pollution, breaches of security, and public liability. Each of these is symptomatic of a breakdown in the administrative processes of a system which can be graphically portrayed in ten words: the cause of any downgrading incident is an error. The result of any incident is some form of business interruption. The cost is reduced productivity. The ultimate cure is excellence in work performance at all levels.

From the preceding it is obvious that loss control effectiveness is a function of management's ability to keep the risks inherent in an operation to the lowest acceptable level. This statement in turn prompts another question: How can the administrative processes be maintained at a level high enough that the inherent risks are kept at an acceptable low level?

The answer, of course, is proper management. Proper management is contained within the four words—planning, organizing, directing, and controlling. The main elements in risk management, to which these four requirements are applied, are identification, measurement, selection, and implementation.

At this point, two questions pertinent to evolving programming can be asked with regard to the changing role of the safety programmer: (1) where have safety people failed to help catalyze the administrative processes to the desired high level; and (2) what can be done to upgrade the profession to meet the demands of administering a total environmental or total loss control program?

Four points of failure are cited. Safety personnel have failed to fully accept their responsibilities as a member of the management team; failed to recognize the etiological problems; approached the accident prevention programming with tunnel vision; and accepted inadequate sets of values.

Equally important to where has the failure been is the question: why has there been failure? There has been failure because of lack of professional knowledge and skill; lack of the drive necessary to achieve established goals; conviction; and lack of enthusiasm.

Having determined where and why failure has occurred, what must be done to avoid further failure and, in fact, reverse the unfavorable trend in losses of human and material resources?

To answer that question, the professional programmer must do three things: earn personal stature, broaden control base, and communicate effectively. To earn personal stature, there is a need to be objective, increase skills and knowledge, deal effectively with people, and, be part of the management team.

The second step is critical. Understanding the need has come more slowly than the technological developments. No longer can programmers expect to succeed by pounding on the podium of emotionalism of injury prevention. The best way to take care of injury prevention is by programming to preclude all errors that could lead to downgrading incidents. The programming of the future has to be total loss or total environmental control.

The third step is basic to all inter-personal relationships—the need to communicate effectively. Three points are emphasized: create interest, provide facts, and induce action. Saying what must be done is easy. Individual responsibilities are spelled out in general and specific terms. In general terms, there is a need to remove cliché blocks, increase knowledge, think in management terms, and develop skills to deal with people.

Removing the cliché blocks is quite essential. Some of them are: management doesn't support me—management doesn't know—the safetyman is not respected—the union bucks the program—the W.C.B. allows too many claims—most accidents are backs and hernias—it is always production first—I've got a good program, but nobody listens.

More specifically, there is the need to be knowledgeable about the current and futuristic techniques required to bring and keep understanding abreast of advancing technology. Included are: the concept of total loss control, systems analysis, behavioral sampling, job analysis, critical incident and incident recall techniques, etc.

When all of the preceding are grouped together, the function of the program and the programmer can be divided into two parts: (1) The ability to uncover operational errors leading to downgrading incidents; and (2) The need to provide program vehicles to preclude their happening. To effectively apply these requirements, profiles of the program and programmer must be made as a base to determine what action-plans are required. The profile of a program has three basis steps: (1) A determination of what is being done. (2) An evaluation of how well they are being done. (3) An action-plan of what needs to be done.

In the action-plan, the objectives and needs have to be evaluated and the organization and program reviewed. Based on the analysis, an action-plan can be recommended. It then has to be implemented and an audit vehicle provided. Regardless how effectively these things are done, there is a need to maintain the program at a continuing high standard of excellence. This is one of the difficult management responsibilities—controlling to meet high standards.

Similarly, an assessment must be made of the professional safetyman by testing his academic knowledge, technical knowledge, and personal characteristics. A series of pertinent questions, to which values can be given, permits measurement of the incumbent programmer's current status and evaluates his effectiveness. From the analysis, an action-plan can be planned to upgrade the programmer to the new plateau expected.

Oliver Wendell Holmes said, "A man's mind stretched by a new idea can never return to its original dimension." I believe safety professionals can no longer practice safety in terms of injury prevention as a satellite function to quality and quantity of production. Advancing technology and changing standards will no longer permit this approach. Those who do not move will be left behind.

I will close by asking a very simple but direct, basic question: In the interests of sound management, what personal commitment are you prepared to make to meet the obvious future demands?

A LOOK AT THE OCCUPATIONAL SAFETY AND HEALTH ACT

By ROBERT D. GIDEL
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The legislative implications of the Occupational Safety and Health Act and the revised rules under the Walsh-Healey Act are considerable. The Congress is greatly involved.

Congress is concerned not only about what the Federal government should do about safety and health standards, but about the role of the Federal government in a whole lot of related areas. There is an ever increasing demand being made for the Federal government to take action to protect the safety and health of its citizens in every phase of their existence.

Our environment, both on and off the job, includes the question of the role of the Federal government in air pollution, water pollution, noise pollution, product and consumer safety, motor vehicle and traffic safety, fire safety, mining safety, pure food and drugs, airlines and railroad safety—and occupational safety and health. We are fouling the nest, so to speak, and many groups are demanding that the government do something about it.

We have almost a trillion dollar ballgame going in this country, according to the gross national product, yet do not have a complete or proper set of safety or health rules for the game. This demand for action has been translated into existing and proposed legislation of various sorts. The national dialogue which has been generated revolves around:

1. Should there be national or local standards?

2. What type standards should be developed? Should they be intermodal and interdisciplinary?

3. Should Federal or local authorities enforce the standards?

4. Who will finance the programs?

5. What about research and development needs?

6. What about training and education needs?

7. What about statistics and other data?

There are common denominators and interrelationships in all of our environmental problems, and we have to begin to understand them and consider them in everything we do. A few examples illustrate the need for governmental agencies and their advisors from outside of government to consider all ramifications of their standards or regulations setting activities before something is promulgated and frozen into law.

For example, until now industry could exhaust a hazardous dust, fume, or substance outside of a plant in order not to exceed the threshold limit value of allowed exposure to workers in the plant. Now, the air pollution people are outside telling us to keep it inside—or meet their standard outside.

Until now, industry could flush dangerous substances outside the plant to keep from over exposing workers beyond our standards, or for other purposes. Now, the water pollution people are outside telling us to keep it inside—or meet their standard outside.

Until now, labeling or placarding of hazardous substances for transportation emergency purposes filled the need that existed. Now, however, the need is greater and more sophisticated, and the needs of users, processors, and consumers must be taken into consideration in any national labeling system.

Until now, the Federal government has taken an active role in safety and health only in the limited areas where Federal jurisdiction was clearly indicated, or as an advisor and consultant to states, individuals, and organizations. It has relied on the historical authority and responsibility of states to regulate in their areas and the responsibility of employers to provide a safe and healthful place of employment. It seems, however, that many states and many employers have not properly exercised their authorities and responsibilities, so we have come to a point in time when the need for a more uniform and coordinated national

safety and health effort is supported by the facts.

Since we are discussing safety in the handling, use, storage, transportation, and manufacture of unhealthful substances, let me say a few words about our findings in these areas and our past actions, proposals, and contemplated actions.

First, after investigating several hundred fires, explosions, suffocations, poisonings and the like, we found that too many products were being put on the market with too little information concerning their ingredients, properties, spill or leak procedures, and personal protection needed in emergency situations. We developed and promulgated, with the help of industry and labor, regulations (under our shipyard authority) which state that our material safety data sheet, or information comparable in content, must be provided for a dangerous substance or the user will be in violation of the law if he uses it. This requirement also applies under our Walsh-Healey regulations, and we will be pursuing its broader application in the near future. We are happy to see that many manufacturers are attempting in good faith to provide this information.

Second, there are at least four (MCA, NFPA, ICC, AG, HEW) standards for labeling and identifying hazardous substances and numerous Federal and state agencies enforcing variations of these standards. This creates considerable confusion in workers and consumers and makes it almost impossible to establish a nationwide program of control. We have put together a proposal to attack this problem. We have discussed it with numerous groups and feel it is now time for use to move on it.

Third, there are few training courses available on the classification, labeling, and control of hazardous materials, and the need exists in every work site in the country. Again, you cannot marshal a nationwide training and educational program, because whose standard or system are you going to use? We expect to develop a national training program to match our standard proposal.

Fourth, since we don't have one national standard but several, we are short on research and development facilities to provide the needed backup data. Our technical experts, up to now, have for some reason refused to agree on criteria for classifying dangerous substances, so we have different criteria for different laws, and the proliferation of our too limited research and development backup capability is extreme. Where the experts refuse to agree, it seems we will be forced to compromise these differences with our expertise in order to get the show on the road.

Fifth, we are short of trained professionals who know how to deal with chemical problems, and the shortage is getting more critical day by day. There are hardly any industrial hygienist types in the pipe being trained at all, I am told. Our experience with engineers, medical doctors, and other professionals is the same and we may never see the day when there will be enough to supply needs. Therefore, we have to somehow sub-professionalize the professions where we can and stretch those that exist further.

For example, it doesn't really take a fully certified industrial hygienist to collect most samples, take noise measurements, and make portions of many surveys. By the same token, it doesn't take a graduate safety engineer to make most plant safety surveys; we'll have to pull out duties and tasks the non-professionals can handle and so spread our limited professionals better.

We have developed a proposal to accredit professionals of various types to make plant health environment surveys and certify the department's regulations are being met. It will be published in the *Federal Register* in the near future. We presently have similar accreditation systems for shore based cranes and ships' cargo gear certification. The same concepts will be used in our Construction Safety Act regulations and our other regulatory areas.

Sixth, changes in technology, new processes, and new materials are developed faster than we are presently able to develop standards for control under the voluntary system of standards development. We are presently immersed in problems with chemicals, radiation, noise, black lung, byssinosis, asbestosis, and others; the needed standards for proper instrumentation, sample collection, measurement and evaluation techniques, and allowable exposure levels to individuals either don't exist or are very hard to come by. It is very difficult to get agreement on containerization standards, another new area of concern.

Seventh, since the U.S. is so disorganized in the areas mentioned previously, we are being completely outmaneuvered in the international standards area. We cannot present a unified U.S. position as do other countries present at such international conferences. Containerization and materials labeling standards are two areas that concern us greatly at the present time.

As to the legislative picture, let's review the authorities we now have and the actions taken to date. Then, I would like to crystal ball gaze into the future.

There are four existing Federal laws administered by the Department of Labor covering occupational safety and health. Three require contractors who work for the government to meet safety and health standards. The Walsh-Healey Public Contracts Act applies to contracts for materials and supplies exceeding $10,000. About 250,000 contracts, 75,000 plant locations, and 27 million workers are subject to it at one time or another.

The McNamara-O'Hara Service Contract Act applies to contracts for services to the government exceeding $2500. About 25,000 work locations and six million workers are subject to it.

On August 9 the President signed the Federal Construction Safety Act. This Act covers all Federal and Federally assisted or financed construction contracts exceeding $2,000. Prime contractors and sub-contractors are covered. Our estimates indicate that about 50 per cent of all construction in the country will be subject to this law. This means some $50 billion worth of construction at some 200,000 work sites involving some 2.3 million construction workers are to be protected.

Our maritime safety programs, under the Longshoremen's and Harbor Workers' Compensation Act, applies to practically every shipyard in the nation and every stevedoring operation in all the nation's ports. It covers some 2,000,000 workers.

In all, then, these four existing Federal Acts apply to about half the workers in the nation at one time or another, in practically every industry that exists.

What has been the policy of the Department of Labor? Our actions taken under the Walsh-Healey Act best describes this. On May 20, 1969 the new Walsh-Healey Public Contracts Act safety and health standards were promulgated. Although the Walsh-Healey Act is over 30 years old and there had been a considerable amount of aggravation and concern for several past years over its safety and health requirements, several significant firsts were established on this date.

1. For the first time, a Federal agency with national authority adopted reference standards developed by others as the basis of its regulations instead of writing up a completely new set of specification standards.

2. The standards adopted by reference were those of several nationally recognized agencies with a reputation for having voluntarily developed the best bodies of information on the subject areas covered. (ANSI, NFPA, ASME, ASTE, ACGIH, CGA)

3. The standards of other Federal agencies were adopted by reference also wherever the agencies' special expertise was manifested by such a document. (Bureau of Mines, DOT, HEW, DOD, AG)

4. Where a nationally recognized standard did not exist but a great need was demonstrated, special requirements were written in. For example, a national limitation on noise at the worksite was established for the first time.

5. National requirements for the control of fire and explosion hazards, health hazards, and reactivity hazards were adopted. For example, the threshold limit values of the American Conference of Governmental Industrial Hygienists, NFPA 704M, and other related standards were adopted. There are, of course, many other provisions in the regulations, but these have seemed to be the most controversial. Why did we use this method of regulations setting and why did we take action in the controversial areas? The Walsh-Healey Act involves just about every type of employer and industry in every state. To draft a set of regulations which could apply to such a diversity of activities and which would be personalized to every industry would take years and dozens of experts. It would also ignore all the good work done to date by various organizations.

The most effective way to cover the situation seemed to be to adopt those nationally recognized standards which had been voluntarily developed by industry to guide its own actions. Reactions to our proposal were favorable and so they were promulgated.

The most controversial subject is noise. For 15 to 20 years we have been accumulating data and experience on noise. There is nothing mysterious about the subject any more, and it seemed about time that a regulatory body set the stage for doing something about it. We reviewed the literature, drew upon our experience, and drafted our proposals. We knew that (1) a very few industries couldn't meet any noise level we might say was required; (2) most industries can meet the required level if they are required to meet it; (3) engineering technology responds more quickly and effectively when government requirements provide motivation and incentives and a market for its services; and (4) those few industries which couldn't meet any reasonable noise level now should begin to re-evaluate and reappraise their operations and initiate some constructive actions.

In most industries and operations, technology has advanced to the point where the environment can be controlled to meet the standards. Reasonable time limits can be allowed where special costs and equipment or alterations are required. Where technology is not so advanced, good faith can be shown by an employer by initiating hearing conservation programs; providing and requiring the use of personal protective equipment; initiating discussions with technicians, designers, and machine manufacturers in order to set plans and completion dates, if possible, for new machine designs and new methods and processes. When new machines are purchased and new facilities built or otherwise obtained for operations, specifications should include noise level limitations and control. Good faith by an employer in attempting to meet the intent and purpose of the regulations will be the key test.

What do we expect the results to be?

We expect the technology which has been developed over the past 15 to 20 years to now be applied at work sites to protect workers from being exposed and suffering hearing losses. We expect designers and manufacturers to start reducing the noise levels generated by their products or to provide means for operators to be protected from the excessive noise levels. We expect better and more effective personal protective equipment and devices to be developed and made available. We expect some of the old, outmoded, and obsolete noise processes to be replaced with more modern, efficient, and quieter processes. We expect the increased demand for expertise in this field to result in more students studying the subject and getting trained in environmental control as a career. We expect more consultants and consulting firms to provide services in this subject and, of course, we expect fewer workers to end up with needless hearing disabilities. We also note that states will promulgate compatible noise regulations to provide protection for workers not covered by Federal laws.

Control of hazardous materials has not kept pace with the ever increasing numbers and types of materials used in industry and the varied processes using them. Because of this, we have adopted as regulations the threshold limit values of the American Conference of Governmental Industrial Hygienists and the various standards of the National Fire Protection Association. We expect to see that more attention is given to providing protection to workers from toxic substances.

When dangerous gases, vapors, fumes, dusts, and mists are generated, we require that personal protective equipment be used, and such protection must be approved for each specific application by a competent industrial hygienist or other technically qualified source. We have been asked what we mean by this.

Special knowledge is needed in determining the proper control measures and protective equipment and devices to be used when hazardous substances are used or generated. Access to such knowledge must be provided either by full time staff employees, consultants, or persons specifically trained in the subject area. Certain recognized agencies test and approve equipment and devices for use in specially hazardous situations. Persons competent to evaluate and prescribe appropriate approved control procedures and devices must be used to assure the meeting of the intent and purpose of the law.

We are developing a program to accredit organizations to make environmental surveys and certify our standards are met. We already have an accreditation program for firms to test cranes. Here, again, we hope that states will promulgate compatible regulations to protect against hazardous substances.

Whenever we require the use of personal protection as a means of controlling worker exposures if engineering controls aren't feasible, we always get the question, "What should be done if workers refuse to use personal protection?"

Our position is that it is management's prerogative and duty to see that all means and measures are taken to assure that work is conducted in a safe and healthful manner. This will require good education and training techniques and effective and forceful supervision. The standards state that personal protection shall be provided and *used*. This puts a burden on the worker to cooperate and use what management provides. The U.S. Department of Labor will cooperate with the employers, whenever and however appropriate, to assure the cooperation of employees. However, the Federal government cannot become directly involved in labor-management relations of this sort.

We also hear so much about the so-called stupid unsafe acts of employees, and that they are really the ones the government should regulate. But, did you ever consider that maybe a lot of workers are quite remarkable in their performance on the job? With the limited indoctrination and training they get before being put on a job, plus the skimpy supervision they get on the job, plus the unsafe machines and equipment they must work with, they have to be remarkably alert and constantly nimble to keep from being washed out instantly.

It is no credit to one's intelligence to take out frustrations on a poor guy who is injured, just because he was out of synchronization the 999th time he was supposed to dodge something and got clobbered. A worker can't be pre-occupied with his job and produce the quantity and quality expected if he has to be pre-occupied with the hazards on the job. This is why good management designs out or engineers out all the hazards they can; not for safety per se, but for improved production.

We have been asked if the Department expects records of all injuries to employees to be kept, whether disabling or not.

Yes, we do. In small companies, there are few disabling injuries in a year's time so that keeping records of all injuries is the only way a manager will be able to analyze his safety problems.

Large corporations with the best safety programs keep records of all injuries, not just disabling ones, since it is often only a matter of chance as to an injury being serious enough to be disabling or not. Good managers want all the information they can get to see if bad operating trends are being set and operations are tending out of control. Good faith in meeting the intent and purpose of the law and in engineering any accident prevention effort starts with recording and using injury statistics to control accident cause factors.

We have been asked if the Department expects to provide some help to small companies who do not have full time safety staffs and may not have access to all the safety and health standards adopted by reference.

We certainly do. We are developing an *Inspection Survey Guide*. This guide will list by hazard category all the items our field engineers will cover in an organized survey of a field operation. Each of these items to be inspected will be keyed to the standard we have adopted which covers the subject. When an engineer finds a violation he can immediately cite the standard which is applicable. These guides will be used by our engineers and will also be made available to employers subject to the law to use as a self help guide in voluntarily meeting the regulations whether or not we survey their operations. This guide should also be valuable to insurance engineers, state inspectors, and company safety engineers. It will be the first document developed which ties all existing standards to a working tool or guide which can be used by anyone to assure that operating conditions are kept under safety and health control.

We now have before us, on the verge of enactment, a National Occupational Safety and Health Act. This act will require, generally, every employer affecting commerce to meet safety and health standards. Depending upon the content of the final version when finally enacted, up to 70 million workers and seven million employers may be affected.

I have already stated that our four existing legislative authorities cover about half the workers at one time or another, in practically every industry that exists. Therefore, the enactment of an omnibus safety and health law should not really be an unduly

traumatic experience for any of us. It really boils down to how the government is going to exercise its authority—under existing separate laws, or under one large umbrella.

Let's look at its major provisions. I might say the detailed provisions vary from day to day, since it is in the mark-up stage, and different interests are negotiating. There are key provisions I feel confident we can briefly discuss, however, that form the backbone of the legislation and illustrate the basic purpose and intent of the law:

1. It directs the president to appoint an independent national occupational safety and health board made up of qualified professionals which would promulgate standards I expect they'll be required to use national consensus standards and established Federal standards where they exist, also proprietary standards. They'll be allowed to develop or initiate new standards through or separate from these organizations if they should not produce within a reasonable length of developmental time. Interim standards may be provided for. If so, I think our present Walsh-Healey standards would fit the situation quite nicely.

2. It will provide for enforcement of such standards by the Secretary of Labor or the states. The actual details of the enforcement procedure are hard to forecast but will no doubt provide for citations for violations, and penalties if they are not corrected within a reasonable period of time. In cases of imminent serious harm, special citations will be allowed, subject to legal hearings to protect from arbitrary and capricious actions.

3. It will provide incentives to states to upgrade their laws and their administrative and enforcement capabilities by providing up to 90 per cent Federal grants to develop plans and abilities whereby the state can take over and enforce the Federal jurisdiction. Once a state plan has been approved and a federal/state agreement consummated, up to 50 per cent Federal grants will be available to finance the state's continued administration of the law.

4. It will provide for advisory committees and for hearing procedures in every key area of administration and enforcement to assure due process and an exchange of information between all interested parties.

5. It will provide for collecton and compilation of injury and occupational health statistics on a national basis in a state-Federal-employer cooperative program. This will for the first time tell us the scope and degree of our problems and help us direct efforts where the problems exist and leave the good guys alone.

6. It will provide for safety and health research and development under direction of the Secretary of Health, Education and Welfare, including studies of psychological factors, innovative methods and new technology, motivational and behavioral factors, ambient dangers, toxic substances and allowable concentrations, personal protective equipment, and other related matters. The health department will be allowed right of entry to make inspections and investigations in order to conduct its studies and research.

7. It will provide for training and employee education programs by the Secretary of HEW to provide an adequate supply of trained safety and health professionals, and by the Secretary of Labor to train employers and employees in the recognition, avoidance, and prevention of unsafe or unhealthful working conditions and the prevention of occupational injuries and diseases.

8. It will provide for a phasing out of conflicting or duplicative regulatory authorities of the Secretary of Labor over a period of years.

9. It will require the head of each Federal agency to establish and maintain an effective and comprehensive safety and health program for Federal employers consistent with that required of industry.

Benefits would flow in numerous directions and to numerous groups if such an act were passed.

1. States could be the prime benefactors. The bill attempts to provide a means for a constructive Federal-state effort to provide standards and funds for a state to administer an effective safety and health program.

2. The National Safety Council and all local safety councils would benefit. They would have many more persons promoting their services and organizations wanting their services.

3. Organizations with operations in several states would have one set of safety and health standards to meet. There would be national minimum standards.

4. There would be an upgrading of safety personnel. With a national law and standards to meet, safety personnel would have to be of a high calibre to be able to perform as a member of management's team and keep accidents under control and see that standards are met.

5. National statistics could be collected for the first time and utilized so that time and resources could be directed where the problems exist and leave those doing a good job alone.

6. Funds for safety and health research and development to answer the problems of new technology would be available for the first time. No one has been able to produce such funds before.

7. Formal and specialized training and educational programs would be initiated to develop a basic educational system for the creation of safety professionals which does not now exist. A base could be laid for developing safety as a major profession and career opportunities which do not exist now would be created.

8. Federal safety would get a boost. Federal agencies must initiate comparable programs.

The primary purposes of the legislation are: to establish uniform national safety and health standards for protection of workers at the work site; to provide incentives to states to bring themselves up to minimum performance levels and so take over operating responsibility from the Federal government; to strengthen all existing safety and health programs; to provide for much needed safety and health research; to provide for much needed safety and health education and training; and to collect national statistics to help us direct efforts and measure results.

What motivated the administration to propose its bill?

1. Lack of action and support for safety and health at the local level.

2. Lack of any single uniform and directed safety and health purpose in this country.

3. A statistical picture showing a need to get things off dead center.

INDUSTRIAL HYGIENE— ITS RELATIONSHIP TO SAFETY

By CDR. SAMUEL BARBOO, MSC, USN
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The safety movement in the United States can be said to have been firmly established by the passage of the first state compensation laws, beginning with New Jersey in 1911. Although occupational diseases were made compensable by Wisconsin legislation in 1919, the incipient industrial hygiene programs were but obscure organizations in five states.

The manpower conservation needs of WWII, coupled with generous federal grants and support, led to the staffing of industrial hygiene programs in major industries and federal agencies.

The post WWII period saw an exponential increase in toxic substances introduced into the industrial environment and insured perpetuation of industrial hygiene programs. The present introduction of harmful by-products into our air and watersheds has mandated further expansion of industrial hygiene programs for the control of industrial pollution.

Navy Industrial Hygiene History

The Navy Department, in cooperation with the WWII Maritime Commission, created industrial hygiene positions in the numerous Navy and civilian shipyards. Uniformed industrial hygienists, originally chemists, were ordered to postgraduate instruction at Harvard and Columbia Universities. Since 1942, many of these officers completed service, remained as Navy Reserve Officers, and presently are employed as industrial hygienists in civil service in major Navy industrial

activities, mainly shipyards. There are today 25 Navy industrial commands staffed with one or more full-time industrial hygienists, located in all nine shipyards, seven major air stations, and other activities.

Recent Administration of the Navy Safety Program

Within the last four years, safety programs received added impetus by a rash of aircraft carrier fires. Human mortality and exhorbitant expense of shipboard fires has resulted in an administrative reorganization of the Navy safety program. The administration is organized by mission, comprising the following four components: aviation, submarine, shore activity, surface ship.

The program presently is being transferred for central control by the Navy Safety Center, which advises the Chief of Naval Operations in safety policies, evaluates safety trends, conducts surveys, and analyzes data and serves as a data repository and central information source.

The safety program is further subdivided into such program elements as occupational health, which is managed by the Bureau of Medicine and Surgery. Traditional safety programs such as fire protection, hazardous materials, and explosives control are managed by the Chief of Naval Material.

In Navy Department small shore activities comprising less than 600 persons, the safety office is considered a part-time collateral duty. Activities with 600 to 5,000 employees staff one safety officer for each 1,500 personnel and major fraction thereof. There are but 25 Navy industrial activities staffed with one or more industrial hygienists.

It is therefore apparent that safety officers must participate in at least the areas of recognition of hazardous industrial materials and practices having the potential for occupational disease. Since the services of safety engineers are separate from those of the medical department, regulations dictate the relationship between the medical department shall be one of sustained collaboration.

Joint Role of Safety and Occupational Health Programs

In Navy activities, safety and occupational health programs have mutual concern in the areas of sight and hearing conservation, illumination intensities, radiation exposure, industrial ventilation, and thermal stress (heat and cold).

Our common task is to insure there are no voids between programs, such as, for example, might occur in an electrolytic metal-plating shop. The measures for the control of the inhalation hazard of chromic acid mist must include provision for engineering design to avoid acid splashes. Another example may include the common hazard shared between inhalation toxicology and fire control (e.g., benezene as a highly toxic chemical and its associated fire hazard).

Successful Navy programs of interaction among most aspects of environmental control have been most effective in the participation of a health and safety committee, membered by an industrial hygienist, a fire chief, a safety director, a supply director, and a production officer.

The committee convenes once each month to discuss matters of primary but mainly overlapping concern. The most common matters are the procurement, labeling, storage, or containment of flammable and toxic chemicals. Other examples include participation among production, safety, and industrial hygiene concern with gasoline-powered forklift vehicles; production—procurement, whether gasoline powered or battery powered; safety—routing for safety and operation in flammable environments; industrial hygiene—carbon monoxide emissions and the operating efficiency of the internal combustion engine.

Safety and production engineers confer in work methods and procedures in conformity with safety measures. The supply officer alerts the hygienist to a significant procurement of an exotic or exquisitely toxic material, such as beryllium metal procured for the machine shop.

MOTIVATION—ITS RELATIONSHIP TO SAFETY

By THOMAS W. GALLAGHER
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In order to have safe working conditions and habits we must engineer, educate, and involve both management and labor in our safety plans and programs. Since management is responsible for the safety and health of their employees while at work, we must first gain their interest and support.

Since our Division's approach to the realization of our goal is contained in these three elements—engineering, education and involvement—we must further our efforts in training, instructing, consulting, and promoting accident prevention. We in the Commission's Division are actually in the business of motivating people to work safely, and for this reason, it can be said that all of our programs and services are geared to getting people to want to do the things they need to do to keep them safe and sound.

Before you can create motivational programs you must first know some of the factors and characteristics which appeal to the average employee and/or supervisor. The ten most commonly referred to are: desire for recognition and praise; desire for security; desire for personal and material gain; desire to serve and help others; desire for self-preservation; rivalry—the desire to compete; leadership—to be outstanding or have authority; loyalty—desire to cooperate; conformity—to be and do like others; pride—desire for self-esteem, self-satisfaction and praise.

Next, we must know the kind of attitudes we want in employees. We want a willingness to cooperate, a readiness to respond in the interest of better safety practices. We would like to see all employees willing to comply with safety rules and regulations, to follow recommendations and procedures, to influence others to work safely, to avoid creating unsafe conditions, to learn more about safe methods, to make safety suggestions and, all-in-all, to reflect a safety minded attitude.

To develop this kind of attitude in all persons would be impossible. It is not impossible, however, to develop a semblance of such an attitude in all employees.

How can we achieve this?

By getting people (as I said earlier) to want to do the things they need to do; we must talk in terms of their self-interests. We must stress the personal gains of working safely. Supervisors must have weekly safety meetings with their people and they must have individual safety contacts with them, also. The supervisor must stress with each man those things that are important to him. The supervisor must connect the employee's working safely with what he desires and wants.

We must compliment safe workers, identify troublesome unsafe practices, analyze the trouble points, and make the necessary changes. We must stress the point that accidents can and do happen and that the severity is a matter of chance. We must never let an unsafe practice go unchallenged. We must continually instruct, warn, and discipline. We must be ever alert if an employee can make more bonus or piece work by operating unsafely and sell him on the long range benefits of using safe practices.

One thing should be made clear about motivation and that is, that there is no single solution to the problem of motivating people. A safety program is not a complicated plan applied to simple uncomplicated people, but rather, it is a simple plan to complicated people. People are too complex for any single solution approach.

We have mentioned some practical solutions. There is no magical short-cut solution.

I believe that the average employee (and, unfortunately, some management people) will listen to facts and statistics, but they won't hear what we're saying because our actions speak louder than our words.

The humanics of the safety job is where we need to concentrate more of our attention, increasing our efforts toward motivating people to want to do all that is necessary. This is a difficult job, but an absolutely necessary task.

How does this work in Ohio?

First, we discussed our ideas with the chairman of The Industrial Commission, and with his counsel and support we contacted the companies in Ohio, their associations and organized labor, each in their separate area.

The chairman of the Commission consulted with the governor and they both, publicly and with great enthusiasm, endorsed our programs and by executive proclamation declared The Industrial Commission's Division of Safety and Hygiene as the "safety director" for all employers in Ohio. We were then motivated by these events to really go all out in our efforts.

We met first with the manufacturers, and we expressed our ideas of a safety program that could be used by all industrial employers in Ohio. We told them we were going to organize a safety committee from among their peers who would write the program, and that the Division would do all of the editing, art work, printing, and distribution at no cost to any employer in our state.

At this meeting we motivated the employers by touching on those things that had some emotional or economic effect on them. In turn, their actions to their managers and safety people enthused this group to the point where they wanted to participate from the inception.

In our next meeting we asked the society of Ohio Safety Engineers to take over the chairmanship of this new industrial program, "Pattern for Progress," and we also asked them to select the committee, not only representative of each geographical area of our state but also from a good cross section of our industrial plants.

The same procedure was followed with regard to the trucking, construction, arborists, and other industries, giving us such programs as: Pattern for Progress (industry), Roadmap (trucking), CISCO (construction), Tree of Life (arborists, etc.), and many others in the small business and service industries, as well as our high school program in industrial arts and vocational education.

This, then, was the second step of our motivation in safety.

Each year these committees have changes in personnel, and each year our programs are rewritten and they get better and better to the point where they are not only highly regarded in Ohio but nationally and internationally as well.

We have pointed out our motivation factors with top management, the trade associations, and labor. Our next step was the line supervision and the employees. Here we moved in with our Supervisors Safety Training Program, a 12 week, two hours a week, classroom course for supervision, which has 14 subjects and is held in a classroom atmosphere. We have our own instructors whom we certify, lecture periods, discussion periods, films, tests, and graduation certificates. We have, in the past eight years, completed thousands of classes averaging 20 supervisors per class, and the results are tremendous, far exceeding our wildest expectations.

In this program we are motivating the line supervisor by giving him not more responsibility but the tools and the know-how to help him function successfully. These supervisors, in turn, are our instruments in motivating their subordinates (the employees) in safe working attitudes.

In all of our programs we include handouts for supervisors and employees alike. These items, of course, are over and above the regular materials necessary in all of our programs.

The chairman of the Industrial Commission conceived the idea that perhaps we could furnish a safety director to those companies who either were too small to employ a full time supervisor or were showing poor experience in their safety efforts and who were on a penalty rate.

This program is called the "Safety Director Program" and is offered first to employers who are penalty rated, then to the employer without safety supervisors, and last to any employer so inclined to use it.

How does it work?

We meet with the chief executive of the company and discuss not only the accident experiences for the previous five years, but we show him his payroll figures for these years; what the base rates for his industry were; what his payment came to because of his experience, and what rates the Industrial Commission anticipated he would be paying, which in every safety director company would have been on a penalty basis. Then we explain how, through this pro-

gram, he can reduce the accidents and his insurance to an 85% credit. This information motivated these selected employers to immediate action.

It is a known and proven fact, in Ohio, that safety programs or safety laws, rules, or regulations will not work or survive without some motivating influence from top to bottom and back up from bottom to top. This is why Ohio is the safest occupational state in our nation and why safety people come to see our programs and our systems, not only from our sister states but from many nations outside of the American continent. Our safety record is not perfect, it's not as good as we'd like it—but you can bet we keep working at it.

Nothing has been or will be done in this world of people and animals without some motivational force. The animal in the jungle only kills to eat or for self-preservation. The baby cries because it is hungry, uncomfortable, or what have you. Man works to eat and survive and to improve his lot.

You and I are in our chosen field because we are motivated by one of the ten characteristics I mentioned earlier; desire for recognition, security, to serve and help others, leadership, personal and material gain, pride, etc. There isn't one area of our lives that has progressed without some motivational activity.

And so it is in accident prevention or safety, as you choose; it cannot, it will not succeed unless here and now you and I are motivated into doing more to find new and better ways to motivate management, supervision, and the employees into wanting to do those things they must do to live, work, and play safely.

We don't have the perfect answer in Ohio, but we do have the perfect attitude, and that is that we are not going to let up for one moment until we do find that answer. We are the leader in our field and with the help of God, our Commission, management and labor, we're going to find it.

IMPORTANCE OF SAFETY IN POLICE WORK

By CHARLES T. COBB
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Public safety is a prime objective of police departments. This is accomplished in many various ways, with numerous pieces of equipment, but mainly with manpower. To accomplish this objective expeditiously with the equipment and personnel allotted, it is of the utmost importance to have safety in police work.

Personnel, both in the field and in support, are the largest item in any police budget (Boston Police Department 1970 Budget of $37½ million—94 per cent is for personnel). Therefore, I will concentrate on this area first.

When police officers are injured, either on duty or off, they are ultimately lost to the police service for a period of time. This loss of service has a dire effect on the operation of the department concerned and also on the cost of operation of the department, with a net result of a decrease in public safety.

It would appear that most injuries to officers occur while making arrests. This type of injury could probably be reduced by physical fitness programs and training in arrest techniques. The day-to-day police operation does not give the average officer an opportunity to maintain the peak conditioning and physical efficiency that is occasionally needed in these troubled times. In 1964, Deputy Chief Joseph A. Peters Jr., of the Schenectady, New York, Police Department recognized this in an article in the *F.B.I. Law Enforcement Journal*, in which he stated: "Never before in the history of law enforcement has there been a greater need for physically fit police officers."[1]

Subduing a psychotic person, arresting a desperate criminal or coping with a frenzied group of demonstrators are activities that require strength and endurance. The officer that has failed to stay physically fit is not up to this sudden propulsion into physical endurance and thus is prone to injury. Once injured, he may need medical assistance and in all probability will be unable to continue working until his injury has healed. This chain of events has a two-fold adverse effect on the operation of the police department:

1. It reduces the number of personnel available for duty.
2. It increases the department budget cost for medical service and injured leave.

Injuries incurred on motorized patrol (automotive, motorcycle, scooter) in some cities are higher than the injuries from arrest and, in most instances, at least run a close second. This is an area of injury that, with proper safety practices, could and should be greatly decreased.

Many of these injuries are from carelessness. This carelessness not only results in loss of personnel but has a side effect of poor public relations particularly when the officer concerned is clearly at fault.

Included in motor vehicle injuries is the controversial subject of rapid police pursuit, commonly referred to as "hot pursuit." According to the Physicians for Automotive Safety Committee, more than 500 Americans die and over 1,000 sustain serious injuries each year as a result of hot pursuit of law breakers, most of whom have committed only minor traffic offenses. Part of this toll are police officers who are ultimately lost to the police service; the rest are citizens who have a gripe against the police along with the untold numbers of people who might witness the incident or hear about it in some manner. This type of injury has a three-fold adverse effect:

1. It reduces the number of personnel available for duty.
2. It increases budget costs.
3. It creates a strain on public relations.

In our present day society, public or community relations with the police has become a subject of constant discussion by all sorts of people, and I think safety in police work has its place in this field.

I have mentioned previously the adverse effects on public relations caused by the carelessness of police in motor vehicle operation but, conversely, imagine the good effect created by the example set by safe, courteous police operations. It is all well and good to teach an officer to be polite in his personal contact with the public, but all the good done is lost if he drives away recklessly.

In summary, I would say that there is a great importance in safety in police work particularly in the saving derived by less damage to property, less time lost by personnel, less cost for medical services, less cost of civil suits, less cost for pensions and, last but by no means least, better police-community relations.

1. Peters, Joseph A., Jr., "Physical Fitness—A Must for Police," *FBI Law Enforcement Bulletin*, Vol. 33, No. 9 (Washington, D.C.: U. S. Dept. of Justice, September 1964).

SAFETY TRAINING FOR POLICE

By LT. LAWRENCE K. EVERSON
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A questionnaire developed by our former safety director was mailed to various state and municipal police agencies throughout the United States. It covered 18 subject areas of safety training.

Question number one deals with the classroom phase of driver training. Of the agencies that returned the questionnaire to our department, 80 per cent indicated they devoted substantial hours to this facet of safety training related to a police function. Specifically, of the departments polled, an average of five classroom hours was devoted to driver training during recruit training and an average of three hours during in-service training. Is this enough hours devoted to this important function? I don't think so. The National Safety Council's Defensive Driving Course is in itself an eight-hour classroom session. Furthermore, this course should only complement the true driver training course—pursuit driver training.

The second question related to behind-the-wheel driver training, which is really much more important than the classroom phase. During the classroom phase the foundation of course is laid, i.e., the fundamentals and principles of driving; however, during the behind-the-wheel portion you must test and evaluate whether or not the student can apply these fundamentals and principles.

The responses revealed that some departments didn't administer any behind-the-wheel training; while the maximum was forty hours.

The third question dealt with firearms training including: pistol or revolver, rifle, shotgun, gas gun and equipment, and mace or equivalent. The replies again showed a great variance—0-53 hours. I'm sure training or lack of training is justified in the minds of many police administrators because in the past they hadn't deemed it necessary to have equipment such as mace or a gas gun, etc. However, in today's society, every department of any substantial size must realize that potential violence requires preparation. Therefore, in preparation for combat violence, departments will have to purchase equipment such as mace, gas guns, etc. and train their personnel in the operation of this equipment.

Question four involved personal safety—the art of self defense. With attacks on policemen becoming almost commonplace, it is imperative that today's officer be schooled in the art of self-protection.

Question five related to first-aid: basic, advanced, and medical self-help. Not only must the police officer be able to help himself in time of danger, but he must also be able to help the citizen who has met with danger, tragedy, or accident. This could involve a traffic accident, a home accident, a dispute, or any other situation which requires effort to save the life of another.

Question number six related to traffic direction and control. This function involves preserving the scene at an accident location for the benefit of the accident investigators and being able to direct the flow of traffic around the accident scene smoothly. In addition, during rush hours and other times of potential traffic congestion, a police officer must be trained to conduct the flow of traffic in the most expeditious manner possible. Traffic must flow so there is the least possible chance of damage to vehicles or property and injury to vehicle operators, occupants, or pedestrians. This takes trained police officers.

Question seven involved handling electrical hazards. Many times, operators of vehicles involved in electrical accidents escape relatively unscathed only to die in the aftermath of the accident by touching the electrical line. If a police officer is properly trained, he'll know how to handle the situation and save not only himself from death or injury, but also the vehicle driver and occupants.

Question eight related to lifting heavy objects. There is a right way and a wrong way to lift heavy objects. An officer, by knowing the right way, can save himself possible injury and can save the department lost man hours.

Question nine relates to patrolling a beat. In the rural areas, I would imagine even today most patrolling is accomplished through one-man patrol cars; however, in the larger urban areas, departments are resorting more and more to two-men patrol cars. Why is this necessary? Because the elements of danger and violence have increased considerably in the last several years. With these factors in mind, police departments must recognize that their men must be highly trained in all aspects of patrolling a beat, whether it be foot or vehicle. Preserving life and property is more than ever a full time job and requires the undivided attention of the police officer.

Question ten related to handling abnormal people. When dealing with this type individual, a police officer must remember to never let his guard down. The mentally incompetent person may seem ever so innocent, but the situation can explode into violence and tragedy without warning. Policemen must be highly trained to handle this individual, not only from a physical standpoint but also from a psychological one.

Question eleven related to riot and mob control. Training hours devoted to this subject varied from 0-40. Some departments placed great emphasis on this function, while others apparently gave it very low priority. In this incendiary age all departments must be trained in how to handle mobs and riots.

Question twelve was a two part question relating to disturbances—family fights and tavern or barroom incidents. This involves an area where a large percentage of police officers are injured or meet death. Regardless of this fact, many departments don't devote any hours of formal training to this critical area. Values and standards must be re-evaluated relating to police officer safety and efficiency.

Question thirteen involved an area of primary importance today—bomb squad training. Bombs and the placing of bombs by radical individuals or groups are becoming a real threat in and to our society. Therefore, we need police officers who have received highly specialized and intensive training in bomb disposal to combat this new form of warfare.

Question fourteen also concerned itself with a problem that today's police department must combat—sniper tactics. We've all read about the wholesale slaughters committed by deranged individuals. We as police officers must be able to respond quickly and in an organized manner to dispose of an individual of this type. But we can't afford to lose several men in the process. Here again, we can effectively meet the problem, but only if we're properly trained.

Question fifteen related to search of persons taken into custody. How many times have police officers met death unnecessarily because they've violated rules, regulations, and principles concerning taking people into custody? Policemen must be trained in how to handle people taken into custody, not only for the officer's safety but also for the prisoner's safety and even an innocent bystander's safety. Handling of prisoners reflects on the police officer, his department, and the police professional image.

Question sixteen, transporting of prisoners, is closely aligned with question fifteen. The police officer of today must, more than ever, be cognizant of the prisoner's rights. He must also recognize that the prisoner's safety is also in his purview. Of course, the police officer must be aware of the necessity of handcuffing certain prisoners for safety's sake.

Question seventeen involved stopping and approaching a vehicle. Regardless of why a violator's vehicle is stopped, the police officer must approach each unit realizing that potential danger, even death, can be lurking in the shadows. The most innocent appearing situation can suddenly explode with violence if the officer lets his guard down. Training is the only answer to this potential problem, not only training in proper procedures but also training and retraining in officer attitude.

Question number eighteen related to another deterrent to crime and the criminal and officer safety—roadblocks. Very effective procedures have been devised relating to conducting roadblocks, but they are worthless unless they are properly implemented. Therefore, policemen must be intensively trained before we can expect roadblocks to be adequately administered. Police work is becoming increasingly specialized and, of course, involves safety training for police; therefore, police administrators, managers, training directors, and supervisors must be made to realize that accelerated and intensive programs are necessary to substantially increase police competency and efficiency.

TRAFFIC ACCIDENT INVESTIGATION— A KEY TO SAFETY

By CAPT. CHARLES W. MURPHY
Commanding Officer, Accident Investigation Dist., Philadelphia Police Dept.

Since the introduction of the motor vehicle into our lives, the accident incidence has become an increasingly enormous and complex problem, resulting in death, suffering, and loss of billions of dollars to millions of people.

The accepted belief that police departments possess responsibility in the area of traffic safety emanates from the fact that they are, in essence, a public protection agency. Therefore, establishment of controls for reducing the number of deaths and injuries occurring

on the streets and highways, which thereby lowers the accident rate, accomplishes one of the police's major objectives—public protection. It follows in reason that when an accident occurs on a highway which is police regulated, it is a part of their responsibility in the total traffic safety picture to report and/or conduct an on the scene investigation of the traffic accident. The purposes of the investigation are: (1) to determine the facts relating to the accident, and; (2) to record and report this data to appropriate agencies so that corrective action, either judicial or physical, can be taken to reduce causative circumstances. The main objective behind investigation of traffic accidents is the submission of reports which will provide an indice which can be used in determining the overall effectiveness of the traffic safety program.

Accident reporting, as opposed to accident investigation, is the collection by the police of readily available required data about the accident. Accident investigation, on the other hand, is a far more detailed process. The word, "investigation," demands a complete inquiry and systematic accumulation of information pertaining to the accident. It is the time-consuming process of determining why the accident happened. It is the consensus of authorities in this field that all accidents involving serious or grievous injury and/or extensive property damage should be investigated thoroughly, regardless of the existing policies and opinions found in various police departments throughout the nation relative to what accidents should be reported only (due to manpower, equipment, etc.).

Because of the local public, legal, and political mandates, it has been nearly impossible for any one person to develop a best method for supervising the police activity in a traffic accident investigation program. Much has been written in regard to the proper procedures to be used in conducting traffic accident investigation, determining the causative factors, and the implementation of possible corrective measures. This writer believes that the suggested procedures for conducting the investigations as outlined in the *Traffic Accident Investigator's Manual for Police*, published by the Traffic Institute of Northwestern University, are as applicable as any criteria available in the traffic safety field to date. At the present time, there are three recognized types of procedure being used by most accident investigators: (1) for the purpose of this discussion, normal investigations at the scene of the accident will include fatal accident investigations; (2) leaving the scene of the accident (hit and run) investigations; and (3) investigations of late-reported accidents.

Normal or Fatal Accident Investigation Procedure

The following steps are suggested in this type of investigation:

1. Upon notification, proceed to the scene, quickly but with extreme safety.
2. Park vehicle safely upon arrival at the scene.
3. Prompt action must be taken to keep the accident scene from becoming worse and to prevent further injury and damage.
4. Care for the injured and protect personal property.
5. Ascertain if it is a hit and run case.
6. Locate principal persons involved in the accident and interrogate them (operators of vehicles and/or pedestrians).
7. Locate and question witnesses (ascertain if on-lookers may be possible witnesses before dispersing them from the scene).
8. Record all physical conditions found at the scene (special attention to short-lived evidence).
9. Prepare a field sketch of original conditions at the scene; supplement with photographs.
10. Examine and test the vehicles involved.
11. Determine causative factors of accident.
12. Follow-up with enforcement action, if warranted.
13. Take necessary steps to clean up scene.
14. Make proper notifications where applicable.
15. Re-interview principals and/or witnesses at the hospital, doctor's office, etc., if they were not sufficiently questioned at the scene. Record additional information obtained.
16. Review notes of evidence and testimony and write up reports.

Leaving The Scene of The Accident Investigation Procedure (Hit and Run)

At the scene, the following steps are suggested:

1. Steps 1 through 4 as above.
5. Determine validity of hit and run status.
6. Protect all possible physical evidence.
7. Question witnesses and victim, if possible.
8. Examine physical evidence.
9. Ascertain description and travel of vehicle (and, if possible, operator); transmit this information for immediate broadcast.
10. Look for additional identification witnesses.
11. Search for additional evidence of vehicle for positive identification.
12. Re-broadcast if better description is available.
13. Record evidence (sketches, photographs).
14. Request additional assistance, if needed. (May become necessary at any stage during the investigation.)

Follow-up investigation:

1. Search immediate accident vicinity (sidestreets, parking lots, etc.)
2. Canvass all garages, repair shops, etc.
3. Notify parts dealers, where applicable.
4. Ascertain owners of vehicles similar to the make and type of vehicle through registration and investigation, and physically inspect same.
5. Re-visit the hit and run scene.
6. Re-canvass area for possible witnesses.
7. Publicize the case on television, radio, news media, etc.
8. Ascertain identity of owner and/or driver and take suitable corrective action according to local laws.
9. Review notes of evidence and testimony and write up reports.

Late-Reported Accident Investigation Procedure

The following steps are suggested:

1. Question all principals (operators and/or pedestrians).
2. Visit the scene to check and record conditions.
3. Canvass the vicinity for possible witnesses.
4. Interview all passengers.
5. Examine all vehicles involved.
6. Review case and write up reports.
7. Take suitable enforcement action, if possible.

There is no argument that the investigation of traffic accidents requires a greater degree of skill and training than the recruit training provided; but there does exist some disagreement on the amount of specialized training needed. Since the conviction rate in cases where there is personal injury or serious property damage is extremely important in the accident prevention program, the patrolman who investigates this type of accident must have a greater technical qualification. In deciding who will investigate accidents, there are several important considerations: (1) caliber and number of personnel available; (2) amount of training required; (3) frequency of minor accidents as compared to major accidents (do not forget how important public opinion is when considering this aspect); and (4) budget available to the department. Nevertheless, all personnel should be capable of completing a standardized accident report in sufficient detail to provide the information required to support engineering modifications, selective enforcement programs, and the police department's educational responsibilities. This writer agrees with the theory that a specialized unit under central control is most advantageous in municipalities where there is an extremely high accident rate. Regardless of who is chosen to investigate traffic accidents, there are two factors which should be indelible in the mind of every investigator: the importance of the purpose of the investigation; and the value of fixed procedures.

Since accident reports and records are used to determine the scope of the traffic control problem and to plan effective countermeasures, they are an integral part of the administrative process. It is generally agreed that the quality of the records maintained has a direct relationship to the quality of police administration. Accident reports can be used as the basis for the institution and operation of a sound accident prevention program; as a measurement for comparing current performance with similar jurisdictions and/or the national average; and as a

means of justifying and gaining support for the safety program. The information obtained from the investigation should provide material for all phases of the safety education program.

When accident reports and records are properly analyzed, the analysis becomes one of the most effective tools an administrator has to transform policy into action. Proper analysis can only be accomplished by using that information supplied by the report and/or investigation. The investigation report is, in reality, the "eyes and ears" of the record and analysis personnel; thus, the record and analysis personnel will code and report only that information which is supplied by the investigator.

Our obligation to the public calls for plans to be established and enacted for the prevention of traffic accidents before they occur. This obligation is shared by traffic engineers, safety educators, judicial branches, and safety organizations. Accident trends should be closely scrutinized and the forces at command should be applied where they will be most effective. But without question, the police effort is wasted unless some action is taken to reduce the causative factors by those agencies mentioned above who are responsible for judicial enforcement, education, public information, driver testing and licensing, research and development, and traffic engineering and legislation, who receive and must act upon the results of the investigation program if the high rate of accidents is to be reduced.

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AN EFFECTIVE METHOD FOR RECORDING ACCIDENT DATA

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When we feel deluged with problems in protection against fires, we may take some comfort in the knowledge that fire has been causing problems for a long time. The Greek God Zeus in his wisdom decided that men should not have fire. Prometheus pulled off the most romanticized theft in Greek literature, and since then men have lived with fire which had been reserved for the gods. Then Zeus created woman (Pandora) and sent her to man. I was never certain whether this was to set up the homey atmosphere of a woman working over the kitchen stove, or whether there was a more profound implication. Since neither fire nor woman show any signs of departing these terrestrial haunts, we should use our best efforts on the one which seems most subject to control—fire.

Civilization was understood by the ancient Greeks to be the direct result of the gift of fire. Certainly no civilization could exist without it. With ever greater sources of thermal energy at man's command, the question could well become, "Can civilization exist *with* fire?" The answer may well depend upon whether man exercises more energy and intelligence in creating thermal energy than in controlling it. We have a bottleneck in the United States today in developing better planning for fire protection. We have an overwhelming amount of technical information, but we have problems putting it to use. Anyone who reads the monthly journals to stay abreast of new developments in fire protection will agree that the absence of fire technology is definitely not our limiting factor. The conversion of technical information into useful data is the key to accelerated progress.

The use of data in developing fire protection plans has a great deal of appeal. Any fireman will tell you that no two fires are alike. We know a great many technical facts about fire structures. We know about evacuation procedures under varying circumstances, and about the toxicity and flammability of many newly developed products, to name a few, but it's hard to decide what to do with the information that we have in any particular instance.

The idea of using data from previous accidents, including fires, to help prevent future accidents suggests that we expect to find a pattern. We expect to be able to predict the future better because we have examined the past. We learn from our experience, but we can learn also from the experience of others. We don't have to make every mistake in the world to know it was a mistake.

All of us would like to get ahead of the fact and take precautions before an accident or a fire occurs. No one chooses to conduct a post mortem of an accident if he has an alternative, but where does his information come from? How do any of us know what to expect from a piece of machinery, or from a chemical process, or from a physical configuration of a structure? How can we evaluate the hazard? At some level or other, we have learned from man's previous experience.

It is only on the leading edge of science that man can afford the exhaustive research and testing which can prevent an accident from ever happening. For most of us, the challenge comes in the administrative skills of using the research of others to maximum advantage and in avoiding mistakes which result in accidents by learning all we can from the mistakes of others. Our challenge is the management of information about fires and other accidents.

The first emphasis on the method of recording accident data must be upon the utility of the data. There is no point in spending time and money for information which can't be used to prevent future errors. There is little value in asking for lengthy written statements which usually amount to a defensive narrative concealing more than they reveal. There is a negative value in asking questions on an accident report form which insinuate that some one was at fault. The worst possible time to investigate an employee's error is just after one of his errors resulted in an accident. There isn't any question as to whether the blame can be pinned on someone. The question is whether it will help to do so. We can answer that question by considering how candidly each of us would cooperate with an investigator who is exposing our errors.

The next emphasis on the method of recording accident data should be upon the segregation of the data. There must be some orderly index that will tell us that data relevant to property management is separated from data about training, and that both are separated from legal information. Further, these mutually exclusive categories of data should be structured to agree with the functional responsibilities of the organization.

We can tell, by studying an organizational staffing chart, which manager is responsible for any particular activity within the enterprise. It is also reasonable to suppose that when he was given responsibility for an activity, he was also given the responsibility to perform that activity without errors. If there are errors in his operation, then he is the manager who needs the causal data to correct the errors. All this seems almost too obvious to need restatement. However, when we compare the categories of accident cause and cost data collected by many accident report forms with the organizational chart of the same establishment we realize that that agreement which should exist between the two isn't always that obvious after all.

The next emphasis on the method of recording accident data should be upon the total review of each accident incident. It is an extension of the concept of mutually exclusive categorization of data. Each management question on the modernized accident report form may be answered by selecting from a preprinted list of possible responses. These preprinted responses to the several categories of questions are assembled into a coded book of instructions and indexed to agree with the format of the accident report forms.

The primary benefit of this method of recording data is total mental review of all contributing factors. The supervisors and others who scan the listings of responses are reminded of possible management errors

which they might have overlooked if left to their own reflections. Further, the distinctions which must be drawn between similar (but not identical) responses demand more definitive and specific answers and, when taken together, the comprehensive review on the one hand and the definite specificity on the other combine to give a very clear profile of management errors which produce accidents.

The ease of recall is crucial in developing a method of recording accident data. The best information is useless until it can be isolated from a mass of data and put in the right hands in intelligible form. There simply isn't any feasible method to process a significant amount of data without a machine. Automated data processing is expanding in volume and in fields of application at an extraordinary rate and for good reason. We can use the swiftness and accuracy of computer technology to search for causal relationships. The prospect of examining file drawers full of forms, one at a time, in search of information which may or may not prove useful, will discourage anyone.

There is no race between computer technology and safety administrators. If we codify our accident data and use computer technology to quantify and relate as much data as is economically feasible, we can use our experience to do more of the decision making which we should have been doing all along. The computer does absolutely nothing that can't be done without it, but it does it with incredible speed. It deserves well earned respect, but it does not warrant apprehension and suspicion. It is well understood only by the expert, and the best advice I can offer today is to seek the advice of an expert. My early independent efforts gained me nothing beyond a headache and wasted time. Thanks to the Department of the Interior, my counterparts and I can review hundreds of bits of information from each of thousands of reports in only minutes. Without this service, I'm afraid we'd resemble a band of modern Don Quixotes charging an unending number of illusions of problems.

Fires, as with other accidents, have causes; those causes have patterns. An effective method for recording accident data will reveal those patterns to us and enable us to spend our time on causes which are real. It will liberate us from handling stacks of forms in search of simple data. It will permit us to do what we came to do—spend our time on fire and accident control.

APPLYING SYSTEMS ANALYSIS TO FIRE FIGHTING SYSTEMS

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Systems hazards analysis has proven itself to be an essential part of the control process. Over the past decade, this analysis technique has found acceptance by many industrial and governmental agencies in their quest for the location and control of hazards within their respective operations. The results obtained from the technique have contributed significantly to efficiency, effectiveness, and overall mission capability.

The very thought of systems analysis suggests a sophisticated analytical approach associated with complicated mathematics and engineering technology. One who interprets it this way is partially correct—correct from the standpoint that the approach is analytical. However, one does not have to be mathematics-oriented to use the theories and concepts of systems analysis effectively. The only requisites are sound reasoning and logic coupled with an understanding of the effect of hazards on a system's operation.

Although systems safety analysis was originally developed as an engineering tool with which to discover potential failures and the effect of these failures on sophisticated mechanistic systems, the same theories and techniques can be readily applied to finding failures in management systems, production systems and, as we will apply them here, to the evaluation of fire fighting systems.

The primary objective of this paper is to acquaint the manager of a fire protection organization with the methods and techniques of systems analysis and to describe how he may apply these tools to finding hazards in his fire fighting systems. To accomplish this objective, we will view fire fighting systems in such a manner as to uncover hazards or potential hazards in work procedures, equipment, tools, man-machine interfaces, etc., which have the capability of culminating in an accident and/or catastrophic situation.

We will find that systems hazard analysis is nothing more than a formalistic, qualitative method for identifying those critical operational methods, techniques, procedures, etc., which have a profound effect upon the successful operation of a system. In the actual performance of a systems hazard analysis we will be breaking a system (operation) down into a detailed number of steps or processes, closely examining these steps to discover potential failures; viewing these failures in respect to their effect on the effectiveness, efficiency, and safety of the system; and, finally, providing effective countermeasures as required to remedy the undesirable conditions.

The thesis of the systems hazard analysis is that hazards may be eliminated by the process of looking for undesired events in the system under study and then finding those failures which are responsible for these events. The undesired events checklist lists events peculiar to a fire fighting system which are considered potentially injurious or even catastrophic to the system's operation.

We will purposely move the direction of the analysis toward finding those elements in the system which can cause problems (failures). We will be, in effect, failure oriented. We will be thinking in terms of failures because (1) it is easier to get mutual agreement on what constitutes a failure, and (2) it is easier, from a psychological standpoint, to find "holes" or mistakes in something than it is to find all the elements of success.

Methods of Acquiring Information

Before we launch into the discussion of the analysis process itself, we will first discuss some of the "rhyme and reason" behind it. To begin, we must understand how information is obtained, since the acquisition of information concerning hazards is the primary purpose of our mission. Four basic methods of information acquisition will be discussed: experience, testing, conjecture, and analysis.

Experience

Information gathered as a result of direct past experience is deemed the most highly

desirable. Indeed, if we wanted to know exactly how an operation or part of an operation would fail, we would get our most reliable information from the man or men who have operated with that system, who understand all its complexities and problems, and who have themselves discovered the failure and corrected its cause.

Although direct past experience is highly desirable it is difficult to obtain, especially when we want information either on a system which we are designing ourselves, or one which has not been used sufficiently enough for data on its inherent hazards to have become known. Since direct past experience is not always available, we must choose the second alternative, that of related experience. When we cannot find the man who has worked with systems exactly like ours, we must look for those who have had experience with systems similar to the one we seek information on. In each case, experience is the most desirable form of information we can obtain.

Testing

When neither direct or related experience is available, our second alternative is to test out our system under actual conditions, looking for information pertaining to its behavior and the modes where it may fail. Unfortunately, testing has drawbacks. To begin with, we cannot simulate all the possible failure modes which our system will undergo in actual operation. Second, it may be economically, physically, or politically infeasible to test.

Conjecture

The third available method of acquiring information is called conjecture. With this method, we find ourselves making decisions based on an intangible form of data almost intuitive in nature. Decisions come about as a result of an unexplained phenomenon within the mind of the decision maker. Some claim that the decision is brought about by an undefinable process of induction and deduction without a conscious awareness of the process. This method may work under certain circumstances. In fact, it may be the only method available at a given time to solve certain forms of problems. While decisions coming about through conjecture are worth noting, they will not be considered to any great extent for our purpose in analysis.

Analysis

The fourth method of information acquisition is that of analysis, the method which provides the logic for systems hazard analysis.

A workable definition of analysis is "a directed process for the acquisition of specific information pertinent to a given system."[1] Its main purpose is to provide information with which to foster decisions. For the purpose of this paper, we will be using the analysis process for finding information pertaining to failures and their effect on fire fighting systems. However, the same methodology, as stated before, is used for production systems in general.

Analytical Approaches

As previously stated, analysis is a method for acquiring information. How we process this information, draw valid conclusions, and make decisions is the subject of our next discussion. As we learn from the exponents of logic, we think, make judgments, and draw conclusions from information acquired from the processes of intuition, induction, and deduction. We use these approaches singularly or in combination in the process of making decisions.

Intuition

Intuition, as we will learn, differs markedly from induction and deduction. Instead of proceeding logically, a step at a time, intuition provides an instantaneous perceptual insight into a problem; it is almost extrasensory in nature—a flash of light—happening so fast that the decision maker is unaware that the process is taking place.

In critical situations, the intuitive person can sense those factors necessary for his decision and is able to make the proper judgments necessary to solve the problem immediately.

While we will not overlook the advantages of intuitive decisions under certain circumstances, they will not be emphasized in our analysis process, the reason being that intuition is not repeatable. We cannot and must not rely on intuition to make decisions, especially when the decision may have a catastrophic effect on the operation of our system. Instead we will rely on one or both of the following approaches.

Induction

The inductive process, based on predictions from observable data, can tell us what can occur and is the basis for what is called the single thread analysis, a form of analysis which allows us to consider the effects of failures on a system's operation from the standpoint of its components, their failure in a particular operating state and, finally, the effect of the component failure on the system. The single-thread type analysis forms the basis of the systems hazard analysis.

Deduction

In deductive reasoning, we start with a theory, then apply it in an attempt to find out the causes of system failures. In our dealings with the systems hazard analysis, we will be using both the inductive and deductive approaches.

Benefits of Systems Hazard Analysis

The benefits of systems hazard analysis are countless. The following are examples of some of these benefits.

1. Identifying hazardous elements, conditions, and potential accident sources.
2. Determining where these hazards are in the system.
3. Determining the significance of their potential effect on the system's operation.
4. Providing information with which effective control measures may be established.
5. Determining the physical and mental qualifications required of a man, including his motor skills, for the specific task he is involved with.
6. Discovering and eliminating procedures, techniques, motions, positions, and unsafe actions that are potentially hazardous.
7. Locating areas for further analysis.
8. Identifying possible interface problems which may result in an accident.
9. Uncovering special areas of safety consideration such as system limitations, risks, etc.

Preliminaries to Analysis

The remainder of this paper is devoted to the specific application of Systems Hazard Analysis to fire fighting systems. Before we get involved with the application of the analysis techniques, certain definitions must be understood.

Definitions

Safety: "Freedom from those conditions that can cause injury or death to personnel, or damage to or loss of equipment or property."[2]

System: The word "system," as mentioned several times during this discourse, will be defined as a "composite of operational and support equipment, personnel, and facilities, which form an entity capable of and/or supporting an operational role within the constraints of a given environment."[2] More simply stated, a system is any purposive entity acting along with its environment. A unique characteristic of a system is that it must exist for a reason.

Man-Machine Systems: Our efforts will mainly revolve around man-machine systems. A workable definition of a man-machine system is "an operating combination of one or more men interacting with one or more machine components, whose objective is to produce a desired outcome from given inputs within the constraints of a given environment."[3]

Efficiency and Effectiveness: Before attempting the analysis it is critically important that the analyst know exactly how the system functions. It is mandatory that he understand the system by viewing it as a whole entity, as well as a series of integrated subsystems, defining its objective, understanding its requirements, and determining at what levels of efficiency and effectiveness it is performing, before he can determine those elements which will be required to improve the system's operation.

Two words have been mentioned here which require our close attention. Oftentimes, these words are misunderstood and, even worse, used interchangeably. The first is "efficiency." When we consider the efficiency of a system, we are in effect asking if the system is making optimum use of its resources to achieve its desired output. Rarely will we find a system operating at 100 per cent efficiency. More often, because of physical and economic limitations, systems are forced to operate at lower levels of efficiency.[5]

The second word is "effectiveness." When we look at the system in terms of effectiveness, we are in effect asking ourselves, "Is this system accomplishing its objectives?"

When answering this question we must be cognizant of the fact that a system may be highly effective while not coming up to the highest levels of efficiency. In other words, a system does not necessarily have to be efficient to be effective, or vice versa.[8]

The Flow Process

A valuable method of acquiring information about the system is to review the flow process. This technique will enable the analyst to gain a more thorough comprehension of the subsystems, methods, processes, transfer operations, inspectional techniques, and man-machine interfaces pertinent to the system under analysis. The flow process, Figure 1, is designed to depict the system's operation and to make comprehensible its methods, process, etc. Each step is viewed as a subsystem in its own right.

Selecting the Operation for Analysis

The responsibility for selecting the particular operation to be analyzed rests with the fire control manager himself. In an organization where many hazardous operations exist, or where potential hazards seem to be inherent in all operations (such as fire fighting systems), certain available clues will serve as guides. These known data are:

1. Injuries. The fact that injuries are prevalent in a specific operation is often a signal that something is wrong with the system's operation. For example, human error, equipment failure, environmental failure, etc., may be setting up hazards responsible for accidents.

2. Recurring accidents. Operations with a history of recurring accidents responsible for lost-time injuries, mission interruption, and/or excessive costs, etc., are candidates for hazard analysis.

3. Operations with known potential. Some operations are seemingly hazardous by nature. Even though an accident has never occurred, the fact that a severe one could occur is sufficient reason for analysis.

4. Interference—mission delay. If a survey of the operation indicates areas where work methods and/or practices are interfering with the effective accomplishment of the operational task (breaking equipment, etc.), it becomes obvious that a hazard analysis is required.

Careful consideration of the above factors will serve to determine the order and priority to be assigned in selecting the operations for analysis.

The Concept of Boundaries

Before we are able to conduct an analysis, we must limit ourselves to a particular segment of the overall system. The necessity of establishing limits around a specific segment of a system gives credence to what is referred to in system's language as the "boundary concept." The use of boundaries enables the analyst to cut out a segment of the universe which he wishes to focus his attention on by establishing a hypothetical line around it. Boundaries are also useful because they restrict the scope of the problem to a size commensurate with the time available and the cost of the analysis. To effectively "bound" the system, the analyst must make a subjective appraisal of the overall system in light of known clues, prior to actually working on the problem.

The systems hazard analysis as it will be applied to our analysis of fire fighting systems will rely on (1) the process of inductive reasoning, the process mentioned earlier, whereby conclusions are drawn by generalizing from many specific cases, and (2) deductive reasoning, where we postulate states of existence based on a theory. When we combine these processes in systems analysis, we are essentially developing a methodology with which to scrutinize the entire system in an attempt to ferret out all of the possible ways in which its components could fail and what effect the consequences of these failures will have on the overall system's operation. Of course, we cannot be so naive as to think we will ever find all the ways in which our system may fail. Instead, we must be satisfied with the discovery of as many failures as is possible at the time of the analysis with the information on hand at that time.

When we make a hazard analysis, we are basically building a data bank of systems failures. This data bank will serve to provide the information for all future decisions concerning the safety and reliability of the system.

Functions of Systems Hazard Analysis

The overall functions of a systems hazard analysis may be grouped into the following four categories:

1. Systems hazard analysis must be an integral function in all operational designs. It is during this design stage that effective

STRETCH HOSE LINE TO ROOF VIA OUTSIDE OF BUILDING

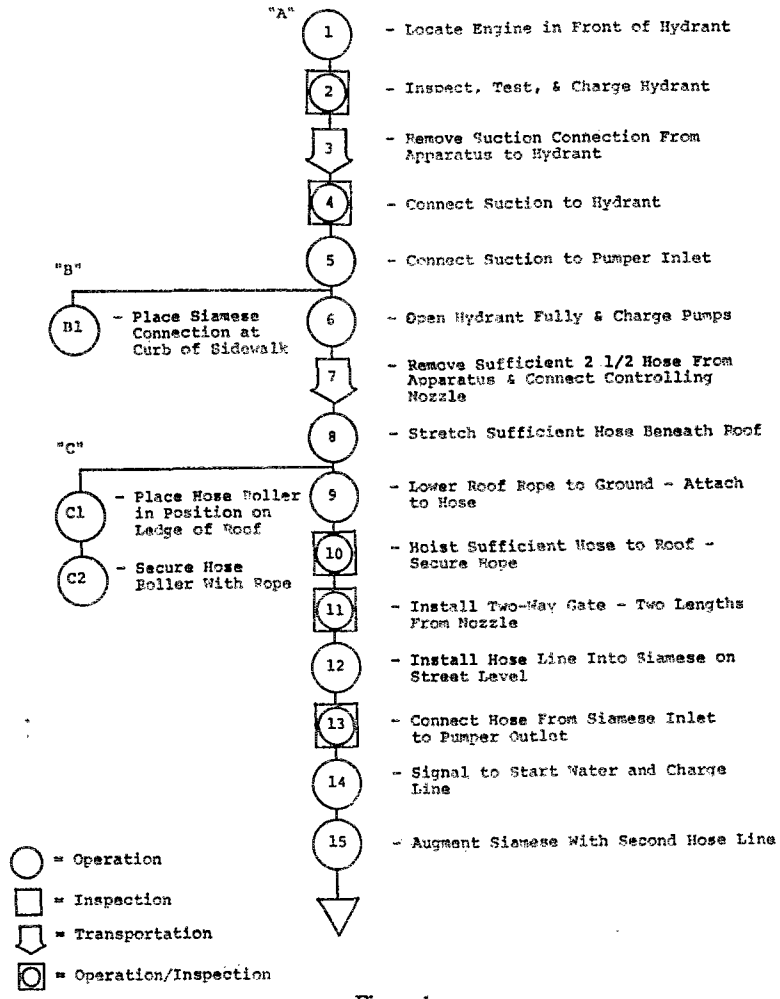

Figure 1

controls can be applied early enough to eliminate causative factors responsible for failures in the system's operation. The data acquired from analysis also serves to identify and control deficiencies in the system's further development.

2. Safety review of an existing system to determine if its design, operation, procedures, etc., are adequate from the standpoint of safety.

3. Evaluation of all proposed modifications or redesign of the system's operation and/

or its equipment to insure that no new safety problems are created.

4. Continual monitoring of the system's operation to insure that loss control requirements are indeed adequate and that they are being complied with.

Analysis Checklists

Many systems are similar from the standpoint that their components, processes, man-machine interfaces, environment, and mission, lend themselves to analysis by virtue of pre-established criteria. This is especially true for the fire fighting systems. Based on this premise, special checklists, designed to cover general hazardous elements, have been developed.

It is not intended, nor is it even suggested, that the checklists cover all possible hazardous elements. They do, however, provide guideposts around which more specific inquiry may be made and relationships drawn. They represent lists of general undesired events, hazardous conditions, and hazardous energy forms which are pertinent to the evaluation of fire fighting systems. The analyst will use these lists to discipline his thinking while considering each function under analysis.

Typical Undesired Events: loss of fire control; loss of water supply; excessive water pressure; burst hose lines; injury to firemen; death to firemen; death and injury to civilians; interruption of mission; loss of fire building; explosion; structural failure; release of toxic materials; breakdown in communications; equipment failure; human failure.

Typical Hazardous Conditions:

1. Firemen Are Exposed To or Come In Contact With: toxic materials, substances, etc.; inadequate ventilation; irritants; heavy objects; slippery, uneven, or rough surfaces; hazardous arrangement, procedures, etc.; hot materials; rough, sharp or cutting surfaces; electrical shock; noise and vibration; flame—high temperatures; weather and environment; explosion; radiation—ionizing or non-ionizing; vehicle accident; weakened building structure; collapse; flying debris.

2. Physical, Psychological, and Physiological Stressors: drugs and medicine; alcohol; intoxicating vapors, dusts, fumes, etc.; fatigue—overexertion.

Typical Unsafe Acts

1. Failure to use available personal protective equipment—head, eye, respiratory, body, hand, foot.

2. Improper use of available personal protective equipment or using incorrect type.

3. Working with electrically charged equipment without adequate electrical grounds.

4. Horse play.

5. Gripping objects, tools, etc., insecurely.

6. Improper use of tools and equipment—using worn or defective tools and equipment; making safety devices inoperative; using hands instead of hand tools; failure to shut off equipment not in use; failure to secure tools and equipment against unexpected motion; failure to place warning signs, signals, tags, etc.; overloading equipment.

7. Improper lifting and pulling.

8. Improper work position.

9. Operating or working at unsafe speed.

10. Failure to provide escape route.

11. Inadequate manpower.

12. Inadequate relief (by supervisor).

13. Driving errors—failure to secure apparatus.

The Approach

The first step in the analysis process is to reduce the overall operation into convenient functions (sub-operations, each representing a particular step in the operation). Each sub-operation is then analyzed individually and all hazardous elements in or associated with the operation identified. Even though we are seemingly concentrating on one function at a time, we must always remember that each of these steps is part of the overall system under study, and not an isolated entity. Each step has effect upon other steps in the overall operation. These interfaces must be considered as we pick our way through the analysis.

The key point to remember while working through the analysis is to start at the output of the system (completed mission), and then determine those failures which may detract from its successful completion.

The analyst must be thoroughly familiar with the procedures involved in the operation before he begins. His first step is to draw a flow diagram which describes each step in the overall operation from the time

it starts through its completion. Each step must be broad. Details are omitted. It is important that the analyst not make the breakdown too detailed since at this stage of the process, details would only serve to cause confusion and impede progress.

A simple operational breakdown sheet can be made with relative ease to aid the analyst. As illustrated in Figure 1, four basic symbols are used to depict the stages in the flow process. Any operation can be broken down by using these standard symbols. If the operational steps are properly defined, it will be comparatively easy for the analyst to focus his attention on them and analyze them in depth.

Once the operation is broken down into successive steps or functions, the next step is to acquire an analysis matrix, a special format designed to facilitate the recording of data pertinent to the system under study. This particular format has proven its usefulness in applied situations. Space is provided for recording particular relevant information concerning the identity of hazards, their cause, the effects of these hazards on the system and, finally, the corrective measures required to remedy the situation.

The following descriptions are indicative of the information required for each category in the format:

1. Function—the particular sub-operation being analyzed.

2. Tools and Equipment—hardware required for the operation.

3. Mode—identifies the system phases which are applicable.

4. Hazardous Element—identifies the elements in the hardware of function being analyzed which are inherently hazardous.

5. Hazardous Condition — the condition which has the capability of causing an accident.

6. Triggering Event—that element which could initiate (trigger) the hazardous condition into becoming a potential accident.

7. Potential Failure—the potential failure (accident) which could result from the hazardous conditions.

8. Effect—the possible results of the potential accident.

9. Hazard Classification — this category provides a qualitative measure of the hazard's effect and is categorized as follows:

Category I — Negligible: Conditions which will not result in personnel injury, systems damage, or mission interruption.[2]

Category II — Marginal: Conditions which can be corrected or controlled without injury to personnel or major system damage or mission interruption.[2]

Category III—Critical: Conditions which will cause personnel injury or major system damage, or will require immediate corrective action for personnel or system survival.[2]

Category IV—Catastrophic: Conditions which will cause death or severe injury to personnel, system loss, and/or mission failure.[2]

10. Corrective Action—this category is reserved for listing those control measures necessary to eliminate or control the identified hazardous condition and/or potential accidents. Corrective actions will fall into the following categories: engineering design of tools, equipment, apparatus; incorporation of safety devices; procedural revisions; personnel requirements; and supervision.

Using the Matrix

In a systems hazard analysis matrix, each function in the operation is viewed in accordance with the criteria as listed in the checklists. These checklist data are purposely designed to guide the analyst so that he considers as many of the hazard criteria as possible in his analysis of the safety of each function. The completed matrix will contain information on every function in the overall operation. The information will be used as the basis for providing effective controls.

Example 1

Mission: Stretch Hose Line to Roof Via Outside of Building

Equipment:

1—1,000 gpm pumper
Sufficient 2½" hose
1—Siamese connection 2½"x2½"
1—Two-way gate, 2½"x½"
1—Controlling nozzle, 2½"x1¼"
(or other as conditions warrant)
1—Roof rope
1—Hose roller
1—Life belt

General Description of Operation:

1. Pumper is connected to the hydrant and its pumps are charged.

2. Sufficient 2½" hose is stretched from pumper and arranged in folds at the base of the building directly below the point where the hose is to be hoisted.

3. Three men take roof rope, hose roller, gate, and life belt to roof. Hose roller is placed into position on ledge of roof between windows below and secured with attached rope. The end of the roof rope is then lowered to the ground.

4. Firemen on the street attach controlling nozzle to hose. When rope is lowered to ground, a clove hitch and binder is tied on the hose two feet away from the male butt, and a half-hitch on the nozzle. Command is then given to hoist the hose line to the roof. When hose line is in position on roof, a siamese connection is inserted in the hose line on street level, and the hose is connected to the pumper.

5. At command, the men on the roof haul up the rope and hose line until approximately 10 feet of the third length of hose is on the roof. A rolling hitch and binder is then tied beneath the coupling two lengths from nozzle end. The two-way gate is inserted between second and third lengths from nozzle. Line is lowered until the couplings are on underside of hose roller. Rope is then pulled taut, and secured to a substantial object.

6. At the command to start water in hose line, gate is opened and stream is directed on fire.

7. When the hose line on roof is in operation, a second line of 2½" hose is stretched from the pumper into the other siamese inlet. This line will augment the water supply.

Based on this general description of the operation, the analyst will construct a flow diagram. As is evident in Figure 1, each function of the overall operation, although precise, is briefly stated. Each step is accompanied by a corresponding symbol which denotes the action being performed. Function A2 indicates that both an operation and inspection are being performed simultaneously.

Each of these steps is to be viewed in accordance with the criteria of undesired events, hazardous conditions, and typical unsafe acts. These data are purposely designed to guide the analyst so that he considers as many of the hazard criteria as possible in his analysis of the safety of each function.

Results of Systems Hazard Analysis

The information generated by a systems hazard analysis is a highly significant data source. Data resulting from a thorough analysis of all possible failure modes provide the basis for design, redesign, and the incorporation of safety and fail-safe features which render failures in the system less probable and less critical in terms of overall performance. Such data can and should serve as valuable reference material in uncovering hazards and potential hazards, and aid in the prevention of repeating those discrepancies which have already been defined.

Other results of the systems hazard analysis can be adequately grouped into the following categories:

1. Eliminating significant hazards uncovered by the analysis through equipment, personnel, or procedural adjustments.

2. Reducing or controlling those hazards to personnel and equipment which cannot be eliminated.

3. Isolating hazardous operations from other activities, areas, and personnel.

4. Providing control measures where failures would adversely affect the system or cause a catastrophic event through personnel injury, equipment damage, or inadvertent operation or movement of critical equipment.

5. Designing, locating, and arranging equipment components so that access to them by personnel during operation, maintenance, repair or adjustment will not expose them to such hazards as electrical shock, cutting edges, toxic atmospheres, etc.

6. Avoiding undue exposure of personnel to physiological and psychological stresses which might cause errors leading to injuries.

7. Installing effective standardized warning systems on hazardous components, equipment, etc., for the protection of personnel in the event of system failure.

Uses of Systems Hazard Analysis

Throughout this paper analysis has been used primarily as an engineering tool for system design purposes, system improvement, and to appraise a system's operational effectiveness and safety. While it is used most commonly for these functions, it does serve other valuable purposes:

Education. The data acquired from a hazard analysis is particularly useful as an aid for teaching personnel about a particular system in terms of its operation, man-machine requirements, where and how failures can occur, what effect these failures would have on the system if they should occur and, most important, the subsystems which need constant monitoring to assure continued safety.

Investigation. A systems hazard analysis is also extremely useful for accident investigation. By reasoning backwards from the pre-determined undesired events, and the conditions responsible for these events, the investigator is in a more desirable position to assess the system prior to the accident and to find the hazardous elements and/or human failures which were responsible for the problem.

Communication. By recording data pertaining to a system in a logical manner comprehensible to others, the analyst is more readily able to convey his findings.

Fault Trees

The information acquired from a hazard analysis may be taken a step further. By injecting the information into a logic diagram or, as it is commonly called, a Fault Tree, the analyst is able to pinpoint the failures which contributed to the cause of the undesired event or fault as uncovered in the preliminary analysis. In effect, a fault tree is a straightforward process for telling how a particular failure can occur within a system. Beginning with a foreseen undesired event, the fault tree traces the sequences of possible events which could lead to the unwanted happening.

Development of a fault tree requires greater insight and knowledge of a system's operation and the analysis process. For a more thorough understanding of the fault tree concept, I recommend reading the series by Recht in *National Safety News* on the subject of Fault Tree Analysis.

When selecting the proper countermeasure to control a problem uncovered in the analysis, the analyst should consider the following four engineering control principles, ranked according to their desirability: (1) eliminating the hazard at its source by correcting mechanical and physical hazards; (2) intercepting or controlling the hazard before it reaches the man (shielding, guarding); (3) providing personal protective devices where controls are inadequate; and (4) instructing employees relative to specific job procedures. In addition to the previous possibilities, combinations of each may be employed to reach an acceptable solution.

Before an attempt is made to develop numerous solutions to the hazards associated with an existing operation, consideration should be given to the possibility that there might be an entirely different way of performing the task which will eliminate the hazard.

When a change is made, this change should be closely studied to determine if the new solution will indeed solve the problem and not, in fact, create a new one. Oftentimes, in the process of eliminating existing hazards, new ones are formed.

Upon completion of the systems hazard analysis, the information must be implemented into the organization's work techniques. Procedures and techniques must be made known to the personnel who are responsible for the system's function.

The person who carries out a systems hazard analysis will find that, in addition to all the benefits previously mentioned, it enables him to learn more about the system he supervises and causes him to gain a more thorough insight into operational techniques, human and machine capabilities, and overall system functions.

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MOTIVATING TOP MANAGEMENT TO ACHIEVE DESIRED SAFETY RESULTS

By KEITH E. BARENKLAU
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In order to better understand the subject at hand we might ask ourselves, why does top management appear to need motivating as far as the safety effort is concerned? Most of us have believed and stated for a number of years that safety is a function of management. It logically follows then that it would be management's responsibility to assess the priority given to the safety effort within the organization. Why then do we say that top management needs motivating?

Management is interested in the safety effort. They are interested in a lot of other things too. Men who occupy top management spots are extremely busy people. They, like us, do first what they feel is most important. Perhaps one of the reasons that top management appears to need motivating is the fact that safety oftentimes just isn't a part of the executive purview. Perhaps safety specialists have themselves to blame for some of this. Top management tends to look at things through an economic screen. Although this is true of safety professionals also, there might be a tendency to overlook the economic considerations in favor of humanitarianism or other social goals which are also quite important in safety but which tend to fall a bit outside of the normal executive purview.

Safety professionals pretty well all agree that safety is a very hard thing to measure. If an organization is building small internal-combustion engines for example, and 80 are supposed to come off a line each day, you don't need Felix Oppenheimer or someone like that to tell you there's a problem if only 70 come off the line on a given day. One of management's prime goals is production, and production rather readily gives itself to accurate and instantaneous measurement.

If top management asked the question, "Have we been safe today?" how would we answer it? We would say we haven't had any accidents today, or we could say that we didn't have any near misses today, but it's pretty hard to say that we had a safe day as such. We may have had several close calls that could have resulted in injury or property damage, but since they didn't materialize the day appeared to be relatively safe. Perhaps we as safety people should develop better measures; indeed, many of us have, and we will discuss these a bit later.

Management's goal is production. Most organizations are in business to make money. This, then, is what gets top management's first attentions. We as safety people have to make safety fit in to the regular production picture. Perhaps we should stop talking about safety and start talking about safe production because, in fact, it appears that this is what we really mean. We must strive to build safety into the production effort so that it isn't an "add on."

Let's look further at the safety effort through the eyes of top management. Top management has two basic resources. These resources are men (people haven't changed much over the years) and machines (machines have changed greatly as the technological revolution has developed).

We said that basically people are still people, but that machines and the technologies have greatly changed. Thus, top management's two basic resources have to be rather carefully examined in order to determine the true niche for the safety effort. As we all know, the technological revolution is and has been in full bloom for some years. The dictionary of occupational titles, for example, is obsolete when it comes off the printing press. People are doing jobs today that no one ever heard of, much less named, as little as a few years ago. Gordon Volkenant of Minnesota, who worked with Professor Fleming on the cathode ray tube for television, had an observation on the technological revolution. He stated that 90 per cent of the scientists who have ever lived are living right now. This shows the magnitude of the technological revolution—a revolution that is very much a part of top management's purview of his production efforts.

The Management Commitment

Perhaps what we're truly talking about here is the fact that it is necessary to get a commitment from top management in order to achieve job safety. Several rather natural factors stand in the way of quickly obtaining a top management commitment—safety goals might tend to be fuzzy, incidents (accidents) are relatively rare except in larger operations, or the etiology of the safety movement within the organization might be somewhat obscure (what are we trying to do with our safety program again?).

Another roadblock to obtaining a management commitment might well be the fact that safety professionals over the years have tended to treat symptoms rather than causes. For one who has spent many years in safety this is a hard thing to admit. Accidents are symptoms. Accidents are the results of operational errors. When we have accidents we should immediately look within our organization and try to determine the error which allowed this accident to take place. This is not an easy job because there are often a multiplicity of causes for accident and injury. This fact alone tends to obscure the safety efforts and so in the midst of his busy day, top management tends to overlook the obscurity and thus the safety effort itself.

How can we obtain top management's support? Let's stop preaching and start analyzing. Let's stop wringing our hands and start shaking the bushes. Let's put our zeal for safety into the management framework in which we find ourselves operating and give the safety effort some direction. Following is a list of items which will help us obtain top management's support:

1. We need a policy statement from top management regarding the safety effort.

2. We need to establish goals for the safety program.

3. We need to establish responsibility and accountability as far as the safety effort is concerned.

4. We need to structure meaningful reports.

5. We must then put the whole package before top management and attempt to involve them and all management in the safety effort.

This may sound like quite an order so let's look at them individually. If your company or agency has no policy statement, endeavor to get one from top management. If you can't get one, write down exactly what you think it is. After all, we're not stupid, we have worked for this organization for a long time, and even though there might not be a written statement we could perhaps write one that would do the job. This gives us a point from which to start.

Before any program can be successful, we must have goals. These must be meaningful goals that are activity oriented and aimed at defined problems. All goals should have a measurable base period. It's no different in safety than in anything else. Above all, goals should state the results that we expect to achieve. Let's be realistic about our goals for our organization. Let's leave the dreaming to dreamers and take a rather realistic hardheaded approach regarding what we should and can accomplish in a definable base period of time.

Much has been said (preached) about responsibility and accountability. People simply must be held accountable. When responsibilities are delegated and accountability is fixed, the safety effort (or any other effort) makes progress. If top management won't establish responsibilities and hold people accountable, let's do it ourselves within our own sphere of influence. This will prove valuable later when we report progress to top management.

The fourth item mentioned has to do with reporting of results. We should structure meaningful reports built along economic guidelines. Some day, all of the frequency and severity figures will perhaps wither away and in their place will be dollar signs. I'm not shaking my finger at frequency and severity, and I realize that these figures are necessary—particularly on government reports. What I am saying is that these figures don't usually mean very much to top management. They, like other obscurities in safety, fall outside of the executive purview. Why not state our report in terms of dollars? If we have a $1,000 accident, how many units will we have to sell in order to make up that loss? If we have a $10,000 accident, what kind of an appropriation will we need to make it up? What work will

have to go undone because of this accident? This is the type of thinking and indeed the type of reporting that gets through to top management. Economic reports fall naturally into the executive purview, and believe me they will get noticed. This report should also include a statement of goals accomplished, objectives met, and outlines for continued progress. With a report of this type, top management has to get interested.

Now we're in a position to put the whole package before top management and if we properly assessed our role, set and achieved our goals, and reported them in an economic management type fashion, we will get what we asked for, namely, support from top management.

This spring, Earl Givens of the Ford Motor Company spoke to a group of safety people in Milwaukee. He talked about this subject of motivating top management toward the safety effort. Earl stressed, as I have tried to stress here, the fact that we should not wait until we're asked. If we don't have a policy, write one down. Write down what you think it would be if the boss wrote it. This provides us some guidelines and a starting point. Top management usually wants to be a good corporate citizen. They want their company or their agency to be recognized in the business or governmental world. What better place to develop this good citizenship than through their safety effort? Another thing we can do is work to get the big boss on a safety committee or into a safety organization. Top management, again being much like us, are good competitors. Why not say, "Boss, you can do a better job in this committee than the president of Ajax Manufacturing Company."

In summation, let's not forget a prime point. Top management will go along with things that are economically feasible, that return a bit more than a dollar for each dollar spent. Top management wants to participate in profit improvement programs, even if we might call them safety programs. When the boss asks, "What will it get me?" we can say, "Boss, it will get you five things." These five things are:

1. Money—money which accumulates from lack of accidents. Money which transfers directly from overhead to profit on the company balance sheet.

2. Money—money that would ordinarily be spent for fire and equipment losses were our safety program not up to standard.

3. Money—money saved through reduction of workmen's compensation premiums because the boss wants and gets a safe work place and holds others accountable to achieve it.

4. Money—money that would be spent paying cargo claims, filling out papers, and doing things over.

5. Money—money spent replacing employees with unskilled substitutes who in themselves might be a cost until they become trained.

Management's goal is production; so is ours—safe production. Management wants to be a good corporate citizen. So do we, and we can help them achieve it through a working safety effort. I'm sure that the above suggestions are not a magic formula for success. They do work, however, and have worked in many organizations and agencies. We, like top management, want safety production and we will get top management's support if we show them that we know how to do it.

EMPLOYEE SAFETY—A CHALLENGE

By DALE R. TANKERSLEY
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We can either accept this noble challenge and work at it vigorously, or we simply fail ourselves and every employee in our respective organizations. No more—no less.

Now that statement in itself may sound pretty flat. But if we analyze it closely, that is all any of us can do. We must keep working and keep searching for new ideas and techniques to solve our problems. If I or anybody else had all the answers to the circumstances surrounding accidents, we could then simply prescribe for them and forget about our problems. Unfortunately that's not the case, so our endless task of searching goes on.

If I don't have the answers, what do I have? I have a few ideas that if successfully implemented will go a long way toward solving our problems and perhaps disclose some of the answers for which we are all so ravenously searching.

Initially, employee safety within our respective highway organizations must be cast as a classic and timely challenge to all employee at all levels of the organization structure. For too many years personal safety programs have met with fleeting and intermittent attention from management people. The competition for their attention has been fierce, and the corps of safety people vying for it has been small and their comparative voices weak.

We as the stalwarts for personnel safety must indisputably show that safety is the coming thing in highway organizations. This philosophy was accepted years ago in the private sector through the collection and application of statistical and economic data. Unfortunately, we in public service do not and cannot participate in the form of bonuses, the monies which are saved on insurance premiums and reduced production costs as the result of good safety performance, therefore, the same incentive is not there for us as in the private sector of business. However, I believe that this can be an effective means through which to convince our managements that safety is classic and timely. With ever mounting demands for available tax dollars, an analysis showing the robbery of those dollars as a result of accidents can be a most effective argument in gaining support for employee safety. Hopefully, through this medium we can gain the impetus for safety comparable to that given other phases of highway work. Then and only then, can we achieve and effectively proclaim the results of employee safety, as we have in other areas of highway operations.

Turning to the problem of the rank and file employee, it behooves us to be particularly sensitive to his suggestions, promoting those which have merit and diplomatically eliminating those which for many reasons may not or cannot be implemented. I think, too, that more emphasis should be given to the human engineering aspects regarding the equipment these people are asked to maintain and operate.

For example, we have for years purchased 12-foot long replacement snow plow blades, obviously to fit a 12-foot plow. That's logical. But in our anxiety to purchase as cheap a unit cost as possible, we didn't stop to think that more often than not *one* man would be changing that blade—it only weighs a mere 163 pounds. We, in Idaho, have experienced many injuries to backs, fingers, hands, legs, and toes because of these heavy, awkward brutes. We are now purchasing and installing two six-foot lengths. It's much easier and less costly in the long run.

For another example, how about the size of material samples required on construction projects? Not too long ago a new requirement came out for catching a larger sample of concrete, going from ¼ cubic ft. (50 lbs.) to ½ cubic ft. (100 lbs.). Obviously, there was very little, if any, consideration given whatsoever for the poor inspector who was going to have to catch that sample and carry it somewhere to perform his tests. How many of you have tried carrying 100 pounds in a bucket? It puts quite a strain on the old spinal column.

Another good example is snow removal equipment. How many of the auxiliary controls which are installed in snow plow equipped trucks were put there for the ease and convenience of the operator instead of for the ease of the mechanic installing them?

In how many vehicles do we require seat belts to keep people from bouncing around, yet fail to provide adequate space to store jacks, chains, etc., to keep them from flying around?

When we construct automotive shops, do we always provide adequate ventilation and exhaust systems?

These are just a few examples of what we should look for and hopefully correct in the interest of accident prevention and employee morale.

I firmly believe that over the years we have unknowingly kept asking the employee to adjust to this or that, to do just one more task until now, with the newer more sophisticated equipment, he has in some instances become confused. Man is only so efficient within himself in spite of all his resourcefulness. We must begin to adapt machines

and equipment around the employee, similar to what has been done in the space programs, and stop compromising his safety for the ease of manufacturing.

In this connection, it isn't too far fetched to consider color coding of gauges and dials on complex instrument panels for ease of observation. Nor is it too remote to consider designing controls for touch identification, which would tend to reduce the chance of incorrect control movement when operating at night, or when it is most advantageous to keep the eyes on the road. This list could go on and on, and it is up to us to search out and provide the leadership needed to motivate change.

We cannot let the safety of our own employees be subordinated or overshadowed by the more popularized and publicized transportation safety. After all, our employees are on the front line of transportation, and they should receive front line and priority attention. Anything less for our employees would be dereliction of the highest order by responsible management.

As you know, safety is a two-way street. We have for years asked and told and preached to the employee to "Be careful," "Watch the other guy," etc. We've sloganized safety-first. We can no longer appeal only to the emotions of our personnel—instead we must appeal to their intelligence and integrity which will sustain a longer lasting motivation as opposed to the short lived emotionally charged fanfare of yesteryear.

I think it is time that our departments start looking at the whole picture and become a full partner with the employee in doing what needs to be done. Once we have shown our colors as safety people in action who can undisputably show management the economic and morale issues involved and demonstrate to the employees that we can effectively implement new ideas and suggestions when warranted, we will then receive from all quarters the full support for our great cause—employee safety.

HOW TO DRIVE AND SURVIVE

By DONALD S. BUCK
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Most anyone can drive, but few can do it without involvement in an accident. If you were certain that you drive safely, you'd have no need for insurance.

If you drive, you have two choices: one of taking risks; one of not. If you take risks, you have two chances: one of being in an accident; one of not. If you're in an accident, you have two chances: one of being hurt; one of not. If you are hurt, you have two chances: one of dying; one of surviving. If you die, you have two chances—so why take risks in the first place?

Half Were Wrecked

Vehicle registrations in this country in 1967 totaled 100 million, including over 16 million trucks. One in every four vehicles (24 million) was wrecked seriously enough (i.e., damage of $100 or more) to require an accident report. Additionally, another one in every four vehicles (26 million) was banged up to some lesser degree which did not require a report. This makes a total of 50 million vehicles wrecked last year. With every other vehicle in this country wrecked annually, are you statistically overdue?

In general, we know how those 50 million vehicles were wrecked, the reasons for the upsets, the rear-end collisions, the sideswipes, and the "broad-siders." We also know why those 50 million vehicles were driven by persons who were worried, hurried, inattentive, drowzy, tipsy, or otherwise unable to go for 365 successive days without an accident.

Half Were Not Wrecked

Fifty million Frenchmen may not be wrong; how about the 50 million drivers who did not wreck their vehicles last year? Did they have their share of near-misses? Did "Lady Luck" ride with them, or was it something more than "luck?" Trucks and buses, which comprise 16.2 per cent of all vehicles, are more difficult and dangerous to operate than passenger cars, but they were involved in only 10.7 per cent of all traffic accidents. Obviously, something more than luck is involved!

How to Avoid Accidents

The logical way to avoid accidents is illustrated by the old timer's story on how to avoid snakebite. After living 80 years in a rattlesnake infested area, he was asked how he managed to avoid snakebite. He answered, "Snakes live in the woods, so I try to stay away from there. If I must go in the woods, I go in winter when snakes hibernate. If it won't wait, I go on a cool day, when I can see the snakes out sunning themselves. If I must go on a warm day, I watch and listen for them. I wear heavy clothing and boots so if a snake strikes, I am protected. Despite all this, if I am bitten, I'll fix the snake so he won't bite again, then I'll get to a doctor. The next time, I'll stay out of the woods."

The parallel in how to drive and survive: Accidents tend to occur on streets and roads at certain places and during peak periods; so, if possible, don't drive where and when accidents most frequently occur. Watch and listen for the other driver and heed his warning. Try not to get hit, but wear safety belts for protection. If you can't avert a crash, avoid a head-on collision. If, despite this, you are hit and hurt, fix the other driver's wagon by "preferring charges," then get medical treatment for yourself. Next time, don't drive there.

There are six practical ways to drive and survive:

1. See hazards. To avoid accidents, each hazard must be seen before it's too late. You cannot effectively see hazards if windows are frosted or fogged, nor if headlights are dirty or misaimed, nor if you fail to wear needed prescription spectacles, nor if blinded by sunshine or headlights. When the driver in an accident admits that, "I simply didn't see the other vehicle until it was too late," it is an admission that something was wrong with the technique of seeing. To help see more effectively defrost and defog windows and windshields. Fill the tank of the windshield washer with a cleaning solution, instead of water. The solution contains solvents which will remove dust, dirt, grime, and frost. Some drivers may not realize that the alcohol base in windshield washer compounds is quite effective for washing away frost. Apply an anti-fogging compound to inside window surfaces. One application will prevent fogging for a week. Defroster spray in pressurized cans will dissolve Jack Frost's whitewash, but wipe away the "melt" before it can refreeze. Defroster hoses become disconnected, causing drivers to attempt to "come in on instruments" when windows are frosted or fogged. A good windshield scraper is more effective for removing frost than fingernails or prayer. The air conditioner will remove moisture from the air, thus clearing fog from windows.

Have adequate rear view mirrors. Rear view mirrors outside the vehicle broaden the field of vision to the rear, help with backing, and eliminate that blind spot hiding place for traffic police. Outside rear view mirrors adjustable from inside add to safer seeing. Particularly effective among inside rear view mirrors are the wide-angle, multi-sectioned types which provide a 180 degree view to the rear without having to turn the head.

Protect against glare. The sunshade aids vision. Too often, it cannot be used because it serves as a catch-all for maps, receipts, and papers. Dark glasses will tone down glare and may make you look like a movie star. If prescription glasses are needed for driving, wear them! Failure to wear spectacles when needed is like trying to fly blind—an unprofessional way to drive.

Keep windows clean. Windows are difficult to see through when exterior surfaces are smeared with assorted bugs, grime, and dirt and when inner surfaces are covered with the patina of smoke. Service station attendants faithfully clean the outside surface of windshields, but the inner surfaces often go long without being touched, except by greasy hands. Clean the glass with a paper towel or a wet cloth.

Keep dashboards clear. Papers on the dashboard ledge may interfere with vision because they are mirrored in the windshield. Clear away this stuff or cover it with something dark.

2. Be seen by others. Make sure that the other guy can and will see you in time.

Drivers hit what they don't see. This is true, day or night, snow or rain, backing up or going ahead. The more surely you are seen, the better are your chances of not being hit. You must find ways to arrest the attention of other drivers in time, despite the competition of mini skirts, bright lights, and traffic. To be more readily seen, drive a light colored vehicle. Dark vehicles are unseen "sitting ducks" after dark. Light colored vehicles are easier to see, except in a blizzard or a sandstorm. The safest color combination likely would be alternate (herring bone) stripes of reflective white and fluorescent blaze orange (a vibrant color foreign in nature, which jars the viewer's senses, and is especially conspicuous at dusk). There may be some reluctance to ride in a rig with a blazing orange-red rear end, but it's better to be seen than dead.

Use reflective tape. Ample use of reflective materials, particularly on the rear of the vehicle, is likely the best single means for making sure that we're seen, because they light up vividly from other vehicles' lights. Inexpensive stick-on reflective tape is available wherever auto supplies are sold. Reflective paints (both spray and brush-on) are also available. The rear ends of my vehicles are liberally reflectorized, and will be seen from a great distance by anyone else behind me. Even if my tail lights fail, my vehicle will present a conspicuous red warning to anyone behind it at night.

Keep lights clean (head lights and tail lights). The more light, the better. That well-scrubbed look on lights will help you to see and be seen better.

Use headlights during daytime. Studies show that other motorists will more readily spot your vehicle if headlights are turned on in daylight. Since Greyhound started using headlights on buses in daytime, their accidents have been reduced 12 per cent. To be seen, keep lights on.

Use emergency lighting when stalled. An emergency warning kit containing lights and flags is essential protection for any vehicle stalled in traffic, particularly at dusk or night. Most vehicles are equipped with a switch which will cause all four parking lights to intermittently flash a warning, but many motorists forget to use them. In addition to carrying the conventional flags and fusees, I carry a folding reflectorized warning sign to set behind my vehicle, and a "Send Help" flag to affix to my aerial.

Dim lights first. "Dim it, dammit!" Dim your headlights when meeting other vehicles, and do it before the other driver dims. Some drivers confronted with blinding lights, take delight in "giving 'em back the full treatment" by deliberately turning on all four high beams, but the other driver is sometimes unable to do anything about his lights. An overload will depress rear springs and elevate light beams. Your high beams will jam his vision and prevent your being safe. Disoriented, he may veer toward your lights, like the proverbial moth attracted to the flame. To remind the oncoming driver to dim quickly, flick to high, then low, beams. Even if he fails to respond, keep your beams down, and don't make him resort to guess work to pass you. At least one of you must see to be safe.

3. Keep awake. Drowzy drivers become involved in one-vehicle crashes. They continue straight when roads suddenly turn. They fail to see stop signs and traffic lights. They slam into stalled vehicles in broad daylight. It is futile to admonish drivers not to get sleepy. Drowziness is not a condition which is responsive to will or intent. Several factors contribute to sleepiness. High on the list are heavy meals, fatigue, and lack of sleep. Drowziness is also induced by that popular and effective tranquilizer better known as alcohol. Eyes repeatedly exposed to glare from oncoming lights will rapidly tire and invite sleep. Comfort, silence, inadequate ventilation, leaky exhausts, and tobacco smoke also contribute to drowziness. There are several practical safeguards against sleepiness:

Catnaps. Instead of fighting sleep, choose a safe spot and catch some shuteye. Sleep is the best treatment for drowziness.

Stimulants. The coffee break is the drowzy driver's best friend. Mild stimulants such as coffee, tea, or coke help to offset drowsiness. Additionally, the physical activity involved to stop for a cup of java will quicken the pulse and perk up consciousness. Rest stops on some expressways may be 40 miles apart, so carry a thermos of coffee. "Pep" pills (i.e., amphetamines) are used by some persons to offset need for sleep, but these often do more harm than good. The tired driver who is denied sleep by drugs may experience

unhappy side effects from the drug, such as seeing the "little men who are not really there."

Moderate cold. Exposure to cold quickens the breath, stimulates the pulse, and clears the mind. A cold shower would effectively jar one awake, but built-in showers on vehicles are uncommon. There is a practical substitute. Dip a cloth into cold water or wrap it around an ice cube and apply it to eyes, neck, and face. This effectively eliminates drowsiness. It also helps to open the windows and ventilators.

Exercise. Sleepiness is offset by an exercise vigorous enough to quicken the pulse and breath. The driver who indulges in a few deep knee bends will look dizzy but not drowzy. Tone can be restored to wearied mind and muscle by jogging briskly.

Let someone else drive. To dispel all desire to sleep, surrender the wheel to someone else. If you have confidence that your relief driver is wide-eyed and competent, you'll sleep. If you lack that confidence, you'll lose all desire to sleep.

4. Avoid hurry. Speed of itself does not cause the accident, but it does determine crash severity and chances for surviving. The faster we go, the harder we hit; and the harder we hit, the worse we're hurt. What speed is most conducive to accident involvement? 90 mph? 60 mph? 40? No! A study by the Bureau of Public Roads shows that it is zero! A vehicle standing on a fast road at night is most likely to become involved in an accident. A negative speed (backing) could be even more dangerous. Backing is our most accident-prone driving maneuver, considering the distance traveled. Particularly lethal are the attempts to back upon an expressway after missing an exit. To survive, we must go to the next exit instead of trying to back up. Any speed substantially faster or slower than other traffic is hazardous. The safest speed is keeping up with the crowd, which minimizes need to pass and be passed. Changes in speed or direction, such as sudden braking or stomping it are hazardous. It's not important how fast you drive, but it is important how you drive fast. Higher speeds introduce some important considerations.

Speed reduces turning ability. Fast moving vehicles can't swerve or turn sharply. The turning ability of the vehicle falls off as speeds go up (it varies with the square of the difference in speed). The steering wheel may be yanked over at 20, but the same maneuver at 40 might overturn the vehicle. Tires which are squealing on turns are sounding a warning that they have just about lost their grip, so ease up or else.

Speed increases stopping distances. Speeding vehicles cannot make quick stops unless they hit trees or bridges. When speed is doubled, the skidding distance increases four times. (It varies with the square of the difference in speed.) Tailgaters have little choice other than to hit vehicles ahead which suddenly slow down or stop. They often erroneously insist that their brakes failed. A skidding stop in 20 feet at 20 miles per hour is exceptionally good and calls for good tires and dry road surfaces; the best stop at twice this speed (40 mph) will quadruple the skid (80 feet). At 60 mph the skid will increase nine times (180 feet). These are the skidding distances only, and do not include reaction time distance. Each driver should make an emergency test stop at 20 mph, then measure the skid marks. Then, try it again at 40 mph, being ready to let up on the brake pedal if the vehicle starts to jackknife or crab. This will help the driver to understand why extra distance between all other vehicles is the best way to avoid involvement in rear end collisions.

Safest speeds vary. The safest speed depends on conditions, such as the pace of other traffic, the condition of weather and light, the legal speed limits, the driver's *mental and physical condition* (sober? wakeful? unhurried?) and condition of the vehicle (tires? brakes? load?). To evaluate your speed, look at your passengers. You likely are going too fast if they instinctly apply imaginary brakes or brace themselves against the dash board or hint that the local police are tough on speeders. If tires or brakes "sound off," you are speeding. You likely are speeding if you constantly watch for police.

5. Avoid collision. Despite your best efforts, the time probably will come when you must face a crash situation. What you do when the chips are down will determine whether it will be a hit or miss—and whether you will survive.

Leave yourself an out. Drivers should constantly select emergency alternate "landing

sites," the best place to head for when the chips are down.

Expect the worst from other drivers. Drivers avoid collision by expecting the worst from others. Safe drivers may drive fast, but they drive scared, expecting other vehicles to veer, turn, or stop suddenly, and always expecting tires and brakes and lights to fail. They anticipate that other drivers will be lost, drunk, sleepy, sick, in love, worried, or drugged. In this pessimistic outlook, it is better to be wrong than dead.

Expect the worst. Safe drivers expect the worst. One of each four tires will fail before it wears out. Half of all drivers experience brake failure. One-third experience headlight failure. In cold weather expect shady areas and bridges to be icy. Expect pedestrians and cyclists to be on the wrong side of the road. Diamond-shaped signs warn of hazards ahead, so slow down for the "cockeyed square." Expect it to rain, snow, or sleet. Prepare for the worst.

Choose safe options. Each driver is constantly choosing courses of action from numerous options, some of which are more hazardous than others. Wise drivers select the safest option. The choose expressways where possible to avoid the higher risk of two lane roads, even though this involves extra mileage and tolls. They travel by day (accidents are more severe at night). They dim first; they help others to pass; they don't tailgate. They clean windows before wishing they had done so. They tap horns instead of riding the horn button. They don't contest the right-of-way. They consider that other drivers who hurry may have valid reasons. They don't allow themselves to get "mad" at other drivers. They drink coffee instead of cocktails before driving. They slow down before they have to. They don't make the other driver guess where they're going.

6. Crash survival. Despite your best effort, an accident likely is ahead in your future and the chances are 50-50 that it will be this year. If we must crash, what can we do to survive?

Minimize impact. The driver's first line of defense is his control over speed and direction. He can lessen the impact of collision by using more moderate speeds when the probability of collision increases. He will be prepared and able to minimize impact, provided he has not befuddled his early warning system (vision and judgment) with drugs or drink. The sooner he can spot and identify the hazard, the quicker he can slow down and the less will be the shock.

Avoid head-ons. Lethal impacts are particularly prevalent in head-on crashes and in collisions at right angles. To survive, avoid head-ons and intersection-type crashes by heading for the brush. Plough into the dirt bank instead of a stone wall or a big truck. The ditch may be rough, but it will be gentle compared to a head-on collision, particularly if the cargo behind continues to move forward after the impact.

Avoid side-swipes. The side-swipe collision with an oncoming vehicle usually will carry away the steering linkage and put the primary impact point near the driver's seat. To avoid the collision, it may be better to leave the road. You may regain control; at least, you can pick a more yielding target than is offered by side swiping another oncoming vehicle.

Use seat belts. If you knew when your next accident would be, you'd need only to fasten seat belts slightly in advance. Because you are not certain, fasten belts every time. Nearly all of those who fail to survive will be unbelted. They will be slammed around in a tumbling vehicle until the doors fly open, allowing the victim to be ejected and crushed in the roll over. The bouncing will unseat the unbelted driver, dislodge his foot from brake pedal, and prevent him from retaining or regaining control. In contrast, the belted driver has some chance of regaining control because he is held in place. As the vehicle crushes and decelerates, his belt slows him down, exposing him to more gradual impact forces, and increasing his chances for survival. Use of seat belts has reduced injuries to chest areas, but head injuries continue at about the same rate. Shoulder harness will lessen the impact forces to which the head and face are subjected.

De-energize. Energy-absorbing water-filled pneumatic bumpers are available which effectively reduce impact forces common to "fender benders." These devices effectively offset impact forces equal to 15 to 20 miles per hour. Other de-energizing devices include the energy-absorbing steering wheel assembly, the padded dash, the frangible rear

mirror, the recessed instruments on the panel, the safety lock doors, the safety glass windows, the jettisonable windshield, the X or box frame, and the hard top on the vehicle.

The prospects for driving and surviving is not a very promising picture. But, since you have made it safely to here, why not try for another mile, then still another? Miracles are not needed to survive; merely drive expertly. Safe drivers may not consider themselves to be experts—they merely try harder.

Summary

Each year, 50 million vehicles are wrecked in accidents, and 50 million avoid accidents. It is within your power to drive and survive: you must make sure that you see well, are seen, keep awake, avoid hurry, avoid collision, and survive the crash.

It is not easy, but it is possible for any driver to drive—and survive.

A HEALTHY PERSON IS A SAFER PERSON

By EDWARD R. ANNIS, M.D.
Past President, American Medical Assn., Miami, Fla.

The smart person is the one who lets someone else do the driving after he has had a few drinks, perhaps one too many. Many people will say that there have been 50,000,000 American drivers who had several drinks, even some who had "one drink too many," who were not involved in any accident. The next comment one would expect would be, "Are they the lucky ones?" Yes, they are alive, and they are the fortunate people. Basically, however, most drivers are alive and well because they follow accepted rules. The point I wish to make is that it is not luck that we are talking about, we are merely discussing the techniques of defensive driving—this is the important aspect.

My thesis is that a healthy person is a safer person. Even a youngster, who has good health, is a safer individual and is able to adjust more quickly to his environment. It is human nature to go from generalities to specifics even before one has gathered all of the facts. It is important that one should not make conclusions before one has gathered and assessed all the factual information. It is generally conceded that when a certain event occurs, that event, although viewed by many people, is visualized from different points of view. I cannot overemphasize one basic point: before making decisions, get all the facts, verify them, ascertain them, evaluate them. The remarks I make here are applicable in medicine as well as in life. The fact is that accidents involving motor vehicles are preventable, providing the drivers are in full control of their faculties. Just as a child can be brought into this world and live a full life if he receives protection and care during his formative years (primarily from one to five) by the same token a driver can be taught to drive safely over a long period of time if he would only learn to adapt his driving to the environment or to the condition under which he lives.

Motor vehicle accidents are one of the greatest causes of death. Unfortunately, many of these accidents occur during the middle years of life. Far more deaths under 45 take place on the roadway than from degenerate diseases. Last year, the National Safety Council reports, there were 56,400 motor vehicle deaths. We have much to learn in the field of accident prevention.

I recall my younger days on the east side of the City of Detroit, Michigan. The business leaders at that time were fully convinced that it was most economical to safeguard machinery in order to prevent the loss of arms and legs and fingers. Today, no one disputes the need and necessity for safeguarding automated equipment.

How can we build in safeguards in our daily lives, in our driving habits, even safeguards against our own shortcomings? It is fascinating to me the number of ways in-

dustry has discovered to help us in the field of preventing accidents. As I travel from city to city and visit various airports, I am impressed by the air line employees who use protective devices such as earplugs and earmuffs in order to reduce the noise caused by jet engines. We have the means of providing safeguards in all fields of human activity.

As you all know, industry has led the way in the field of accident prevention throughout the years. In all fields of endeavor, whether it is in physics, science, or medicine, we need the engineer. He is the stalwart who is able to adapt the requirements of science. He is the man who can design and safeguard the equipment that we need in our work; in other words, provide for built-in safeguards. In my work in the hospitals when I describe my needs, I invariably turn it over to the engineer who devises ways and means of solving these needs. Therefore, the engineer in modern technology is the indispensable individual. Although the doctor achieves credit for advancement in medicine, I truly believe that the engineer deserves a great proportion of the credit given the physician. For example, a deaf man is able to hear now as the result of the contribution made by the combination of the physician and the engineer. It is amazing what can be done when the engineer and the medical profession work together.

Let's talk a little bit about the child. Very often a child is characterized as a dullard, stupid, incorrigible, unable to learn. The truth of the matter is that the child either cannot hear or cannot see. That's why it is important that when a child is in school the health authorities make a thorough examination and determine his situation. A child with this type of deficiency, particularly if his name happens to begin with a P or a Q, is placed 'way in the back of the room, which obviously is not to his advantage.

Then there is the individual who is glibly labeled as "accident prone." Yet the truth of the matter is that this individual probably is suffering from a physical or emotional problem which we haven't taken the time to ascertain.

Industry has recognized early the value of health care for its employees. For example, U. S. Steel has a health care insurance program totaling $92,000,000. The American Telephone and Telegraph Company has a program for health care totaling $52,000,000. The American employer, especially large corporations, learned a long time ago how important it is to establish a good relationship between employer and employee, and one of the ways of doing so is to help the employee in accident prevention as well as in medical care programs. This requires systematic and early detection, planning, advice by medical authority, and proper prescription where such care is required. Industry has saved millions upon millions of dollars by not trusting to luck; rather, industry is subscribing to scientific care for its employees. Just as there are ways of preventing automobile accidents, there are ways of preserving the health of employees by a correct health plan.

While visiting England and the Nordic countries Sweden and Denmark, where they do not have as many automobiles as the United States, I was appalled at the number of accidents in those countries resulting from the abuse of alcohol. I believe that the basic cause of these accidents, not only in Europe but also in this country, is the result of the driver venting his frustrations from a position behind the wheel. He may have been angry, upset with his wife's nagging, angry at his boss or foreman, probably beset with emotional problems, worry, fear, and takes out all of his frustrations by acts from a position behind the wheel. Why do we do this? We do this because we're human. Sometimes a child who is admonished senses or feels an injustice, probably generated by fear, and dashes across a street where traffic is heavy and is killed.

Today we have a new term: Ecology. This need for environmental protection and control has been long overdue. It has been wrapped in politics for many years. A good example of this is the mining industry. For example, I was invited one day to visit a town in West Virginia where, upon crossing a bridge, I could see that the whole town was covered with yellow ash from the steel mills. The workers moved about in this for years, only they didn't understand the term "ecology." The workers of the area said, "We knew about yellow ash, but to us it was manna from heaven because it meant jobs—it meant that the mills were at work." Today, we need more than just that.

My son, a physician, tells me that of those injured soldiers who are returned from Viet Nam more are suffering from drugs than from enemy action. Again I refer you to the 56,400 people killed on the highways. Many people point to the other millions who are driving and are not involved in accidents. Again, I want to say that it is not just luck, it is good defensive technique, and the same thing would apply to good health—it is not just luck, it is something that one must do for himself.

Medical science is here to assist you. Thank God for the word "recreate." The body has the ability to recreate itself, and again I go back to the basic thesis that it is not just luck. One can do something about heart disease; we can do something about diabetes, cancer, pollution; and we can do something about absenteeism in the factories. We can do something about overweight, and if we did we would add seven years to the longevity of individuals. We are virtually eating ourselves into the grave. We can do something about stopping the effects of cigarette smoking which, of course, shortens life. All of the things that we have said apply equally to vehicle driving. We can do something about our driving habits. To start, we can control our drinking habits.

We simply eat too much, too well, and drink too much. If we can only learn to do a little bit less, we would be healthier. And so it goes: a healthier person is a much happier and safer individual.

WESTERN APPROACH TO REFUSE COLLECTION SAFETY

By CARL V. SUMME
Safety Representative, State Compensation Fund, Inglewood, Calif.

The West has always insisted on a special image. Perhaps it started with the first cowboy with his bowed legs, rolling a cigarette using brown wheat paper. Well, we're still at it today. We have a Western approach to refuse collection safety.

Every part of our country has refuse, and it must all be disposed of. There are probably many differences in how we do it. In the Los Angeles area, our affluence give us so many cars that burning is prohibited; smog, you know. So land fill seems to be the answer at least for a few more years. When we're all done filling, we put a golf course on top.

Southern California has a lot going for it. We have sunny beaches and beautiful mountains. We get a big piece of the aero-space action, and wage and salary scales seem to be a little higher than in other parts of the country. Our climate is mild—none of that 20 below zero in sunny Southern California. The people like all of this and work to support themselves and their families. Some collect refuse.

But, like everything else in life, there is another side to it. Sometimes our beaches are overcast and overcrowded, yes, at times oil floats in on the tide. In the summer our mountains are a fire hazard, and from the time school is out in the spring, until it begins in the fall, our State and National parks are crowded with people from the cities. As for the aero-space action, if it looks like peace will "break out," high salaried engineers and scientists will be unemployed. As for the higher wage and salary scales, statistics show it takes more to live in the Los Angeles area.

What about these wonderful people who like the climate and work—collecting refuse for a living? They get injured on the job. Preventing these injuries became a challenge to me. I never collected refuse, so first I had to talk to them, follow them on a route, watch them work, observe them at 7:00 A.M., when they start—observe them when they finish. I took a lot of pictures of them doing their dirty, menial job. There is as much "ham" in these guys as there is in the city managers and administrators — *everybody* likes to have their picture taken.

I put about 100 of these slides in sequence, wrote a story to go with it, and put it on tape. I showed this to them at a safety meeting. I did this with the City of Inglewood and the City of Santa Monica. Accidents *were* prevented because of this effort.

These pictures and stories were specifically personal to each city—to the employee group (they're all different) and to their equipment. This made for maximum impact on these employees, but in showing the same pictures and stories to another group 100 miles away, the effect was not so good. So I wrote a completely different story, used pictures from Inglewood and Santa Monica, went over to Pasadena and took some pictures, and put it together in a film strip. It was fun doing it. If you are interested, I would be glad to tell you how you can do it. All it takes is a little talent at picture taking and story writing.

The cities I spoke of are nestled in the Los Angeles area. Some are surrounded by Los Angeles. Others border on at least one side. They vary from 400 to 700 total employees. The City of Los Angeles employs from 1,000 to 1,250 men to pick up their refuse, and has a very sophisticated and effective safety program. When a man applies for a job, he is given a physical examination. If it shows he can't be a refuse collector without hurting himself, he isn't hired. The small cities tell me they can't afford to do it. I tell them they can't afford not to do it. I convinced some of them. After the physical examination—if he passes—the employee is given a full day of orientation. Safety is a part of it. This takes him to the actual job scene. There is demonstration—then he does it.

Los Angeles has a good safety committee effort going too. A driver and a loader is elected from each section (about 40-50 men) to attend. Of course, the district superintendent is there and other management people. Any and all safety problems are discussed.

Sitting on top of all this is the Management Safety Committee. It is composed of the refuse collection superintendent—all five district superintendents—the refuse equipment superintendent—a disposal foreman—the training coordinator—and a safety engineer. Although I mentioned the Management Safety Committee last, *here* is where it must begin—with top management.

The smaller cities I have worked with do not have as sophisticated approach but they do have a good system—and it is my pleasure to work with them in preventing injuries to their collectors.

YOU HAVE TO GIVE TO GET

By GERALD L. HUGHES
Safety Officer, Philadelphia Police Dept., Philadelphia, Pa.

The sentiment expressed in the title of this paper has been re-phrased many times over the years as far back as the Bible, which states, "As you sow, so shall you reap."

It is virtually impossible for three men now on the Public Employee Section representing police to do the tremendous job which is necessary to attain safety for the policeman. This requires the combined efforts of each and every one of us as well as all of the expert opinions and advice that we can get.

Many letters from police departments all over the country have been received by the National Safety Council in recent years, and you can imagine my embarrassment when I read the note in reply to one. This statement, and I quote, "From a perusal of police reports of almost every sector in the United States, I cannot come up with one successful story." In fact, I still do not have a model safety program for the police department. In short, we are years behind the times in providing safety for the police officer. This is not a reflection on the National Safety Council, but it is a true reflection of our lack of care and attention in fulfilling our part of the job. No solutions for a problem are possible without defining the problem. We have neither given the problems to National Safety Council, nor any facts to establish that we have a problem. The statistics and records which I have reviewed in the last three years are terrifying when looked upon from a statistical standpoint. If you cannot or will not join with us, please at least take back to your chief of police and city officials that reports must be submitted if they ever expect to get answers to their problems. We have to give to get.

We have talked for the last several years of organizing a police division so that we could more adequately express our needs and receive expert advice to aid in their solutions. We are indeed fortunate that we can receive this through the National Safety Council. However, I think it should be made clear that we each should understand the responsibilities in attaining our objective.

I would call your attention to an excerpt from the policy statement issued by the National Safety Council and approved by their Board of Directors: "Its overall function is to deal with the accident problem of America. The specific ranges of its field of advice is determined by the enormous toll of life, limb, and property taken each year by accidents on the farms, on the highways, and in the homes, school, work places, and transportation systems of our nation."

In dealing with the whole problem, the National Safety Council concerns itself, through study of the record and through research, with the initial facts of accident incidence, and seeks to establish the ascertainable cause and practical measure of prevention.

At this time, I am proud to announce that the National Safety Council has received a substantial grant for the development and evaluation of an occupational safety program for municipal police. Committees have been named and the study is now underway; reports should be available in the near future. This brings us back to the title of this presentation, "You Have To Give To Get." The lack of response to our request for statistics from you and me has been a tremendous handicap to the Council in securing this grant. All of us must share this responsibility. The National Safety Council is helpless unless we all send in our reports, including the results of our experiences and the methods we have used to successfully curtail the rising accident frequency.

If we expect the National Safety Council to do this job and attain the standards they have set, we must furnish the fuel to keep the fire going. How much better the end results would have been had we quit talking and started acting several years ago is a moot question. However, it is not too late. We can and will organize. We have reached the point of weeding out the talkers and gripers, and putting the doers to work. We, in order to do the job, need regional representatives and many committeemen. Although the present grant is for the municipal police, the organization must not only look at present needs but at all future needs. My organizational proposal would be to roughly divide the Police into four categories: municipal; county and state; federal; and security.

With adequate personnel in each of these sections, a division could be formed to channel our efforts directly through the Public Employee's Section to the National Safety Council, and would open the lines of communication and give enough information and statistics to the National Safety Council so that they in turn, could give us the necessary tools to do a proper job for our policemen.

We welcome as members of this committee representatives of the Police Chief's Association and any police fraternal organization or security organization, stressing the fact that we have but one objective—safety for the policeman.

In summation, our number one need is a Division of Police, composed of policemen, as a general committee to help gather information and data and see that this is forwarded through proper channels so that we, in turn, can receive the guidance and help which we need and which the National Safety Council has so generously offered. This is not a prestige job but one that requires a moderate amount of time and dedication to an objective. We all have to give to get.

I would like to finish with a story told to me years ago about an old country preacher who went to various churches, his only renumeration being what was put in the collection box. Being wise, before he went to the pulpit to preach, he always put a half-dollar into the box. This Sunday in particular, he had taken his young son along for the services. After the sermon, he went to the front door to shake hands with the congregation and to slow up the procession going by the collection plate, so that everyone had adequate time to contribute. After all the people had gone, he and his son went up and picked up the collection plate; to his dismay, there was nothing in the plate except his original half-dollar. His son looked at his dad, shook his head, and said, "Pop, if you had put more in, you would have gotten more out."

If you are willing to put more in, I'll guarantee you'll get more out.

FIREARM SAFETY

By SGT. RAYMOND A. KING
Chicago Police Dept.

Police officers are authorized to carry revolvers to insure that they have the best means of protecting themselves from death or serious bodily harm while performing their duties as law enforcement officers. What an officer may do for his own protection or defense he is required to do for others, be they a citizen, a fellow officer, or a prisoner.

As added protection the Chicago Police Department makes available other weapons. A police officer may never have an occasion during his entire police career to fire a weapon in the performance of his duty, except on the range. On the other hand, there are those who have found it necessary to use a weapon more than once. It is not necessary for a police officer to be a gunsmith to become efficient in handling and firing any weapon. He must however, be aware of a weapon's capabilities, its working parts, its operation, and its dangers.

These dangers include those to himself and to others. Fear of a particular weapon will only lead to disaster if the fearful person attempts to use the weapon. Overconfidence as to the particular knowledge of the weapon with an oblivious attitude toward its dangers can also lead to disaster.

Police officers must make split second decisions in the course of their daily duties. Critics of these decisions have more time to weigh the problems and have the added advantage of knowing how the situation turned out. This hindsight is not available to the police officer at the time the decision must be made. Probably the most important decision an officer will be called on to make is that of when to shoot. A death or serious injury resulting from a gunshot can affect many people. The failure of an officer to shoot could result in death or serious injury to himself or other citizens. The danger to innocent bystanders complicates an officer's decision of when or whether to shoot. This decision in most instances is one that only the individual officer can make.

The use of deadly force by police officers is authorized and regulated by statute. Such force, known under the statutes of the State of Illinois as "force likely to cause death or great bodily harm," includes the firing of a firearm in the direction of the person to be arrested, even though no intent exists to kill or inflict great bodily harm, and the firing of a firearm at a vehicle in which the person to be arrested is riding.

The statute provides that a police officer may use a firearm in certain instances:

1. To defend himself from death or great bodily harm. In such instances, not only is the officer protected by state statute but the right of self-defense is also guaranteed by the Constitution of the United States.

2. To defend another person from death or great bodily harm. This is also a function of a law enforcement officer.

3. To effect a lawful arrest if the arrest is being resisted by a forcible felon to such a degree that it makes it necessary for the officer to do so.

4. To effect any lawful arrest if the arrest is being resisted to such a degree that it becomes necessary for the officer to do so regardless of the offense if the prisoner is attempting to escape by use of a deadly weapon.

5. To effect any lawful arrest if the arrest is being resisted to such a degree that it becomes necessary for the officer to do so regardless of the offense if the prisoner indicates that he will endanger human life or inflict great bodily harm unless the arrest is made without delay.

The key words in the language of the law are "when it is reasonably believed." Again, you are reminded that in making the decision of when to shoot (the use of force is likely to cause death or great bodily harm) all aspects of the "reasonable belief" must be weighed. Naturally, in the reasonable belief that when the use of such force is necessary to prevent death or great bodily harm to yourself or another there is only one element. In other instances, however, other elements must be taken into consideration. Also, you must use every possible means at your disposal to make the arrest without using this deadly force.

Taking into consideration all the aspects of the state law with regard to the use of force likely to cause death or great bodily harm, the Department has added certain prohibitions:

1. Such force may not be used if there is a "likelihood" that it will inflict death or great bodily harm upon someone other than the person being arrested (an innocent third party). However, this rule does not apply if the officer or another party is in danger of death or great bodily harm. If it is a choice between the officer's life or safety from great bodily harm, and the likelihood of danger to a third party, the officer is entitled to use the force which the law allows, including deadly force.

2. Firearms should not be used whenever there is a danger that their use would outweigh the police purpose to be served by such use. For example, do not use a firearm to prevent an escaping forcible felon if such endangers an innocent party, even if the felon is successful in his escape.

Be certain that you are not endangering other lives when you make that irrevocable decision to pull the trigger. The following practices are specifically forbidden by Department rule:

1. Firing into crowds.

2. Firing over the heads of crowds except on a specific order of a member of the Department above the rank of Captain.

3. Firing at a fleeing car except one in which a person who has attempted or committed a forcible felony is riding.

4. Firing warning shots in the case of individuals where the use of deadly force is not permitted (even when deadly force is permitted, warning shots will not be fired when they are likely to injure persons other than those against whom deadly force is authorized).

5. Firing into buildings or through doors when the person fired at is not clearly visible.

The practices as explained here are applicable to all types of firearms authorized for use of police officers by the Chicago Police Department, which includes:

1. The .38 caliber service revolver.
2. Aerosol tear gas weapon.
3. The 12-guage shotgun.
4. Sub-machine gun.
5. Rifle.
6. Carbine.
7. The 1½ caliber gas gun.

The service revolver and the aerosol tear gas weapon are required pieces of equipment for all officers. Ithaca 12-guage shotguns are part of the equipment on patrol and task force vehicles. Familiarization and practice with the shotgun is afforded each officer as part of in-service training. Periodic training is given each officer in the use of the revolver as part of the Department's firearms training program. Ranges are available for target practice with revolvers on a voluntary basis. Only personnel skilled in the proper use and handling of the submachine gun, rifle, carbine, or gas equipment are assigned to missions when such equipment is requested. The commanding officer of the area robbery unit is responsible for the security and control of these weapons in his area. The officer in charge at the scene of a criminal incident which requires the use of any of these heavy weapons contacts the Communications Center, gives a brief summary of the situation, and requests the type and numbers of weapons required. The Communications Center contacts the nearest detective robbery unit and describes the circumstances prompting the request. The commanding officer or the supervisor in charge of the detective area robbery unit dispatches members of his unit skilled in the proper use and handling of the weapons requested. Additional equipment or personnel are obtained by calling the detective robbery unit in adjacent areas. The Office of the Deputy Superintendent for Field Services and the watch commander of the district where the incident is occurring are also notified by the Communications Center. In civil disturbance incidents, these heavy weapons can be used only with the approval of the Deputy Superintendent for Field Services or other command personnel specifically designated by the Deputy Superintendent.

While on duty, a member of the Department will not arm himself with a shotgun, rifle, machine gun, gas gun, or chemical projector or similar devices which are not Department-owned.

Safety is the primary factor stressed in all training sessions relative to the use of any of the Department's weapons. Safety in handling, safety in its use, safety to the

user, safety to others, safety in cleaning, safety in all aspects of weaponry can never be overstressed. Other training media of the Chicago Police Department, such as the weekly training bulletins and the 35 mm sight/sound presentations, in all material pertaining to weapons stress safety. Safety was a prime factor in the Department's recent regulation prohibiting the use of semi-automatic or automatic pistols, derringers, and derringer-like weapons either on or off duty. The numerous accidents and injuries resulting from the use of these weapons prompted this regulation.

Generally speaking, the following are some of the more basic rules of safety when handling firearms:

1. Never place your finger on the trigger guard unless you intend to pull the trigger.

2. Never point a gun at anyone, unless you intend to shoot.

3. Avoid dry firing in the presence of others, except under the supervision of an instructor.

4. Never leave a loaded gun where someone else may pick it up.

5. Avoid cleaning the gun in the presence of others.

6. Before cleaning check and recheck the weapon to make sure that all cartridges are removed.

7. Never frighten anyone with a gun.

As a police officer, you should never draw or needlessly display your service revolver except for inspection or when circumstances indicate it is necessary. Never assume that a firearm you are handling is unloaded. Check it thoroughly yourself. Even if it is given to you by a fellow officer who insists it is unloaded, make sure it is. There are untold instances where persons were accidentally shot with a so-called "unloaded" weapon.

Weapons used by police officers are for defensive purposes only. You must never forget the fact that the community arms you to defend yourself and others in your company against the people of the underworld. These weapons are not for aggression. However, because an adversary can make up his mind to kill without warning or provocation, and you must wait for some overt act to indicate you are in danger, you must nevertheless be alert for such an act and be prepared for counter-action. Situations which will not necessarily warrant immediate shooting by you can warrant your drawing a revolver or the removal of the shotgun from the squad car.

All firearms are lethal weapons. You must be extremely careful at all times to guard against accidents involving bystanders and fellow-officers as well as yourself. Most officers, in handling their service revolver, are aware of the dangers and handle it only to fire it or clean it. However, other weapons of the Department arsenal usually have to be loaded and unloaded prior to and after use. When loading, unloading, or carrying these weapons, the muzzle must always be pointed straight up. Designated locations have been provided within the district station area for the loading and unloading of the shotgun to minimize any accidents.

There should absolutely be no reason for carrying a shotgun in a squad car mount with a live round in the firing chamber. This is a most dangerous practice. When beginning a relief make certain that the shotgun in the car is not loaded.

Keep in mind that the shotgun has a distinct psychological effect on persons who believe it may be used against them. This psychological effect can be used to great advantage without the need for the actual firing of the weapon. However, never use it to frighten people. Never point it at anyone unless the person is a criminal suspect or the circumstances so warrant: to defend your life or the life of another. Before actually firing the shotgun consider the following factors:

1. The distance between you and the subject.

2. The probable shot spread.

3. The proximity of innocent persons.

4. The type of construction and possible occupancy of the buildings in range behind the suspect.

You must bear in mind at all times that the shotgun has been placed in squad cars to enhance your chances of defending yourself and the lives of others. This privilege must be protected through the use and handling in a safe and professional manner.

Firearm Use Report

Any officer of the Chicago Police Department who discharges any weapon, including the aerosol gas weapon, except in the course of firearms practice, skeet shooting, hunting, etc. is required to make an oral report immediately to the desk sergeant in the district in which the incident occurred. In addition, he must submit a written report to his commanding officer without any unnecessary delay. To facilitate such reporting, the Firearms Use Report was designed. This report is prepared in triplicate—the original to the Inspection Division, the duplicate to the district or unit of the officer involved in the shooting, and the third copy to the district in which the shooting incident occurred. If for any reason the officer responsible for the firing of the weapon is unable to complete the Firearms Use Report, it is the responsibility of that officer's immediate supervisor to submit this report.

You must submit a Firearms Use Report any time you discharge a firearm. This applies whether on duty or off duty. It applies whether the weapon discharged is your own weapon (regulation or otherwise) or is part of the Department's arsenal. It applies whether the discharge of the weapon is on your own or ordered by a superior officer. And it applies to all weapons in the Department's arsenal, including the gas gun and gas grenades.

Conclusion

Bear in mind that the firing of a weapon in the performance of duty carries with it many responsibilities. There is the responsibility of conscience as well as that to your superiors and to the law. Morally, the matter is yours alone. However, your conduct as a police officer will be judged by your superiors. Your conduct legally may even be judged by the courts. Learn what you have a right to do and what is forbidden under the law. When an emergency arises there is no time for deliberation. If you possess a thorough knowledge as to your rights and duties, you will be better equipped to make a quick and right decision.

The policy of the Chicago Police Department briefly stated is as follows: "The decision to resort to the use of firearms should be made only on the basis of the most carefully considered judgment. Under no circumstances should firearms be used until all other measures for controlling a situation have been exhausted. This decision must be based on applicable laws relating to the use of force likely to cause death or great bodily harm and upon a realistic evaluation of the existing situation. Consideration must also be given to the protection of the officer's own life, the lives of fellow officers, and the protection of innocent citizens."

POLICE SAFETY EQUIPMENT

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To those who have been in law enforcement for several years, it is obvious that the profession is more hazardous than it was a few years ago. Today, one needs only to watch television or read the newspaper to see danger to enforcement personnel personified in acts of civil disobedience, riots, and individual shootings.

Since 1960, the National Crime Rate has almost doubled, and this has brought an accompanying risk to the law enforcement officer. His chances of being killed or assaulted are greater than ever before. This risk recently became shockingly evident to the officers of the California Highway Patrol when four members were killed on April 5, 1970, in a gun battle north of Los Angeles.

The killing or injuring of a fellow law officer by the criminal element is always cause for personal anguish to those within the fold. We are especially alarmed when an officer is killed or injured by the criminal element; but although not as shocking to us and not as sensational, everyday accidents experienced by law enforcement officers are just as painful and far more frequent.

Nationally, from 1961 through 1969, there were 345 law enforcement officers accidentally killed. These were accidents where no criminal element was involved. Automobile accidents were by far the most common cause of death. There were 184 officers killed in automobile accidents and 72 killed in motorcycle accidents. While directing traffic

at accident scenes, 36 were killed. Other deaths were attributed to firearms, drownings, and various other types of noncriminal occupational accidents—a tragic end to a police career. Accompanying these accidents were a wide variety of injuries and disabilities.[1]

Administrative involvement in occupational safety needs to be guaranteed by a definite safety program. The California Highway Patrol has set forth their safety program in a General Order. This directive sets forth policy, command responsibility, and composition of the safety program within the Department. It is felt that this program has brought about more involvement and uniformity in our accident reduction efforts.

With administrative attention focused on the problem of occupational safety, much can be done in safety training and equipment to reduce the destructive consequences of an inherently dangerous occupation. Recognition of these two areas of administrative responsibility is the first step in developing an occupational safety program and, hopefully, attaining lower death and injury rates.

Although safety equipment and safety training are inseparable segments of a safety program, the main concern of this paper is with police items that directly or indirectly involve safety of law enforcement personnel. Although safety equipment does not offer a panacea, there have been many developments deserving attention and consideration. Just how far law enforcement has progressed and how far it has to go in developing and adopting sufficient safety apparatus is a moot question, but one that should be constantly considered by all law enforcement personnel.

Items presented in this paper are not necessarily recommended for adoption nor are those devices excluded necessarily rejected. The purpose of this paper is presentation only, in hopes of arousing interest in the area of equipment development, testing, and evaluation. Evaluation of these items should be based on further research relative to individual departmental needs and policies.

Personnel Equipment

Uniforms

The uniform is a traditional part of police equipment. It serves to identify the officer as a member of a law enforcement agency to individuals who want police assistance and protection and to those who want to avoid him. Although usually designed to accentuate the man; i.e., to make him look larger and taller, the uniform provides little in the way of safety design. In too many instances it does little more than provide a target for violent action. In other instances, when visibility is of utmost importance, such as when directing traffic, the uniform blends into background color and shadow.

Experience has taught lessons, and some practical changes have been made. The breakaway tie and breakaway Sam Brown strap have been two such experimental changes; but a really practical safety-oriented uniform has not been developed. The problem lies in developing a uniform practical for the diversity of duties performed by law enforcement officers. From giving a safety talk in the morning, an officer may be called to riot duty in the afternoon—from directing traffic at night, an officer may suddenly find himself searching for a burglar in a darkened building. Because of this complexity of duties, a universal safety-oriented uniform is a difficult item to develop. A partial answer may lie in attachable safety items, such as reflective vests and belts, but perhaps a better answer is in the improvement of uniform design and specialized uniforms.

Firearms and Cartridge Cases

The Colt and Smith and Wesson .38 and .357 caliber revolvers are still the mainstay of law enforcement firepower. The safety features inherent in the revolver have made it a preferred weapon over the years, but safety features and advantages of the newer automatics have persuaded a few departments to allow their use. Quick firepower and reloading ability have long been recognized advantages of the automatic, but recent double-action innovations and firing pin designs have added safety features not before available. This has added impetus to their consideration as a police weapon.

One of the drawbacks to the revolver has been reloading time, but quick loading devices for revolvers have been developed which will save reloading seconds—seconds that may save an officer's life. One such device is the Multi-Loader. The shells are affixed in a cylindrical fashion by means of a rubber grommet. They can be extracted from a specially-designed belt pouch and inserted into the cylinder in approximately two or three seconds.

The police shotgun is the second most useful firearm of the modern police force. Its awesome firepower makes it one of the most deadly weapons in the police arsenal, but one of the problems has been the ready availability of extra shotgun ammunition. One solution is a canvas shell pouch slipped onto the stock of the shotgun thereby affording the officer immediate access to extra ammunition. These shotgun ammunition pouches are available through army surplus at relatively little cost.[2]

The number 00 shotgun load, nine .33 caliber pellets, is a favorite load for the police riot shotgun because of its penetration power and range. One drawback, however, is the increasing gaps within the pattern as distance to the target increases. For instance, at fifty yards, it is possible to completely miss a man within the pattern. With this in mind, the highway patrol recently tested number 1 and 4 loads for denseness of shot pattern and depth of penetration. The number 1 load offers 20 pellets of .30 caliber; the number 4 load offers 27 pellets of .24 caliber. In test firings from seven to 40 yards, it was found, as expected, that the patterns were denser than number 00 buckshot. Surprisingly, however, penetration of the number 1 load was about the same as number 00, and penetration of the number 4 load was less only at the greater distances. Although no conclusions have been reached as to the practicality of using the smaller size loads, they are certainly worthy of consideration and further testing.[3]

A new type of shotgun shell has been developed which may add to the use of the shotgun as a nonlethal weapon. The shell contains polyethylene plastic pellets which give a modified impact, thereby offering a broader use potential. According to sales brochures, the pellets will not penetrate a newspaper at 20 to 25 yards, yet will offer a deterrent impact at three to 15 yards. At a distance of one yard, the impact is supposed to be equivalent to a 210 grain .41 magnum caliber lead bullet.[4]

Holsters

Holster design is important to the safety of the officer. The two basic holster designs are the open-draw type and closed or clamshell. Each offers distinct advantages, and the controversy of which is best will probably continue for some time. The California Highway Patrol banned the purchase of clamshell type holsters in 1962. Although there were few accidents involving clamshell holsters, there were enough to warrant concern.

The clamshell type holster was ideal for the "quick-draw" advocate, and there were a few accidents of this type, but the causative factor in many of the accidents was the trigger being accidentally placed behind the trigger guard instead of in front. In this position, pressure on the butt of the weapon caused the weapon to fire. One such incident happened when the revolver butt became entangled in the seat belt of the patrol car; another was when the butt of the weapon dragged on a restaurant stool as the officer was turning.[5]

However, open-draw type holsters have their drawbacks. With the use of the draw-type swivel holsters, there were reports of weapons falling from the holster. Most of these losses were in the vehicle, the weapon having been found lying on the seat, but officers have also lost their weapons during attempts to subdue combative subjects.

Recently, an officer's gun unknowingly dropped from his draw-type swivel holster while he was subduing a subject in the parking lot of a bar. As the officer got to his feet from the ground where he had handcuffed his combatant, he noticed a friend of the subject reach to the ground and pick up something. This friend of the arrested party walked over and handed the officer his gun with these words, "Here, you better take this before I decide to use it."

A new front-draw holster offers several safety advantages over more conventional holsters. The holster protects the weapon almost completely, and added security is realized because of its design. The weapon cannot be cocked while in the holster and will not fall out of the holster from body movement even with the safety strap unfastened. The holster rides high and close to the body and will not flop around when walking or running; and in the car, the holster does not interfere with seat belts. Drawing the weapon can be accomplished by the wearer from almost any position, including sitting with the seat belt on; but because drawing requires a downward and forward motion, the weapon cannot be jerked out from behind.[6]

Restraining Devices

A recent eight-year Federal Bureau of Investigation study indicated that of 411 policemen killed by felons, most were killed during arrest or prisoner transportation. It is probable that adequate restraint would have saved many of these officers' lives. Handcuffs, although reassuring, are not foolproof. Handcuffs have been picked or unlocked by hairpins, paper clips, and wires, and recently a jewelry box key was found that would unlock several brands of handcuffs.[7]

There has been little change in the design of handcuffs. Although there is room for improvement, they are still the most practical, safe, and effective manner of temporary restraint. However, multiple arrests have long been a problem for the officer with one set of handcuffs, and civil unrest has added to the frequency of multiple arrests. Therefore, additional restraining devices are needed.

Nylon restraining ties offer a lightweight, inexpensive, and effective means of temporary restraint. They can be easily carried and used in addition to the handcuffs, e.g., to bind the feet, or they can be used effectively when several arrests are made. The ties consist of a nylon strip with an eye at one end and a serrated tip at the other end. When the tip is inserted through the eye, it locks into place and will not unlock. It must be removed by cutting. This feature is a slight drawback in that they can be used only once, but since they are inexpensive, replacement can be easily obtained.

The F.B.I. has tested these ties and found the following specifications to be the most effective: Color—milky white; material—nylon; locking barb—stainless steel; length—22 inches; width—$\frac{5}{8}$ inch; weight—$\frac{1}{4}$ ounce; diameter—$\frac{1}{2}$ to six inches; strength—300 pounds minimum. The most effective method of restraint utilized two ties interlaced, binding the subject's wrists back to back. One tie is effective if the wrists or arms are crossed.[8]

Police Baton

The police baton, long a symbol of police authority, is still a key instrument of police effectiveness in safely moving and controlling crowds, effecting arrests, and protecting the officer. The public accepts the use of this weapon when it is necessary and used in a professional manner, despite distortions projected occasionally by the news media. Although the design has remained fairly constant, additional training has added to its potential as a safety device. Approximately 14 per cent of the injuries sustained by California Highway Patrolmen in 1969 were as a result of assaults or individuals resisting arrest. It is probable that the percentage would have been higher had not the baton been used effectively in many instances.[9]

The commonly used baton is approximately 22 to 26 inches long, but can vary from 10 to 36 inches or more. The San Francisco Police Department has adopted the use of two different length batons, a 25-inch baton for regular duty and a 36-inch baton for riot duty. In addition, their tactical unit uses a 38-inch curved baton. The main advantage of the long batons is in their psychological value and the fact that the officer doesn't have to be close to a rioter or arrestee to be effective. In using the longer baton, training is of the utmost importance, because this baton is not conducive to one-handed use. However, with proper training this actually is an advantage because it forces two-handed use of the baton which is safer, more effective, and not as obvious.[10]

With the adoption of longer batons, the carrying of this item of equipment in patrol vehicles becomes a potential hazard. Lying loose in the seat or on the floorboard, batons can become a deadly missile even during a minor accident. Stuck in the seat between the back and seat cushions, they present a point for impalement. Records indicate an officer on routine patrol jammed his 24-inch baton between the seat cushion of the back seat, which left the point of the baton angled toward the front seat at approximately 45 degrees. During his tour of duty, the patrol car was struck solidly in the rear, and the front seat broke, pivoting backward. The baton point penetrated the front seat cushion and struck the officer, breaking two of his ribs.[11]

Although there is no one best way of carrying the long batons, securement of the baton is of utmost importance. Several departments are using sewn or snap loops which secure the baton to the door panels or rear of the front seat, but still leave them readily available. Seat covers are also available commercially which have built-in loops and pockets to secure the miscellaneous

paraphernalia normally carried by law enforcement officers.[12]

Communications

In police work, good communication is extremely important to the safety of the officer. There are many times when "back-up" or emergency aid is needed and needed quickly. The officer has, in the past, been tied to his car radio, but recent developments in the communications field allow the officer to call for assistance, e.g., an ambulance or additional officers, using the vehicle radio as a repeater station or system. Basically, a hand-held, low powered radio unit actuates the higher powered mobile radio in the patrol vehicle. The vehicle radio, operating as a repeater, strengthens the signal and transmits the signal as if the sender were talking from the vehicle. This enables an officer to transmit up to approximately ½-mile from his patrol vehicle. The return signal from the dispatcher or other mobile unit is received directly by the hand-held radio unit. Models are also available which contain a "follow-up" and "panic" button, which will signal the dispatcher silently of an officer's need. The unit will also remotely activate the patrol vehicle's red light and/or siren, serving as a deterrent until help arrives.[13]

Another recent improvement which increases police effectiveness and officer safety is the digital communications system interfaced with electronic display centers. This type system allows automatic computer questioning and switching, and semi-automatic car locator systems which improve officer safety through reduction of turnaround time on vehicle and subject checks, and other requested information. They also offer automatic recording of officer locations and duty status, which enhances supervisory control and provides a ready reference for emergency assistance to all officers. Such a system has been used by the San Francisco Police Department for several months; the Oakland Police Department is considering the installation of a similar system. San Francisco Police Department tested digital communications under a Law Enforcement Assistance Administration grant. The project report concluded that digital communications devices can ". . . provide additional security to field personnel."

In San Francisco a multiple modular communications system is used which makes use of digital communications as a media to supply officer location and other information to a computer. This computer switches encoded messages from the patrol vehicle digital unit to a variety of terminals and other computer systems, including P.I.N. (Police Information Network), C.L.E.T.S. (California Law Enforcement Telecommunications System), California's AUTO-STATIS (Automatic Statewide Auto Theft Inquiry System), and N.C.I.C. (National Crime Information Center). All digital communication is recorded as to type, frequency of occurrence, time of day and location; also the retrieval of information is faster, command and control of car deployment is more efficient, and response time to officer emergencies is decreased.[14]

Patrol Vehicles and Auxiliary Equipment

To law enforcement personnel, the patrol vehicle is not just a mode of transportation. It also serves as office, storehouse, and temporary jail. Therefore, it isn't surprising that accident rates in and around the automobile are higher for law enforcement than for most occupational groups.

The national average in 1968 was 18.88 automobile accidents per million miles traveled for law enforcement, compared to 14.46 automobile accidents per million miles traveled for all other occupational groups. Through a concerted safety effort, our own Department's accident rate has been lower over the last few years. In January 1968, our average accident rate was 12.29 accidents per million miles; in January 1969, it was 9.71; and in January 1970, it was 8.32 per million miles. The accident rate has declined monthly to a low of 7.5 accidents per million miles traveled in June of this year.[15]

Aside from vehicle accidents, strains and mashed fingers are also common injuries for law enforcement personnel in and around the patrol vehicle. Typical is the following narration: "I had my red light and siren displayed toward the 23102(a) (drunk driver's) vehicle. Subject was making furtive movements and took a long time in stopping. My partner exited on the right side, and I exited on the left. While getting out, I slammed the door on my right thumb. I was using the doorpost for support."[16]

To assist in reducing accidents in and around the patrol vehicle, departmental speci-

fications should require that patrol vehicles be designed or equipped to serve law enforcement safety. Besides the normal emergency adaptations, specifications should require disc brakes on the front, heavy-duty suspension, and stabilizer bars. For high-speed operation, certified high-speed tires should be required, and larger size wheels should be considered. Roof-mounted lights should be mounted so they don't collapse the roof upon roll-over, and built-in roll bars should be considered to prevent such hazards.

Within the patrol vehicle the police officer should be secured with adequate seat belts. This is a well-recognized fact, but often forgotten is the securement of flares, batons, and other equipment carried within the patrol car. Lying loose, they become deadly missiles during an accident, and a definite danger to the police officer. To prevent this, all loose equipment should be secured. Utility boxes can easily be built to accomplish this and seat covers with pockets are also available for this purpose.

Sniper-proofing our vehicles is a concept we may also have to consider. Recently, an officer of the Sacramento Police Department was on routine patrol in the Oak Park area of Sacramento. Without warning, a sniper opened fire on the officer with a .30 caliber carbine rifle from the roof of a building. The first shot shattered the windshield and lodged in the dashboard; the second shot went through the roof of the patrol car and hit the confinement (cage) screen, splintering the bullet. A fragment entered the head of the officer causing severe brain damage, and the officer died four days later. The subject was apprehended and is awaiting trial at this time.[17] Similar incidents have been happening in many of our large cities. Deciding what to do in protecting our officers is a difficult project.

After the four California Highway Patrol officers were killed, an elderly, retired nurse wrote our Department offering to donate part of her monthly $89 retirement check to help equip the patrol cars with bulletproof glass. Her offer was declined, naturally, but it was gratifying that she was so concerned with the safety of our officers. Her idea is not new. The concept of bulletproof glass has been previously considered by many departments and turned down; but in the past, sniping at police officers was not as prevalent as it seems to be today. Although bulletproof glass may not be the answer, departments may have to consider some type of vehicle armor if sniping and ambushes continue.

All patrol vehicles should be equipped with a portable fire extinguisher, and small fire extinguishers suitable for on the line riot duty should be considered. With the number of fire bombings law enforcement and private establishments have already experienced, and with the expectation of more attacks, the fire extinguisher is even more important to officer safety.

The California Highway Patrol is currently using a dry chemical Class B and C fire extinguisher. Although this type is generally satisfactory, we are currently testing a dry chemical unit which is designed to extinguish Class A, B, and C fires. If this type is found satisfactory, it will give the officer one more safety advantage which they need.

On June 30, 1968, during riots at Berkeley, two California Highway Patrol Officers experienced the pain and suffering of a fire bomb. While standing in a line formation on the University of California Berkeley campus, a fire bomb containing oil and gasoline was thrown from behind them, bursting at their feet. Burning liquid was splashed on their legs, and they were severely burned from the knees to the ankles. Extensive skin grafting was required, and one officer was subsequently medically retired.[18]

If prisoners are transported in patrol cars, screens and shields are advisable and useful for prisoner confinement. They can be installed to provide not only prisoner confinement but also serve as a roll bar. However, screens and shields should never replace proper searching and handcuffing procedures. Our records indicate a case wherein a Mexican national was stopped by the border patrol in the Oceanside area of California. The subject was intoxicated and was turned over to the highway patrol for processing and booking on a drunk driving charge. Somehow, the subject managed to hide a .25 caliber automatic in his shorts. The highway patrol officer took the subject from the border patrol and frisked him, removing a pocketknife from his pocket, but the .25 caliber automatic was not found. As it was a considerable distance to the county jail, the patrol officer turned the subject over to another officer driving a cage car. The prisoner, at this time, was docile and appeared to be asleep. The prisoner was placed in the cage car unhandcuffed. On the way to the jail the prisoner, who had apparently been waiting for the appropriate opportunity and darkness, suddenly came to life and fired three shots, two of them into the back of the officer's head and one into his right eye as he apparently turned to see what was happening.

Another item that should be considered as an accessory to the patrol vehicle is the pushbumper. The California Highway Patrol and other law enforcement organizations have installed these bumpers, and their use has added to the versatility of the patrol vehicle. They are primarily used to clear roadways of stalled or wrecked vehicles. This aids in the prevention of multiple vehicle accidents, and removal of hazards can be accomplished without back strain or dented vehicle grills.

Specialized Equipment

Riot Uniforms

Riots and civil disobedience require specialized equipment for officer safety. Garbed in the latest riot protection gear, the modern well-dressed riot officer with helmet, face shield, padded jumpsuit, armored vest, shin guards, boots, and with shield and baton in hand, may resemble a knight of King Arthur's vintage. It is in this area, however, that new safety equipment is most prevalent, and new products are daily being introduced.

Most departments are using the traditional uniform during riot situations; but some departments have gone to a specialized uniform. One such department is the Los Angeles Sheriff's Department, which has adopted a coverall type jumpsuit for their plainclothes officers and specialized personnel. Members of the Emergency Service Bureau and Aero Bureau wear the jumpsuit full time; other members keep the coveralls available and can easily become an adjunct to uniformed patrol personnel at riot and other emergency scenes.[19]

There needs to be new innovations by uniform manufacturers and law enforcement agencies and a long inquiring look at uniform tradition. For riot duty, there are new flameproof fabrics available. One such fabric is available in a one-piece uniform for approximately $45. Riot uniforms should incorporate a concept of protection to the wearer from those hazardous conditions and dangerous objects he is likely to encounter during a riotous situation. The traditional uniform does not offer this protection. Most departments do not want their men looking like combat soldiers; however, safety of the individual should be a main concern, and the uniform should not be overlooked as a safety item.[20]

Headgear

Protective headgear has long been recognized as safety equipment in industry, but it has only been within the last few years that law enforcement agencies in the United States have adopted their use for other than motorcycle duty. Recent adoption grew primarily out of the riotous situations and the increasing number of attacks on police personnel.

A 1968 Motorcycle Study of statewide motorcycle accidents by the California Highway Patrol found that ". . . among the surveyed motorcyclists wearing a helmet, 14 per cent suffered head injuries as compared to 31 per cent among those not wearing a helmet." California Highway Patrol personnel assigned to motorcycles in 1969 experienced 168 accidents, yet only two per cent of these officers received head injuries.[21]

In the recent riots and civil disturbances in California, head injuries were minimal as a type of injury to California Highway Patrol personnel; this indicates that proper headgear is definitely an essential safety item.

A few years ago, an Oceanside (California) police officer stopped a station wagon containing two males in the front seat and one male and two women in the back seat, with four children in the rear deck portion of the station wagon. Not satisfied with the registration of the vehicle, the officer returned to his patrol car radio to see if the vehicle had been reported stolen and to check on the registration.

While the officer was sitting in the patrol car waiting for his requested information, two of the male occupants got out of the station wagon and came up on the right side of the patrol car. The subjects initially were mild mannered and very polite, but suddenly, and without warning, one subject hit the officer over the head with a meat cleaver. His

protective helmet took the blow without rupturing, but the officer recalls that he felt the blow down to his toes. The other subject pinned the officer in the car seat, and the officer was unable to draw his weapon. The officer had the radio mike operating and managed to blurt that he was being attacked.

The subject with the meat cleaver continued his attack on the officer, and the officer's helmet sustained major damage and eventually fell off the officer's head. The other subject grabbed the meat cleaver and continued raining blows on the officer's face and back of his neck. In trying to ward off the blows, one of the officer's fingers was completely hacked off and another left hanging only by the skin.

The officer was struck 18 times; 13 of the blows, if delivered at just a little different angle or depth, would have been fatal. The officer's helmet certainly contributed to saving his life, for he sustained no blow which caused brain damage, even though he was continually beaten about the head.[22]

Gas Masks and Tear Gas Equipment

The World War II type gas masks have generally been found ineffective for police use. The newer Army and Navy types are more satisfactory, with the M9A1 gas mask the most effective war surplus mask available. The M9A1, a military gas mask, features dual canisters with changeable filters rather than changeable canisters, and it is adaptable to a voice box, headset, and microphone.[23]

Even with the best gas mask equipment, safety of the officer depends to a large part on his proficiency and understanding of the gas mask used. Improper use of the tear gas or gas mask can quickly leave the officer a victim of his own weapon. The officer should understand the functions and limitations of the type of mask used and should be proficient in donning and securing the gas mask so that it will function properly. The officer should be aware of what he is protected against and not go beyond design limitations. Gas masks normally used by law enforcement protect against CN (regular tear gas), CS (irritant tear gas), and DM (sickening tear gas), but do not protect against low oxygen atmosphere; e.g., burning building, acid gases, organic vapors, or carbon monoxide.[24]

With the best of training, officers are still likely to feel the effects of tear gas either in a riot situation or during training. Many of us, I am sure, have been the victim of a shifting wind. A tear gas antidote has been developed for treatment of those affected by tear gas. It is available in an aerosol-pressured can and contains a mild antiseptic flushing material which provides instant relief from the effects of tear gas when sprayed on the affected area.[25]

Body Armor

Armored vests and other types of body armor are becoming more popular in the police field. Although there are no armored vests on the market which will stop all caliber weapons, they do offer varying amounts of protection depending on their size and weight. The California Highway Patrol recently tested a fiberglas flak jacket weighing approximately 12 pounds. From 15 yards, the jacket stopped all calibers tested up to a .41 magnum and 12 gauge shotgun slug. This does not mean, however, that weight of armor alone is acceptable as a criterion of protection. Design and construction are also extremely important, and each type and brand of armor should be tested to determine the individual degree of protection offered.[26]

Police armor should afford adequate mobility as well as protection. This may necessitate a compromise between size, weight, and the amount of protection desired, but if the armor fits well, heavier armor can be more comfortably worn. If it doesn't fit, even light armor may cause fatigue and chafing.

Because of the heat and fatigue factors of most flak jackets and armored vests, officers are often reluctant to wear them, and administrators are reluctant to require their use except in obviously dangerous situations. It is difficult to foresee a dangerous situation, however. During the recent Berkeley riots, one of the Highway Patrol Officers removed his flak jacket during an apparent lull and was subsequently struck and injured by a thrown knife. His flak jacket would have saved him from injury.

Iron and steel armor have long been used for protection, but for law enforcement purposes, the new bonded ceramic and plastic armor is more popular and practical. By the use of a very hard outer surface, this armor attempts to shatter the projectile before it penetrates. Armor made of fiber material is also popular mainly because of its light weight—some nylon armor weighs only 1.15 pounds per square foot. Ceramic armor is usually made of alumina, silicon carbide, or boron carbide. Being brittle, these materials are usually reinforced by fiber and plastic. With this combination of material, the ceramic-faced composite armor weight required for stopping a 7.62 mm armor piercing bullet fired at short range from a service rifle is about nine pounds per square foot, compared with thirteen pounds per square foot of dual hardness steel to achieve the same result.

There are armored shields also available which offer protection against thrown missiles and some protection against firearms. Construction material varies, as does weight and effectiveness; therefore, like the vests and jackets, each type shield should be independently tested.

All types of body armor, helmets, and shields are usually best constructed from hard-faced armor so that the projectile will be shattered or deflected upon impact. For body protection, the safety armor or articulated plates backed by soft armor are best so that the projectile will be absorbed without ricocheting or splintering. For eye and neck protection, clear polycarbonate-type plastic seems to be the best available.[27]

Nonlethal Handguns

Baton Gun

The baton gun is basically a 37 mm gas gun which fires a projectile containing five wooden pellets one-inch by one and one-half inches. Upon firing the projectile, the wooden pellets scatter rapidly. The intent is for the pellets to sting upon impact without penetration of the skin. They were recently used by the Berkeley Police Department during a riotous situation and were deemed very effective. No injuries or formal complaints were reported from the use of these wooden pellets.[28]

Bean Bag Gun

The bean bag gun is similar to the baton gun but uses a 14 mm army-issue rifle which fires a projectile containing two pieces of very stiff cloth sewn together and containing BB shot. When the projectile is fired, the compacted cloth comes out of the rifle spinning and spreads out so that it strikes the dissident in a flat position. The Berkeley Police Department has tested this weapon, using their own personnel, and found it effective and directional at fifty feet, but they have not used the weapon in actual front-line situations.[29]

Water Gun

The water gun requires a specially-built gun which has a barrel diameter of approximately two and one-half inches. The weapon fires ten-ounce bags of water. The Berkeley Police Department has also tested this weapon using their own personnel. They have found it effective but not as directional as the other weapons. They have not used this weapon in front-line situations either.[30]

Compressed Air-Powered Pistol

The San Joaquin County Sheriff's Office of Stockton, California, recently tested a compressed air-powered pistol. This weapon fires a stunning but nonlethal plastic cartridge, a "noise-confusion" explosive, and a marker dye or tear gas cartridge. The weapon is designed for an effective range of approximately 100 feet, but can be lofted to over 250 feet.[31]

Tranquilizer Dart Gun

From time to time there are questions raised as to why law enforcement officers don't use tranquilizing dart guns. This type of gun has been successfully used on wild animals for years. The tranquilizer dart is actually a hypodermic syringe which is fired by a long or short range CO^2 gas gun. The special hypodermic syringe contains a small .22 caliber charge that forces a rubber plunger to inject the tranquilizing drug upon contact. The two types of drugs mainly used are motor nerve or central nervous system blocking drugs, but tranquilizing barbiturates can also be used. Accuracy varies, but it is usually accurate and effective at 35 yards.

Tranquilizer guns are effective, but for law enforcement use the problem lies in the expertise and time required in preparing an injection. An officer would have to be a trained anesthetist. After deciding to fire at a specific subject, the drug would have to be measured according to estimated body weight; the dart would have to be prepared; the dart would have to be fired accurately; and the officer would have to wait three to five minutes before the drug would take effect. Also, in firing, vital areas of the sub-

ject, such as the lungs, intestinal walls, and brains, would have to be avoided as these areas can be seriously damaged by the .22 caliber discharge. Further experimentation may lead to a tranquilizing weapon for law enforcement use, but at this time, the use of the tranquilizer dart is impractical.[32]

Curdler

The curdler is an electronic device which is adaptable to a public address or other sound system. It emits a shrieking, shrill, blatting, pulsating, and penetrating sound. Although more powerful units are available, a common unit emits sound equal to 120 decibels at 30 feet. At this noise level, mob leaders can no longer incite the crowd and mob hypnosis is broken. The sound gives law enforcement a psychological advantage, and at close range the mob becomes more concerned with seeking shelter from the sound than attacking the police. Police personnel are easily protected by common ear protection devices.

A sound system utilizing the curdler device can also be used to issue commands and directions to police personnel and dissidents above the noise that surrounds a riot situation. The ability to project police commands and messages over crowd noise and over great distances gives police personnel mob control capabilities not before available and with less chance of direct police involvement and risk of potential injury.[33]

Police Lighting Equipment

There are several brands of high intensity lights on the market adaptable to patrol car and aircraft use. They have been used successfully in many facets of law enforcement work. In disturbance and search areas, they have been extremely effective in lighting the surroundings for the safety of the police and consternation of the criminal.

When one considers that 75 per cent of all crime in this country takes place during darkness, it is evident that good lighting equipment is essential to an officer's safety. One of the newest lights offers law enforcement effective illumination up to 4,000 feet or more, yet it weighs only four pounds, is easy to carry, and is fairly inexpensive. The unit can be operated from several different power sources including 12 and 115 volt systems, and in the patrol vehicle it can easily be plugged into the cigarette lighter. It has an intensity of over one million candlepower, which makes it a suitable light source for both color and infrared photography. The Beverly Hills Police Department has budgeted for purchase of several of these lights. Regarding prowler calls, Captain John F. Egger commented, "With just two lights, we would have a whole yard lighted up to provide visibility of anything that might be there."[34]

Portable Roadblock

Physical roadblocks are often effective in stopping fleeing vehicles, but dangerous to police personnel and damaging to police equipment. A device has recently been developed which may be a partial answer. The device is based on a principle similar to arresting cables on an aircraft carrier. It is primarily a net with energy absorbers attached to each end. It is small enough to fit in a car trunk but can be rigged into a barrier by two persons in approximately 45 seconds. The device can be rigged between two poles, a vehicle and pole, or two vehicles, and when properly rigged it will stop a vehicle at 80 miles per hour in 200 feet. In tests, damage to vehicles was light, and test drivers report the deceleration caused by the net was smooth but firm.[35]

The California Highway Patrol has not tested this device, and there are no plans at this time to do so. Preliminary consideration of the device for highway patrol use brings up questions of civil liability and practicality. With these questions still unanswered, we do not anticipate the use of such a device.

Conclusions

With appropriate training and equipment, officers will stand a better chance of performing their duties without injury or death. A policeman is lured into an ambush but saved by a light-weight armored vest; a firebomb is thrown, splashing burning gasoline over a police officer, but he comes through relatively unscathed because of his flameproof uniform and his personal fire extinguisher; a large destructive mob is being incited to riot, but the speaker is drowned out by a curdler unit as the area is lit by a high intensity light, and the dissidents are dispersed without injury; an officer radios for help, and his location is automatically determined and the nearest units dispatched to his aid with the assistance of a computer.

Some of the equipment offered on the market is controversial and inappropriate to the principles of a civilian law enforcement organization. Principles set forth by Sir Robert Peel around 1822 are still appropriate today and should be remembered when considering purchase and use of equipment. Basically, they can be summarized as follows:

> The police exist as an alternative to military occupation, and exist only with the approval of the public. Law enforcement agencies must secure willing cooperation and observance of law by the public to be effective and can do this only by being an impartial servant of the law and by offering service to the public without regard to race or social standing. Police personnel should use force only when persuasion, advice, and warnings fail and even then only to a minimum degree necessary. The test of law enforcement effectiveness is the absence of crime and disorder—not the visible evidence of police action.[36]

Law enforcement should become more actively concerned with the development of new equipment. Although personnel safety will not be solely attained by equipment, modern technology, if applied to law enforcement, can produce equipment which will enable accomplishment of the law enforcement task more effectively and safely. In *The Challenge of Crime in a Free Society*, the President's Crime Commission on Law Enforcement and the Administration of Justice, made the following comments: "In an age when many executives in government and industry . . . ask the scientific and technical community for independent suggestions . . . the legislators, police, prosecutors, lawyers, judges, and corrections officials have almost no communication with the scientific and technical community."[37]

Each department should continuously analyze, research, and evaluate their needs and go forth to the scientific community with their safety requirements. As was stated earlier, equipment per se does not offer a panacea, but with proper equipment, training, and a "safety-mindedness" permeating the profession, occupational injuries and accidents can be reduced while law and order continue to be maintained by highly skilled and properly equipped law enforcement officers.

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A WORKABLE SAFETY PROGRAM FOR POLICE

By CAPTAIN J. PAUL GILL
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Workable safety programs for police departments are workable only if understood, and the ground rules observed, by all departmental personnel. It is not enough that the chief administrator approve and establish a program; he must actively participate in it and show his belief in its value.

Careful planning and controlled implementation are essential elements of success, but many hours of effective traffic law enforcement can be destroyed by the spectacle of a damaged police vehicle, especially if the vehicle is kept in use. No reaction by the public is as swift and extreme as when a police vehicle is involved in an accident that causes serious injury or death. All of these hazards must be avoided with strong and effective controls. As clergymen are expected to avoid sin, police drivers are expected to avoid accidents.

The essential elements of a workable safety program are planning, organization, assignment of duties, training, implementation, and statistical follow-up review and corrective actions.

Planning

Detailed statistical gathering at the beginning to define needs and determine training required is the essential first step. This information should include, but not be limited to:

1. The amount of time allotted to recruit driver training.

2. The content of these training programs within the department.

3. Information on situations underlying police accidents.

4. Type of accident reports used.

5. The various disciplinary practices currently in use to determine preventable accidents, action taken in these preventable accidents, and the positive disciplinary practices in use to encourage safer operation of these vehicles.

All too few departments across the country are realistically seeking programs to reduce police traffic accidents. The trend seems to be one of thinking that by virtue of becoming a police officer, the individual has suddenly transcended all human virtues and becomes, among other things, a police pursuit driver. The fallacy of believing most police accidents are inherent in the nature of the work no longer can be recognized. A recent study of 135 accidents involving police vehicles indicates that 72 per cent of the accidents took place under good weather conditions and not under emergency or pursuit conditions.

Organization

Effective police safety programs must be organized. All personnel must first be made aware of and believe in the need for accident prevention. Early training of all personnel to accept this responsibility as a normal requirement of their duties is essential. A good place to start is in the policy making area. Delineate order changes, then write intelligent, easy to follow orders. Appoint a traffic safety supervisor to work closely with all elements of the department in defining plans and policy. Finally, make it clearly understood that this program is an integral part of the department policy and is a condition of employment.

Assignment of Duties

The selection of a traffic safety supervisor is an important one. He may be referred to under many titles, e.g., motor officer, safety director, departmental safety officer, etc., but his main concern will be that of establishing the tone and enthusiasm of the total program. His rank should be of sufficient grade to command the field officers and he must be responsible, directly, to the head of the department. Some of his qualities must be aggressiveness and salesmanship. His ability to totally involve every member of the department in "living" the program is a determining factor in its success or failure. He must be thoroughly familiar with the operation of the department and have technical knowledge of vehicles and safe driving habits. Some of his duties are:

1. To develop, among the personnel, a sense of responsibility in the operation of police vehicles.

2. To review all accidents involving police vehicles.

3. To determine the cause of police actions and make a decision whether the accident could have been prevented by proper evasive action.

4. To provide an awards or incentive program to encourage safe vehicle operation.

5. To provide personnel with periodic bulletins concerning the accident experience of the department.

6. To keep and post maintenance charts of individual vehicles to encourage economy of operation.

7. To compile complete statistics of accidents involving police vehicles.

8. To teach driver safety in recruit and in-service training. Also, the safety officer should serve on the staff in an advisory capacity and report directly to the head of the department.

The direct, and indirect, cost of repairing damaged vehicles can be misleading. There are hidden costs that must be considered:

1. The loss of the use of the vehicle while being repaired.

2. The cost of supervisory time spent investigating police accidents and appearing before a review board following the accident.

3. The loss of services of personnel disabled by the accident.

4. Pension payment to those permanently disabled and widows of persons who are killed in these accidents.

Training

Many weeks are spent in educating police recruits in all phases of work relative to prevention, apprehension, and conviction of law violators. Little, or no, time is spent on police driver training. Attitudinal changes at this stage are more easily obtained. A good police recruit course must include a driver training program. For those who will progress to patrol or traffic assignments, a police pursuit driver course must be inaugurated. Initially, consideration must be given to an in-service training program for all personnel that encompasses a driver ability test and, based upon results, corrective driver courses under competent instructors.

The police driver has the same responsibility as a civilian driver and, in addition, he is expected to be observant of details that the civilian driver is never concerned with. He must be alert to criminal activity, wanted persons, and vehicles.

No longer can emergency lights and sirens guarantee relatively safe passage of emergency vehicles. Driving know-how is a matter of hard training and diligent application of knowledge. This training begins with basic driver training, vehicle characteristics, when and when not to engage in "hot pursuit," and training in all phases of vehicle management and maintenance.

We have mentioned attitudinal development. No program is worth the paper it's written on without each individual's mental attitude being directed to his and his companion's safety. He must have confidence in his own ability; this comes with training. He must have confidence in his vehicle; this comes with proper preventive maintenance and care of vehicles.

A recent study of accidents in a large police department listed the following as a major cause of police traffic accidents:

1. Over confidence—taking too much for granted.

2. Minimizing the seriousness of minor accidents.

3. Pride in past record—that is, feeling secure because of a no accident record.

4. Faith in experience.

5. False idea — that is, misconceptions about stopping in time.

6. Self-righteousness.

7. Impatience—taking needless chances in tight situations.

The traffic safety director must early learn to recognize these symptoms and how to deal with them. A method of overcoming these attitudes is to incorporate in any driver course a basic course in the principles of momentum, friction, and centrifugal force.

To instill pride and confidence in equipment, a simple check-list that lists such things as physical appearance of vehicle, tire condition, brake operation, steering operation, operation of dashboard gauges, cleanliness of vehicle, and operation of radio equipment

will put the burden and the consciousness of that burden on each officer at shift change.

There seems to be a feeling that a police officer need not have a current, valid driver's license on his person, or that having once been issued a license, no driver refresher training is necessary. In the State of Tennessee, there is no re-testing program to renew a driver's permit. A license can be issued at an early age and is renewable every two years, simply by mailing in the fee to the licensing agency. Thus, if an impairment develops after the initial issue, it oftentimes can and does go undetected until a serious accident occurs. Police are no different than civilians, in this respect. Their driving ability and license must be checked on a regular basis. Should an illness or injury occur, and the officer is placed on drugs for a period after he has been certified to return to work, make sure the drugs will not interfere with his judgment in driving before he is put back on his duties.

To summarize a training program, be sure it includes the following:

1. *Attitude test.* We suggest an attitude test be incorporated, covering psychological aspects of the new recruit. This part of the test should be administered or re-administered to the police drivers to insure that their mental attitude has not changed towards safe driving and lulled them into a sense of false security.

2. *Classroom.* At least twenty hours of classroom instruction setting forth the policy of the department as to the proper operation and care of a police vehicle. Also beneficial to the safety program would be participation in a defensive driving course in conjunction with the police instruction course.

3. *Outside demonstration.* At least ten hours of outside demonstration and participation in the proper handling of police vehicles, both in routine patroling and high speed pursuit.

Many small police departments do not have the funds available to supply vehicles to be used in a recruit driving training program. It can be suggested that old police cars that are normally traded or sold could be stripped of the police equipment (i.e., lights, radios, and sirens), and with the installation of roll bars and other safety equipment, these cars could be readily used as training vehicles.

4. *Practical experience.* This phase envisions the assignment of the officer to a regular beat or zone, accompanied by the instructor. Any weakness of the training program will be observed during the practical everyday operation. Experience has shown that this testing should take place during peak work load hours so that the instructor has the opportunity to observe the driver in his element and operating conditions. The test period should be of a sufficient duration to allow for mental attitude testing at the same time.

5. *Field training* (optional). This phase is designed for the new recruit and may be implemented in lieu of 4 above. Assign the new man to a driver who has a good record. Have him observe the driving habits for one month before allowing him to drive or operate the vehicle. Then use the experienced driver as an instructor, with required reports being rendered for a given period of time.

Implementation

There appears to be no magic time to implement a program such as outlined here. The proper selection of a time is dependent on the completion of all the steps outlined. Partial work in any area will defeat your program. Once the program is inaugurated, unceasing vigil is required to keep it operational. Basic trainees must be trained and started on the program from the first day on the beat. Quick but fair investigative action and, where necessary, disciplinary action, must always be the rule, with a consistent approach to each. A recommended start is to inaugurate the program in the traffic division first, with other divisions following as rapidly as training and testing can take place.

Statistical Follow-Up Review and Corrective Actions

Where a program is started with accurate statistics, updating is no problem. Current statistics are a must. At no time should the traffic safety director hesitate to change or modify the program in accordance with the statistical trends indicated. Advisories or newsletters should be issued on a weekly or monthly basis, with awards announced as well as the bad news.

Conclusion

We believe this is a workable safety program for any and all police departments, with some modifications to fit the larger departments as well as the small ones. There are numerous problems peculiar to departments that must be overcome to make any program successful. Politics, cliques, and favoritism are internal problems and play a large role in the success or failure of any program, but they can be overcome by choosing the proper personnel to head the program. Those chosen must have the backing of the higher echelon and their complete cooperation. If this is done, there is no reason that this program will not work.

OPENING REMARKS

By CURTIS VOLKAMER
Chief Fire Marshal, City of Chicago

It has often been said that safety is everybody's business. How true these words are. If only all persons, young and old, the educated and the ignorant, would only take heed and make safety their business. The National Safety Council since 1913 has worked diligently and endlessly in fostering motivation toward this end.

Industry has for years been cognizant of this need and hired fire prevention and fire protection engineers to cope with building materials and fire safety. They have also engaged safety engineers who have as their objective the prevention of accidents.

It is somewhat embarrassing to think that the fire service, which throughout the years has preached and taught safety to the public, has been derelict in many instances in pressing the same issue among its own profession. Over the years, we have worked under the apprehension that injuries in the fire service were part of the trade. It seemed to be understood and implied that in so dangerous a profession, injury was to be expected. In former years, the more battle scars a man had endured, the greater hero or he man he was considered by his contemporaries.

Surely, as the fire service grew into a true profession rather than just a job classification, a greater awareness became prevalent regarding unnecessary accidents and unnecessary risks. In this dangerous business, we have taken an oath to protect life and property, and we are morally bound to save a life even at the risk of our own. This we have done, this we do, this we will continue to do. Calculated risks are the order of the day; fool hardy attempts never.

Today there are many variances regarding safety education in fire departments. Variances on the amount and level based on the type, size, and amount of activity in fire duty and more so based on "leadership" regarding safety in the fire service.

In our present society, including that of militants, dissidents, and citizens who feel the fire fighter represents authority and the Establishment, we are confronted by situations that did not plague us in the past. Attacks at any hour or time in certain areas by this element in the form of hurled objects such as rocks, bottles, and metal parts, as well as occasional shots fired, have led to some fire departments taking such precautions as enclosing tiller drivers in cage-like devices and arranging for other protective cover to engine men and truck men while enroute to the incident.

It goes without saying that although these devices do afford some additional protection, they likewise slow down the overall response and operation at the scene, which in turn can further endanger these same men by virtue of the progress and propagation of the fire and its increasing danger to them.

An examination of the statistics of accidents to firefighting personnel reveals that, contrary to public opinion, the greatest number of accidents are due not so much to dangerous equipment or the absence of safeguards on this equipment as to some very simple causes, such as falling or slipping; walking into unguarded openings at the fire scene; the falling of objects, tools, and materials from overhead work; the careless use of tools; removal of safeguards; neglect to

use the safety features provided; improper clothing [and this applies to helmets, boots, and gloves]; stepping on projecting nails; lack of adequate inspection by those in supervisory capacities; and carelessness on the part of the fire fighters themselves.

I could cite instance after instance in which firefighters were burned because the fire coat was still on the apparatus—it was too hot to wear. Where firefighters stepped on nails, received electric shocks, and in some cases were electrocuted because the boots were still on the apparatus—it was too hot to have them on, or for some reason or other, the firefighter didn't think it was necessary to wear them. O· of firefighters who had hand and finger injuries—no gloves, or gloves which by any standards should have been discarded long ago.

The Chicago Fire Department records will show that every year between 800 and 900 firefighters are taken to hospitals for treatment, duty connected. Many, of course, are given first aid and released for duty; others are hospitalized for varying lengths of time —some quite prolonged. I am sure that other communities, from New York, Detroit, Philadelphia, etc., to their smallest counterparts could match this figure, ratio-wise and percentage-wise, without the slightest difficulty.

A word here, I think, would be very appropriate about the person who is "accident prone." Some time ago, a national publication with quite an extensive circulation had a most interesting article entitled, "Accident Prone—Fact or Fallacy?" It proved nothing. Nothing, that is, beyond the fact that in about 95 per cent of these so-called accident prone cases the injury could be attributed to just plain carelessness—or what is worse, stupidity. The other cases were the exceptions that proved the rule. I am of the firm opinion that a good, sound, practical education program tailored to meet the needs of the fire service would work wonders in helping firefighters do their work, safely and carefully.

The installation of protective devices and other provisions of safety does not by any means offer a complete solution of the problem of accident prevention. Safety devices can prevent accidents only to a limited extent; they will not, they cannot compensate for carelessness on the part of firefighters themselves. The intelligence and character of firefighters are as important elements of safety as all the safeguards put on fire equipment and tools. Carelessness, in some form or other, has been responsible for the greater proportion of accidents. In a hazardous occupation such as the one which we find ourselves, carelessness sometimes takes the form of downright recklessness, but truth compels me to say that it more frequently arises from thoughtlessness or complete indifference.

We have conducted safety programs based upon the fundamental principal of accident prevention—the education of the firefighter in habits of caution and thoughtfulness. He is impressed with the fact that his own safety, as well as the safety of his fellow firefighters, depends on his carefulness. We stress the responsibility that is his for his actions while engaging in work of a hazardous nature. I have written many articles and have spoken to countless numbers of candidate firefighters. The one thread that runs through the orientation talks is teamwork—his utter dependence upon the other members of his company, and theirs upon him. He is a cog in a giant wheel. He is a member of a team. Every candidate who comes into the Fire Academy receives an orientation manual which contains this information on teamwork which I wrote years ago. The principles which I used then are just as forceful today.

During a candidate's probationary period (which by law is six months, 60 days and upward of which are spent at the Fire Academy), he is educated by practical means to co-operate with other candidates, soon to become firefighters, in the interest of safety. Candidates found guilty of dangerous practices are promptly disciplined. Flagrant violation is sufficient cause for dismissal. There is a right way and a wrong way to do everything. The right way is synonymous with the safe way. When a candidate is assigned to a company in the field, he continues his education along these lines, putting into practice the safety theories which he has had instilled in him. This is a grueling test, a sort of final examination, especially for those who are assigned to units which have more than 6,000 runs each year. How well he performs under emergency conditions depends upon how well we have done our job in the primary stages of his education and, of course, how well he has learned the lessons which are taught in the school of experience.

When municipalities look at safety, many factors influence their viewpoint, not the least of which is the cost to the municipality when safety rules are violated. In the dangerous business of fire-fighting, which by some authorities has a 7 to 1 ratio over other occupations, this amount can assume astronomical proportions. Needless to say, the misery and the suffering resulting from injuries can never be measured in dollars and cents.

Let us turn our attention for a moment to the financial involvement. The municipality has an obligation to the taxpayer to accomplish the ultimate of good with the taxes collected. Most candidates running for public office refer to this as "stretching the tax dollar." The administration appropriates certain monies for each bureau or department for the fiscal year. These monies are allocated on the basis of the cost of operation for the previous year and anticipated additional costs relative to expanded activities or new purchases, such as equipment. Only in that manner can an equitable figure be reached to insure sound economy. If unusual circumstances occur, such as a rash of injuries, the economy is disrupted and there is a serious threat to the tax structure. Like a spiralling chain reaction, this could lead to a revision of the tax component, necessitating the levy of additional taxes on an already over-burdened public. Little wonder, then, that municipalities are deeply concerned for the safety of their firefighters.

COMPUTERIZED HAZARDOUS MATERIALS

By ROGER A. McGARY
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Time, 3:00 A.M. Suddenly, the clash of steel against steel. Moments later you gasp for air—a pungent odor fills your room. Then you realize—hazardous materials emergency.

That particular scene, sorry to say, has been played in our nation a number of times the past several years. Nearly all such emergencies have involved transportation type incidents, although we have had problems with industrial locations and toxic releases.

What can we do: first, as industrial personnel involved in safety and fire protection; second, as firemen—volunteer, paid municipal, or industrial?

We have an obligation to provide for our communities a first line of defense against such disasters.

It becomes a perplexing situation when the local fire department responds to such an emergency—an emergency that we collectively call hazardous materials.

In our plan of computerized hazardous materials we are seeking an alternative to disaster. We think we may be able to provide this alternative for each and every emergency unit in the nation. A simplified method of obtaining information on a split-second basis.

Alternative to disaster—what are we talking about?

First, stop the disaster before it occurs by providing proper information for emergency personnel so that they may cope with any situation that arises.

How does this alternative work?

We know that we can identify many chemicals with such books as the *Chem Card Manual*, NFPA *Fire Protection Guide on Hazardous Materials, Dangerous Properties of Industrial Materials*, etc.

The MCA states that 82 per cent of total tonnage shipped in a year is covered by the 85 Chem Cards. The major hazard that we see within these particular commodities is the fact that, daily, millions of tons of these products are transported over our highway system providing untold exposures.

Some of these exposures are unneeded. In Pennsylvania, for example, you are not permitted through tunnels with explosives or flammables. Instead, you are detoured through numerous populated communities with a much more severe exposure potential. What

is the key to providing protection for those involved?

Of course, it's pre-planning. Pre-planning, whether you are involved with a fire department or industrial location, means having taken the necessary steps to evacuate, rescue, confine, or extinguish a hazardous materials involvement.

Do you have the proper equipment to provide such control?

Whether a fireman or industrial safety man, the complexities of hazardous materials necessitate having:

1. Knowledge of how to handle the material.

2. Proper equipment to cope with the situation.

Within our local areas we have municipal and industrial mutual aid organizations. Each is designed to provide equipment for its neighboring facility that may not be available.

Do you know what is available in your area?

Can you put your hands on the information required to cope with hazardous materials?

This brings us to the meat of our subject —the computer. What will it do for you? That's what you want to know.

Where is your alternative to disaster?

About 8-9 months ago two students in our community college Fire Science and Administration program, both veteran firemen, along with another instructor and myself, became interested in cataloguing and making available hazardous materials information.

Through the several months of initial planning it was the consensus that one central number was needed so that any fire department, through the two-way radio system, could prevent a disaster from occurring.

How to provide this information? It had to be quick and reliable. The computer seemed the logical answer.

Our pilot program is being planned in this manner:

1. Hazardous materials—what do you do with that commodity during an emergency situation: fire, spill, first aid procedures, etc.?

2. Programming the trailer unit numbers of the various common and private trucking fleets with their companies. This enables a fire department to locate the terminal where a trailer was based with its last known commodity.

3. Location of municipal and industrial mutual aid equipment.

4. Location of heavy equipment. The heavy equipment industry has provided us with such information for Allegheny County.

Note that the last two items are specific within our pilot program county. But item 1, identification of the material and what to do with it, is what each of us needs.

How does it work?

A telephone call is all it takes—a direct call to the computer center. The 24-hour attendant would first obtain information from the caller such as "We have a trailer load of anhydrous ammonia that has overturned. What do we do?"

Immediately, the attendant would program anhydrous ammonia into the computer. As the last "a" is programmed the answer is coming back, telling the attendant precautions that should be taken. He in turn will relay this information to the man on the emergency scene.

It will make such recommendations as what to do with the hazardous material involved, fire fighting procedures, chemical handling, physical properties, protective equipment needed, etc.

As most of us know, chemical reactions don't always go as they should. Subsequently, we can't guarantee that the system is foolproof. We are attempting to provide known and recommended procedures.

Of course, this brings into mind one other item. Each of the vehicles involved will be placarded within the DOT requirements. Subsequently, the emergency unit responding will have to do a little research. Research to the point of obtaining either a driver's report or the bill of lading.

With a truck placarded "CORROSIVE," we know it could mean any one of 110 or so items; each having its own personality. In addition we must also remember that DOT placarding is for "interstate" transportation; whereas much "intrastate" transportation in the United States does not require placards. We must also remember that rail and sea transportation vehicles do not placard as is done for over-the-road operations.

How far has our program come?

At present, Allegheny County has provided us with two discs for the computer, capable of 28-million K.

We have about 200 chemicals now programmed. If all goes well we will have our national telephone number and our computer operational by Jan. 1, 1971.

We have had many stumbling blocks to overcome. These have included old line fire chiefs and firemen in our area who have failed to recognize the potential.

On the other side of the fence we have received favorable backing from state and regional firemen's associations, as well as a Pennsylvania State Senate resolution commending the Boyce Campus program and the computer.

Another sidelight of the computer has been formation of Boyce Control. Boyce Control, recognized by the Boyce Campus, is devoted to training programs with a goal of fire service extension work.

One such program has been a 15-hour course on Hazardous Materials. The program has been presented four times this year, with two or three more planned before the end of the year. This 15-hour class includes about eight hours classroom and seven hours field work. We teach in the classroom such items as physical properties, placarding, tank trailer and tank car valving, water supply, foam and its use. On the fire ground we put into operation water supplies and extinguishment with water, foam, and dry chemical.

It is the only training program of its type in Pennsylvania. We're quite sure that few other states have anything similar.

Back to our computer. In addition to the 200 chemicals programmed, we have completed the pilot county mutual aid program. It will be keyed into the hazardous materials file so that when a county department requests information, they may also receive information as to what departments have the particular equipment needed to handle the particular material.

The computer will be operated on a 24-hour basis from Kane Hospital, a county operated facility.

I'm sure that you have at one time or another attempted to locate hazardous materials information. This would find you looking through NFPA, Chem Cards, Safety Date Guides or Sacs' *Manual on Hazardous Materials*. It takes time.

In an emergency, time is what you don't have.

We think we have a method of eliminating the time sequence. It's a first for the national one that will provide untold benefits—benefits that you will derive as you provide the needed protection for your community.

THE STATUS OF SAFETY IN THE FIRE SERVICE

By WILLIAM RANDLEMAN
Editor, Fire Chief, Chicago, Ill.

Fire chiefs have always been concerned about the safety of their men. And although the statistics are meager, the indications are that firefighting is one of the most hazardous professions. An indication of the status of safety in the fire service today could give us a clearer view of where we are going and what needs to be done. In an effort to find out what the state of safety in the fire service is today, we sent questionnaires to a random selection of fire chiefs across the nation. Because of the wide range of types of fire departments, it is difficult to assess an overall fire service problem in a meaningful way. But in an effort to do this we have separated most of our tabulations into three categories: (1) paid departments, (2) combination paid/volunteer, and (3) volunteer departments.

Safety Management Policy

Of the 302 fire chiefs who responded to our questionnaire there is obviously a deep concern for the safety of their firemen, but just how well this concern sees fruition in positive and systematic management action

is questionable. Of all the chiefs responding, only 88 per cent said that they had issued a definite policy on safety to their fire department. The per cent answering yes to this question for the three types of departments was: paid, 88 per cent; combination, 93 per cent, volunteer, 86 per cent.

To get an indication of just how earnestly and systematically the safety policy was pursued, we asked whether one man has been assigned to the responsibility of safety supervisor. Only 49 per cent, or about half of the departments, said they had assigned a man to this duty. Less than one per cent referred to this man with a title such as safety engineer or safety supervisor. As would be expected, more paid departments and combination departments responded to this question affirmatively. Eighty-one per cent of the paid departments, 59 per cent of the combination departments, and 34 per cent of the volunteer departments said they had assigned this responsibility to one man. Of the departments who have assigned someone to this job, there is little consistency in the rank of the officer in charge. Among the volunteers, the job was most often handled by the chief himself. The paid and combination departments usually gave the job to an assistant or deputy chief, with the training officer running a close second.

Another indication of how well a safety program is being handled is the effort to follow-up and investigate accidents. Apparently all departments do not file accident reports and some do not even investigate accidents. In the paid departments, 89 per cent reported that someone files an accident report. In the combination departments 94 per cent file reports, and 72 per cent of the volunteers file accident reports. Only 93 per cent of the paid and combination departments investigate all accidents, while only 80 per cent of the volunteers do so.

How many departments have a method of determining the cause of accidents? According to our survey, 54 per cent say they have such a method. The per cent of those responding with yes to this question are: paid, 77 per cent; combination, 67 per cent; and volunteer, 38 per cent. But the depth to which the cause factor was pursued was not revealed in the questionnaire, although the following information may give some indications.

Records and Data

We asked some general questions about records to find out how well accident records were kept. One of these was: *Do you know what injury or group of injuries are responsible for the greatest number of time-lost injuries in your department?* Of all the departments responding, only 49 per cent said they knew. Of the paid departments 76 per cent said they knew; 57 per cent of the combination departments and 35 per cent of the volunteers said they keep such records. A small number of the departments responding said that this information was based on an estimate. This indicates that even if one central gathering point was tabulating all the information now available in fire service injuries it would cover only about half of the nation's fire departments.

When we asked what injury or group of injuries caused the greatest per cent of time-loss to the department the answers ran the gamut from the common cold to smoke inhalation. Back injuries were the injury most mentioned. Sprains were the next. A close third ranking injury was cuts. Fourth was smoke inhalation, and burns were fifth. Some of the other injuries mentioned were broken bones, heart disease, eye injuries. A considerable number of small department chiefs (about 20 per cent of the volunteer chiefs) reported either no time-loss injuries or few time-loss injuries. This indicates that a small department fire chief does not have available in his own department the data that will show him where his greatest needs are. This only points out the need for the collecting and analysis of data on a national basis.

We thought an indication of the sophistication of a fire department's safety policy could be obtained by asking questions about the use of the universal system employed by industry for measuring and recording injuries known as the Z16.1 and Z16.2 methods. An adaptation of this system is being used in New York City, for example. The assumption was that anyone who had done some homework in safety management would have heard of this method, whether he was using it or not.

The first question was: *Are frequency and severity rates computed by the* Z16.1 *method?* One per cent of the volunteers and combination departments reported that they were using this method. Five per cent of the paid departments said they were using the

system. Approximately the same percentages were obtained in response to the question on the use of the Z16.2 method for classifying and analyzing work injuries. The next question on the questionnaire was: *Have you heard of these methods before?* In answer to this question, 13 per cent of the paid department chiefs said they had heard of the method, while six per cent of the combination departments and four per cent of the volunteer departments said they had heard of the system. Since this method is widely used in business and industry the answers to this question indicate that fire chiefs are not too knowledgeable in the modern safety management techniques used by industry. It is unrealistic to assume that a volunteer department of 10 or so men would be using the latest sophisticated management techniques, but when only 13 per cent of the paid chiefs have heard of these methods, it indicates that the fire service could benefit from some good safety management education.

Safety Training

When you ask fire chiefs whether their training program covers safety, a large per cent respond with a yes. But there is still a considerable number who apparently have no safety training program. In answer to the question, *Do all new employees receive safety indoctrination?* Ninety-seven per cent of the paid departments, 64 per cent of the combinations departments, and 82 per cent of the volunteer departments responded with a yes answer. An indication of just how intensive this indoctrination is can be found in the answers to the question on how this indoctrination was handled—as a part of the regular training program or as a separate lecture or training program on safety. Here, 12 per cent of all departments said safety was treated as a separate part of training indoctrination. Another question we asked which could indicate the intensity of the safety training program was the question on whether firemen were trained in correct lifting and the safe use of tools. Here, the indications are that most departments are giving some indoctrination in this area. Ninety per cent of all departments said they were giving training to their men in this area.

Does your safety training follow an established outline? was asked to find out how systematically the safety training program was handled. Only 38 per cent of all departments answered yes to this question, with the breakdown as follows: paid, 54 per cent; combination, 47 per cent; and volunteer, 29 per cent.

The indications are that while most chiefs are concerned about training and feel that they are providing some safety training, there is little evidence that a large percentage of them are using any systematic, well organized program of safety training.

Safety Inspections

Do fire departments inspect tools, apparatus, and buildings regularly for safety? According to our survey, most of them carry out some kind of inspections, but just how thorough or how regularly these inspections are done is not shown by our questionnaire. According to the survey 97 per cent of the paid, 87 per cent of the combination, and 78 per cent of the volunteer departments have some kind of inspection program for apparatus and equipment.

Information and Materials

We asked the chiefs in our survey where they go for safety training information and general information on fire department safety. The answers to this question revealed a wide divergence of sources of information. Many sources were mentioned, but none stood out as a source most chiefs would go to. Of the 302 respondents, only 30 said they would go to the National Safety Council, 35 to the NFPA, and 11 to the IAFC. Many chiefs sought information from state agencies such as the state fire marshal, state industrial safety commission, state universities, and the state compensation fund. Among the other sources mentioned were: a large fire department, fire equipment suppliers, city safety departments, Bureau of Mines, American Insurance Association and other insurance sources, training manuals, training schools, fire publications, and industry.

Would fire chiefs want a tailor-made safety program for their department if available? Strangely, not all fire chiefs answered this question affirmatively. Of the paid chiefs, 87 per cent said they would like such a program; 67 per cent of the combination chiefs and 73 per cent of the volunteer chiefs answered yes to this question. The objections were that the chiefs did not believe that such a program would be possible be-

cause of the wide differences in the departments and the unique problems each has.

A few fire departments operate under a municipal safety program sponsored and run by the city government. This appears to be a good solution for the small departments.

The final question on the questionnaire was: *What do you think is the most urgent safety need of today's fire service?* The answers to this question show that there is a broad range of opinion among fire chiefs as to what needs to be done. The single item mentioned most was breathing equipment. Some chiefs said better training in the use of breathing equipment was needed, while others said better breathing equipment was the answer. The second most mentioned item was protective clothing — helmets, coats, gloves, eye protection, and so on. The problem of hazardous materials ran a close third. Many of the chiefs feel that better training for firefighters is necessary for dealing with hazardous materials. A few mentioned the need for stricter laws governing these materials.

Several chiefs said that the greatest safety need was simply better firefighting training. Others mentioned physical fitness programs, safer equipment, and driver training. Several volunteer fire chiefs mentioned the need for driver training in relation to the problem of volunteers becoming involved in accidents while driving to and from fires in their personal cars.

Many other suggestions were offered as the most urgent need in safety. Here are a few: good fire prevention, more educational material, more manpower, new safety programs, enforcement of safety regulations, recruiting good men, good training schools, night lighting, sprinklered buildings, riot training. Several chiefs offered general answers such as common sense.

Conclusions

I think our questionnaire could have revealed a lot more interesting information. For example it would have been interesting to interrelate some of the information in ways that we were not able to do in a limited time and without a computer. But even as it is, some conclusions can be drawn from it—some of them are more implicit than explicit, and some are only a confirmation of what keen observers already suspected.

It is clear to me from the survey that in fire departments an organization where safety should be a top priority, it is rarely handled as such. Fire departments have been slow to adopt modern safety management techniques. But also, I want to emphasize that the individual fire departments cannot assume all the blame. It is unrealistic to expect a volunteer fire chief with a 10-man department to apply the latest safety management techniques, particularly without authoritative leadership. The answers to some of the questions show that strong leadership has been lacking. No association or organization shows up in the survey as *the one* which chiefs go to for safety information. It seems to me that if any one organization was doing its job this group would have stood out in the survey.

In my judgment, the situation is a lot worse than it appears by the per cent answers to some of our questions. For example, when you ask a chief whether he has issued a safety policy to the department, he is likely to say, "Yes," even if his policy statement was something like this "Now I want you to use common sense—we don't want anybody hurt."

The survey gives some strong indications of what the fire chief needs:

The first is safe equipment, apparatus, and clothing. This means research. At the present time, it is difficult for the fire chief to find the information he needs on the safety of the equipment, tools, and clothing he buys. Research is needed to give the fire chief some guidelines, for example, on which is the safest fire coat for his department. Research to tell him which breathing apparatus is best for his department. But even more important, in the long run, is research to develop new, safer equipment and clothing. The Fire Research and Safety Act could do this. I hope it will.

The second need is for a national fire service system of recording and reporting injuries. The point here is that we really don't know where our injuries are coming from. The indications are that a lot of fire chiefs seem to think of safety only in regard to fireground operations—putting out the fire. What about the training ground, the overhaul, and so on? The big departments may have the records to show where they must put the emphasis, but what about the lonely volunteer chief with 10 men? Perhaps the

NFPA's new retrieval system called FIRST (for Fire Information Retrieval System Technique) will do this; I'm not sure whether it gets into safety or not.

The third need is for a good source of safety information. The fire chief needs training information, safety management information, films, slides, and so on. Of course it's a good idea to have as many sources of this material as possible, but the volunteer chief does not have the time to contact three, or four or 20 sources for his information. It would be good if he could go to one source for anything he wants on safety. Some group should gather and sift the information applicable to fire departments and make it available. But more important, it should provide the chief with how-to-do-it information: the basic information on how to start and run an effective safety program.

The fourth need of the chief is education. This ties in with point three, sources of information, but there is a difference. Certainly, a part of education is providing safety materials, programs, and so on. But there is more to it. Attitudes must be changed. It is unfair to generalize, but I believe that a lot of fire chiefs feel this way: "You're damn' right safety is important, we don't want any accidents." The key word here is "accidents." In my dictionary, the fourth definition of the word "accident" is *fortune, chance.* I think that in the minds of many Americans this fourth definition is first. It should be listed first in the dictionary because to many that's what accident means — chance, not something that is preventable.

When it comes to fire chiefs, there is another factor. It has to do with the fact that firefighting is a dangerous job. The feeling seems to be that if it is a dangerous job, you have to expect injuries.

Many fire chiefs simply do not understand that safety management is a practical, down to earth function of a manager. And this is the most basic and fundamental educational need—changing his attitude.

Now I think the survey makes one point quite clear. A look at the answers shows it is the small department, particularly the volunteers, who needs help in safety most. These men simply do not have the training time or the management time to do the job. They comprise the largest segment of the fire service, both in the number of men and the number of departments. How to give them what they need and get them to use it is a difficult problem. It appears the entire fire service needs guidance, but these small departments will be the most difficult to reach.

But I am not pessimistic. There is a new awakening in the fire service. If the fire service can put into action programs dealing with the four needs mentioned, we can at least begin to move in the right direction.

What it all boils down to is leadership. The fire chief needs leadership and guidance. Perhaps here is where the National Safety Council and this Division can make its mark.

BLASTING SAFETY

By ROBERT LOWDERMILK
H. E. Lowdermilk Construction, Englewood, Colo.

We at H-E Lowdermilk Co. think of ourselves as mountain highway builders, and almost every highway we build requires some amount of blasting and blasting technology. We have been involved in this type of construction for 36 years, and included in the list of projects completed during this time are parts of the Million Dollar Highway, Monarch Pass, the highway to Los Alamos, New Mexico, and many other highways. Also, to date, we have built approximately 42 miles of Interstate 70 in both Colorado and Utah.

We normally use over a million pounds of explosives per year.

Basic Highway Blasting Techniques

When we drill and blast a normal highway rock cut we first try to determine what type of rock we have to deal with. We then establish the amount of explosives it takes per yard of rock to fracture that rock the

desired amount. We then lay out the drill pattern that will give us that result. In the process of doing this we recognize that confined explosives of varying concentrations per yard will yield varying fragmentations of rock. But as contractors looking for the lowest cost, we try to use the optimum concentration of explosives necessary to achieve a minimum total excavation cost.

The method that is used to both distribute and confine the explosives in the rock is to drill blast holes of specific diameters at predetermined spacings to specified depths. The holes are then loaded with the type of primer and explosives determined best for their conditions. They are also loaded to a predetermined elevation. We then fill the hole the rest of the way with cuttings generated during drilling or with dirt. This filler material in the upper portion of the hole is called stemming, and it acts to confine the explosives. This causes a greater amount of the energy generated at the time of detonation to be transferred to the rock than would be the case if the hole were open above the explosive and left to "rifle" at the time of the blast. The stemming in a hole also has another effect. It also acts to separate the gas bubble generated by the detonated explosives in the drill hole from the surface of the ground, and it has been found that the further that separation is the smaller is the probability that rock will be thrown from the shot.

Another technique that is used frequently in blasting rock cuts is millisecond delay caps, which cause certain rows of holes to detonate in a pre-determined order. This technique when used properly can cause an increase in fragmentation and may also influence the direction of flyrock and the amount of concussion generated by the blast. This tends to protect cut slopes and nearby structures and property. Thus, not only the number of pounds of explosives per yard, but also the distance of the powder from the rock's surface and the order in which the various blast holes detonate, combine to determine the fragmentation of the rock and the amount of throwrock and concussion. One word of caution at this point: although it is usually possible to predict approximate fragmentation and the distance rock may throw, and to reduce somewhat the number of flyrocks thrown in a specific direction and eliminate concussion damage, surprises do occur. Rock hardness may change; faults, joints, bedding planes may be encountered; unforeseeable situations may develop; therefore, always allow as much margin for safety as possible.

The Environment Necessary for an Explosion

Explosives are very fundamentally combinations of chemicals whose molecules, when they are placed in the proper type of environment, unite and re-combine, giving off very high amounts of energy.

Commercial explosives are actually nothing more than those rare chemical combinations which will not combine in any normal earth environment, but will consistently do so with a tremendous release of energy where such environmental conditions as sufficiently high temperature and pressure and/or molecular velocity are brought to bear on their active ingredients in a way that can be both economically and physically convenient. Very simply, this means that modern commercial explosives and blasting agents must, just as fire must, have proper conditions in order to "Go." A recognition of these conditions is one of the prerequisites for effective blasting accident prevention.

Blasting Caps. When looking at the myriad of choices of explosives and blasting agents available on the market, blasting caps are normally recognized as the most sensitive. It is well recognized that sufficient heat, electrical, or shock energy can accidentally cause them to explode at an undesirable time. Much of this recognition of the dangers of blasting caps comes from advertising done by the explosives manufacturers themselves, and it has been found that when the frequency of publication of the dangers of explosives is allowed to drop, the number of individuals, especially children, injured by blasting caps rises. Blasting safety is one realm in which advertising is effective.

In highway construction the potential danger of blasting caps is compounded very markedly, for we have to bring the cap and the powder together. When we place a cap in a stick of powder we build what is called a primer, and it is the primer that sets off the rest of the string of explosives.

There is a sheet inside every case of powder and every box of caps that is commonly called the "Do's and Don'ts." This sheet describes, among other things, how to

build a primer. It is a very simple process but very important, and all primers should be made and placed properly for they have both the sensitivity of a cap and the power of a stick of explosives.

In our company we have enough respect for a primer that we do not build them until just before we put them down the hole, and we do not do that until we check the hole with a wooden loading stick to make sure the hole is clear and the primer can be placed easily at the bottom of the hole. Remember two very important things: (1) never tamp or pound on a primer; (2) always keep caps and powder separated until the last possible moment.

Up to this point our discussion of blasting caps has been applicable to all types of caps —the conventional fuse ignited type, the electric blasting cap, or even the new High Density Primers which are used to set off some of the more modern and insensitive slurries. But since electric blasting caps are the most popular caps used in highway construction, a discussion of some of their characteristics and special problems is in order.

An electric blasting cap detonates when sufficient electrical energy is passed through its legwires, to break the bridge wire within the cap body and cause the spark from the break to ignite the flame sensitive explosives in the cap head. The detonation front thus generated by the cap is what actually propagates throughout the surrounding explosives and causes the detonation of the powder strings in a blast hole. The energy necessary to detonate a cap is not very much, for a small penlight battery can be made to fire several electric blasting caps at once. It actually only takes approximately three tenths of an amp to set off an electric blasting cap.

Because of the sensitivity of electric caps they are delivered to the job with the ends of their legwires tied together in a "shunted" or grounded condition. In this condition it requires a very large amount of energy to set one off. When we use electric caps we make it a policy not to remove the shunts from the legwires until after the cap has been placed in the drill hole and all the holes have been loaded, and the powderman is in the process of wiring the shot together. This thus reduces the danger of unwanted detonation due to static electricity or accidental contact with an electric current.

Misfires. Misfires or undetonated holes make for a condition of extreme potential danger, for misfired holes are usually in ground that has moved, to some extent, and because of this movement it may be very difficult to find the undetonated powder left in the hole. The conditions of the situation must always govern proper procedure and judgment, but in general a misfired hole is usually dealt with, if it is found that its caps are no longer capable of detonating the hole, by first removing the stemming with a semi-conductive hose and then placing a new primer against the powder string in the hole. After this has been done the explosives are simply destroyed by detonating this new primer.

Misfires have many causes, but the three most frequent are: (1) a broken legwire within a series that may not be evident to prior testing by a galvanometer; (2) allowing one of the connections between two caps' legwires to lay in such a position that it shorts out a series of holes or allows enough of the blasting machine's current energy to drain off so that insufficient potential is sent to some of the electric blasting caps in the shot; (3) simply, rushing a powderman so much that he doesn't check his work properly or forgets to wire in a series of drill holes to the rest of the shot.

Another danger is the presence of an electric storm and lightning in a blasting area where holes are loaded with electric blasting caps. In such a case, whenever the storm gets within three miles of the shot there is only one safe procedure—evacuate the shot area and the surrounding area that would be affected should detonation occur.

In 1951 on a dam above the town of Boulder, Colorado, five men were killed when lightning struck a loaded shot. One of the unique characteristics of this accident was that the lightning bolt that caused the accident was the only one seen during that storm.

Lightning carries with it tremendous energy, and there is even evidence that in 1969 lightning may have detonated a shot fused with prima-cord. Prima-cord is an ultra-high velocity detonating cord that can be substituted, in many cases, for electric blasting caps. Prior to that accident, prima-cord was thought to be completely insensitive to lightning. Now, although it is known to be far less sensitive to lightning than electric blast-

ing caps, its invulnerability may be in dispute. That lightning may have caused quite a shock to a few old powdermen.

Explosives

Commercial explosives manufacturers have attempted to design their explosives in such a way that they are relatively hard to detonate without the use of instruments that were designed for that task. But it is possible, when the proper environment is created accidently, to cause detonation of explosives. In the following discussion I will describe how some of these conditions can occur.

In 1952 a fire broke out in a county garage in the State of Colorado. Approximately eight hundred pounds of explosives were in the back room, and the explosives caught on fire. Three men who were fighting the fire died and one was injured as a result of the ensuing explosion.

Several years ago on a highway project, powdermen loaded a drill hole five minutes after the drill had completed the hole. Twenty minutes after the hole was loaded it detonated. Upon investigation, a chip from the drill bit was found in the bottom of the drill hole. The chip had been heated during drilling to such an extent that it had turned blue. It is estimated that a temperature in excess of six hundred degrees is required to make steel turn blue.

At a U.S. Army post in Greenland several G.I.'s were sitting around a fifty-five gallon barrel that had a thin layer of diesel in the bottom which was burning and supplying heat for the group. Suddenly, another G.I. came in the room and foolishly placed a stick of dynamite in the barrel in an attempt to add fuel to the fire as he had heard had been done by many old time powdermen. As soon as the stick was added to the fire it detonated and several men were injured.

In each of these accidents explosives detonated while burning, and although it is well known that explosives manufacturers destroy old explosives by burning them, it is very evident, contrary to the opinion of a surprising number of individuals in the construction industry, that improper burning techniques cause accidents. The probable cause of this is quite simple. In reality, all that has to be done to explosives to have them detonate is to bring them into contact with a sufficiently strong detonation front. When dynamite burns it generates quantities of flammable gas. This gas normally burns harmlessly as long as a sufficient quantity of oxygen is present. But if oxygen is starved from an area and that gas is somehow collected into a pocket, and that pocket of gas is itself caused to explode by a subsequent supply of oxygen, the detonation front generated by that gas explosion may propagate and detonate the surrounding explosives.

The explosives manufacturers recommend but one way to operate when explosives accidently catch on fire—evacuate the danger area and allow the fire to burn completely out. Do not attempt to fight a fire in which explosives are present.

A second way that accidental detonation can occur is by impacting explosives.

Several years ago a powderman was loading a drill hole with stick powder. Suddenly one of the sticks wedged in the hole and prevented the hole from becoming fully loaded. The powderman attempted to correct the situation, as he had many times before, by simply pounding on the powder above the wedged explosives with his loading stick. The hole detonated and killed the powderman. Checking the condition of the drill hole before loading and using sticks of powder of the proper diameter might have helped prevent this accident.

In another accident on a mountain dam project, an operator and his oiler were killed when the operator accidently dug his shovel bucket into approximately twenty-five pounds of semi-gel explosives.

In each of these accidents the exact cause may remain elusive. It is possible that caps or primers were involved in causing detonation, but from the evidence remaining, it has been judged that that was probably not the case. It is known however that grit or small rock particles can markedly increase the sensitivity of explosives and cause them to detonate under a sharp impact. Pounding on an explosive with a loading stick or digging into it with a shovel tooth could be enough impact to cause such a detonation.

There is one other potentially dangerous situation which I believe should be described at this time. Drillers always have the possibility of coming into contact with explosives that have not detonated at the bottom of the hole when drilling in a previously shot and subsequently excavated area. To prevent an accident from occuring and keep a driller

from drilling into un-shot powder in an old hole, our drillers are instructed to use the blow air emitting from the drill bit to clear loose material from above the rock they are going to drill before they start drilling a new hole. In this way they can make sure that what they are drilling into is rock, not powder.

The Radius of Danger

The environment which must be present in order for detonation to occur is not the only critical area that should be watched by a safety conscious individual. The environment surrounding the explosives—i.e., the radius within which damage or death could occur as a result of detonation—should also be carefully observed and analyzed, and every effort should be made to minimize dangers which could develop either before, during, or after the time of detonation.

Part of this effort manifests itself in properly placing a powder magazine in accordance with federal, state, and local laws and regulations so that any accidental detonation of the magazine will do a minimum of damage to individuals and property. It is the reason for placing clearly marked explosives signs on trucks hauling explosives. Trucks so marked alert others to treat them with special care in case an emergency should occur. It is also for this reason that we in H-E Lowdermilk Co., as, I believe, do all major powder users, take careful precautions and attempt to prepare for all contingencies in the preparations we make of the area, community, and community services that might be affected by one of our shots. This includes not only evacuating all individuals to a safe distance from the shot and restricting admittance into the area by locating flagmen at all entrances, but also by contacting necessary authorities and public services to stand by if their assistance may be required, by placing equipment at strategic locations so that roads may be reopened, and by many other tasks that may be necessitated by the circumstances of the situation. We believe that the preparations made just prior to a blast are so important that only one person is given responsibility for the procedures required for any one blast, and it is his duty to make sure that all environmental characteristics are proper. He is then the person who gives the order to the powderman to fire the shot. This duty is entrusted only to experienced personnel who have proper intelligence and knowledge and who recognize the extreme importance of these procedures.

During the blast, however, the greatest possible danger normally results from the flyrock that may spew from the shot. I have read that approximately 50 per cent of all injuries and fatalities from blasting, both on the surface and in mining, result from flyrock. For this reason, I offer this advice for anyone who witnesses a blast. First, stay a long distance from the shot and off to one side. Flyrock in isolated instances has been known to travel as far as one-half mile. Second, if possible have something very substantial between you and the blast, such as a major piece of construction equipment or something equally as strong. Third, after the detonation has occurred and the dust and any flyrock are beginning to soar, do not continue to watch only the blast area and its dust but look up to about a thirty or forty-five degree angle and look for any flyrock that might endanger you or anyone in your area. Fourth, if ever you find that you are within range of a flyrock, or if you observe a flyrock that seems to be floating in one spot in the air and getting larger and you find yourself in danger, act as reason dictates and do not loose your head. Remember, although the density of the hail of flyrock and the facts of the situation actually govern, some individuals have been killed or injured when they unthinkingly turned their back and ran or curled up or took refuge under too flimsy a cover in an attempt to evade as few as one or two flyrock when they might possibly have watched and gauged the flyrock much as one does a high-fly baseball and then taken proper evasive action to avoid being hit.

After the blast has occurred and all flyrock has fallen, danger may also exist to anyone entering the blasted area too quickly. This danger may be of potential rock fall on the cut slope or noxious gases that can occur as a result of incomplete combustion of the explosives. Because of these two dangers, the simple procedure of waiting to enter a blasted area until the gas and dust from the blast have abated may do much to prevent serious injuries.

The latest edition of E. I. Du Pont's Manual on explosives and practices, *The Blasters'*

Handbook, is almost thought of as the explosives industry's Bible, and anyone who may be involved with explosives should read it thoroughly. Other books, such as U. Langefors and B. Kihlstrom's *The Modern Technique of Rock Blasting,* many of The Bureau of Mines *Report of Investigations* series, and some of The Bureau of Reclamation and Corps of Engineers reports, also will add to your drilling and blasting knowledge. One of the best sources of safety information are old accident records. In The State of Colorado, The Bureau of Mines handles these records and a few hours spent reading them can do much to enlighten as well as motivate someone about blasting safety. This is also true of the state laws and/or specifications under which construction is accomplished.

Conclusion

Throughout this discussion I have attempted to cover areas which I felt would be most significant to an understanding of highway blasting safety.

I have tried to point out some of the characteristics needed to create a detonation of an explosive and in the process I have tried to infer that, by not allowing the environment necessary for an explosion to occur, an accidental blast could be prevented.

I have also attempted to describe the radius of danger that explosives may cause and to indicate how the probability of injury or damage can be reduced.

Blasting is yet both an art and a science. It has inherent in its materials many potential dangers, but so long as the manufacturers and consumers of explosives continue to improve both the safety characteristics of the blasting materials and the knowledge and caliber of those who use them, explosives' safe and knowledgeable utilization and the benefits that accrue from that will continue to improve our civilization.

MOWERS AND MOWING OPERATIONS

By CLAUD R. McCAMMENT
Safety Director, State Highway Commission, Topeka, Kans.

In April of last year, I sent a letter to all 49 other states asking them to advise me as to whether or not they provided any type of protection for their mower operators in the form of anti-tipping devices or roll-bars, and what practices were put into effect and what restrictions they had relative to the use of mowers on slopes. Furthermore, I asked a second question as to what if any type of eye protection they required of mower operators. I was greatly surprised at the variety of responses and very appreciative of many of these responses.

At the same time, I asked each person charged with the employee safety responsibility if they would be kind enough to send me a copy of their employee safety manual. Approximately 32 of the states responded. Several of the states had specific manuals prepared, some with specific instruction manuals in regards to all mowing operations.

I found that different states were using different type mowers due to problems that they had in their particular state. Many of them were using the pull type, push type, flail type, and other tractor type mowers that were the rotor type. Many of them brought out the fact that the reason they had gone to the flail type mowers was because of the problem of guarding the rotators in order to prevent debris in the form of beer cans, bottles, and stones that were thrown by the rotators into passing vehicles, and even sometimes into the mower operator and other employees.

Improvement in chain guarding and other guarding for the rotator mowers and changing the height of the blades appeared to be a part of the practices that were resulting in a reduction of the danger caused by the rotator type mower.

It also appeared that one of the other major problems in regard to accident factors was the failure on the part of the supervisory personnel to early in the season of the year examine those areas to be mowed and to place in the form of protective devices a tall marker that would indicate any drop off, ravine, or soft area, especially in the area of creek beds, that might have resulted from new grading or flooding conditions.

Furthermore, the supervisory personnel should see to it that new personnel are properly instructed as to mower operations, inasmuch as it was felt by many of those who replied that the mower operator had a very difficult job to perform and that he needs to know when, where, and how to control his mower by proper steering and seating and how to avoid scalping and bumping by raising and lowering his cutting edges so as to not create hazardous conditions both for himself and the operators of other vehicles. The operator also needs to be instructed that he is confined to a three to one slope if he is operating a tractor type mower and how to recognize this type slope. However, some states preferred to confine their operators to a four to one slope.

Each operator needs to have his attention called to how he rides in his mower seat and how to be careful to be on the lookout for markers that would indicate holes, sharp turn locations, drop offs, etc., when mowing on even flat slopes, but with special attention to a steeper type slope.

These practices are deemed to be essential along with a policy of using older employees if at all possible, as it was found in many states in examining the accident records pertaining to mower operators that in many instances it was the younger operator and newer employee who was involved in accidents.

In a number of states diagrams are furnished to the employees to assist them in judging the slopes over which they are to mow. In many of the states the operator was urged in these instructions to obtain and wear some type of eye protection, a vividly colored safety vest and, in some states, even a safety cap or hard hat, all in brilliant colors that could be seen quite readily by approaching motorists.

The operator should also be instructed to be sure before he starts out to check out the steering, brakes, and lights on the mower, the safety flags, and if flashing lights are to be used that these are in operable working condition. He should also be instructed to be sure that if his state requires the placing of special signs for mowing operations that these signs are to be in place prior to starting his mowing operations and that they be moved along with the job so that at no time is he more than a half mile or mile from his mowing signs. He should also be instructed to check his gasoline supply before leaving his shop and that he should not fill his tank to the top, in order to reduce the opportunity for overflow when on a slope. The filling of the tank should be done carefully and only when the motor is off and, if possible, when the motor and other parts are as cool as possible. A special effort should be made not to allow any gasoline to overflow or drip upon any heated part of the tractor or equipment. No smoking is allowed at or near this operation.

The operator is urged to consider the wearing of a sweat band which would keep moisture from entering his eyes and to wear safety goggles or some form of face covering if a windshield is not provided on the equipment. He should be advised to use a large enough eye protective goggle or face shield that can be worn over any corrective glasses he might need to wear. These goggles or face shield may be tinted, but should not be tinted to the extent of preventing him from observing hazardous conditions.

The operator is instructed to be extremely careful in leaving the mowing area and entering the traveled portion of the highway, even though only a part of his vehicle might extend into the traveled way. This is especially true when it is necessary to mow near guardrails, posts, in entering the roadway or when crossing structures of any nature.

He should also be instructed to be sure that his motor is turned off in the event there is any necessity for [illegible] cleaning of sickle bars, [illegible] and that this be done with [illegible]. He is never to use fingers [illegible]. In the event it is necessary [illegible] sharpening of cutting edges [illegible] goggles have to be worn. [illegible] necessary when a [illegible] or in any other [illegible] apparent special eye protection. [illegible] by many of the states that [illegible] require continuous [illegible] operations were in effect.

I think most of us certainly realize to take many of these precautions and others

that have not been covered not only is good business practice but reduces the opportunity for damage to mower blades, damage to other vehicles, and the possibility of an accident or injury to the mower operator. Good instructions for the operator in raising and lowering the blades and the cutting edges of all mowers to various heights for different types of mowing operations is good business practice as well as an excellent safety practice.

It was found that a number of states had the same experience that we had in our state of having serious injuries caused to their mower operators when the tractor type mower did not have an anti-tipping device or roll-bar installed. When the mower operator did not have these he naturally did not have the necessary protective devices that he should have in the form of seat belts to retain him on the mower seat if the mower overturned. We know from experience, in farm states especially, that many persons working on farms are killed because of lack of training or knowledge in operating tractors and equipment similar to mowers because they do not have the protective framework that would protect them from being crushed.

Many of the protective frames that have been devised by various state highway departments have provided fine protection for the operator. I would suggest that each type of equipment needs to be studied separately in order to obtain the best positioning for these roll-bars and anti-tipping devices. If you are going to require the operators to use seat belts in addition to these protective devices be sure that the seat belt is placed so that it keeps the operator in his seat when travelling over rough terrain and provides proper protection in the event the tractor does tip over. Many of the states swear by this type of equipment and from their actual accident experience say it has given them improved protection for their operators and resulted in the elimination of serious injuries and fatalities.

It is certainly essential that before any operator starts off with his equipment, especially if he is pulling a load, he checks the drawbar or hitch connection to see that it is in good condition. He should also check this during his mowing operation. He needs to be extremely careful when he is pulling such equipment to see that the hitch is of sufficient length and not too short, so that the force is reduced rapidly enough to prevent his towing vehicle from tipping in the event the towed vehicle is caught on ground or in going up or down an incline. He certainly needs to use great care in not slipping his clutch too quickly when he is applying extra power, as here again this may cause his tractor to become top heavy and to be pulled backwards on top of him.

Other states say their practice of not allowing mowers to mow over three to one slopes, together with a pre-spring cleaning of these slopes and areas, has resulted in a reduction in accidents to operators and claims against the state for damage to passing vehicles.

We have found in our state that one great danger with new operators and sometimes with old ones is that they like to experiment. We had an operator lose an arm last year, even though he had been instructed never to touch the guard or any guard without permission. He removed the guard on the power train, a part of the sleeve of his jacket caught in the gears in the gear box, and his entire right arm was wrenched off from the socket.

We have now made a special effort to lock these protective devices in place or weld them in place so that no operator can disconnect any guard of any nature without the mechanic in charge of the equipment making the disconnection and making any correction that is necessary for that part of the mower that is guarded.

I feel that we cannot do too much in the way of training mower operators and safe guarding mowing operations by a good pre-spring surface clean up job and a continuous policing operation being done in the areas to be mowed and in checking to be sure that guards on equipment are properly in place. Be sure that flashing lights are operating and flags are totally visible to approaching traffic, that all employees wear brilliant orange vests and hats, that eye protection is used when windshields and other protective devices are not provided. Protect the operator from serious injury to his pelvis or groin area by keeping him in the seat. Give more attention to obtaining improved seats and their placement for the safety and comfort of the operator. Many of the old

type mowers have poor spring type seats that need special correction and replacement.

All operators need to be properly instructed to keep a sharp eye on their operation and the area being mowed. Proper signing should be in place to advise the general public of these operations. In many cases, due to narrow right-of-ways and roadbed, operators are exposed to the hazard of traffic.

Older employees realize that mowers cannot take sharp turns and that mowing operations require low speeds and careful outlook of all terrain, even if they have to descend from their mower and walk carefully over the area they are to mow, examining it for holes, ditches, and drop offs. They realize the need to use every precaution to not mow too closely to guardrails, posts, or bridge rails as these are very dangerous practices, to raise the blades or cutting bars and lock them in this raised position when not in use, and to use extra care at all railroad crossings.

Mowing operations can be as safe as any other work operation, but it takes continuous planning and continuous efforts on the part of all supervisory personnel to see to it that the mower operator and his equipment are given the very best attention.

No mower operator should ever be allowed to leave the yard with the mower until his foreman is sure that he is competent in its operation and that he is quite familiar with that particular type and size of tractor or mower, with the gears and cutting bars and their operations, and how to raise and lower them before he is allowed to use the mower by himself.

Many of the states use flail type mowers in order to reduce as much as possible the danger that occurs because of the extreme power of the rotating mower. We need to urge our operators be continuously alert to raise and lower the rotators and cutting blades.

There is a need to plan the job well in advance and to not forget that there is also extreme danger from overhead projecting tree limbs. Before any operator mounts or dismounts from the mower the motor should be shut down. The steps and platform should be kept as clean as possible in order to prevent slipping by the operator. No riders should be allowed on any mower, tractor, or any drawbar or mowing equipment at any time, unless there is a special seat provided for them.

In transporting mower equipment to the area to be mowed, special chains should be attached to the mowing equipment and special blocks placed behind the wheels to prevent the mower from tipping off. Extreme care should be used and special ramps should be provided for those mowers or tractors that are brought to a location by truck to assist in their being dismounted properly. Sickle bars and mowing bars should be raised at all times and locked into place when mowing operations are not taking place and when the mowers are travelling from place to place either on their own power or transported on other equipment.

The mower operator should always be sure that his electric turn signalling equipment, as well as his flashing lights and flags, can be seen by other motorists. They should never take any chances in changing lanes or making turns, always give arm signals in advance and wait until traffic clears before entering or crossing any traveled roadway.

If an operator does get into trouble with his equipment in the form of being stuck or mired down, he should seek help and not try to extricate his equipment without help and perhaps cause it to tip over or be damaged.

It is felt that if proper instruction is given and all of the corrective efforts are made, you can go an entire season with a very limited amount of problems relative to equipment damage or accident. If one careless act is committed and if the supervisor feels that the employee was properly instructed and it was the employee's fault, he should be taken off the mowing operations.

It is felt that much greater attention should be given by Department officials in the selectivity of the various types of mowers for the various types of operations that take place in each state due to the terrain and the type of growth that occurs within any state. In our state we have heavy crops of weeds that require the heavy type mowers in some areas, and light grass shoulders in others.

In our state also we have narrow shoulders that cause a serious hazard because mowing

must take place close to the travelled way. The shoulders in most cases are not paved and a grass shoulder is the only type of protection provided for the motorist.

One thing I failed to mention is the fact that most states are using the triangular "Slow moving vehicle sign" on the rear of all mowers. Other states have large signs that say "Mowers" or "Mowing Operations" on the rear of the mowers.

URBAN PROBLEMS IN TRAFFIC SIGNING AND STRIPING

By WILLIAM E. TUCKER
District Traffic and Safety Engineer, Division of Highways, State of Colorado

Regardless of the type area involved, whether it be urban, suburban, or rural, the basic tools used by traffic engineers are the same. These tools are, of course, signs, signals, and markings, and they are generally referred to as official traffic control devices. It can be stated that any traffic control device should meet five elementary requirements: it should fulfill an important need; it should command attention; it should convey a clear simple meaning; it should gain respect of road users; and it should be located to give adequate time for response.

The Traffic and Safety Section of the Metropolitan District is comprised of three units: field studies and investigations unit; signal maintenance and construction unit; and signing and marking unit. At the present time, this represents a total complement of 30 persons. In many cases, the implementation of traffic control improvements represents a combined effort on the part of several sections of our District. We work closely in many respects with maintenance section and field construction forces. Furthermore, we work with other governmental agencies within the Metropolitan District. Colorado state statutes declare that incorporated cities and towns with populations over 5,000 are responsible for the maintenance and operation of all traffic control devices on state highway routes within their respective jurisdictions. The law also states that all such devices shall be approved by the Division of Highways. This means adherence to the *Colorado Manual on Uniform Traffic Control Devices* and requires extensive cooperation between the Division of Highways and city engineering and traffic departments.

There are several ways in which operational type traffic control problems are recognized.

First, we have our surveillance and observation procedures within the Division. Increasing traffic congestion and potentially hazardous situations, in many instances, are quite obvious and corrective steps can be taken. In these cases, improvements are usually made with the thought of being on top of a situation before it actually becomes a major problem.

Secondly, we have accident records information, furnished by Staff Traffic Engineering Section. These data, together with other traffic study information, enable us to design improvements such as up-dated signs and markings and traffic signal control, together with revised channelization and other roadway geometric improvements.

In this accident analysis field, we investigate the scene of every fatal accident which occurs on the state highway system within the District. The investigating police officers who cover such accidents are interviewed and their official accident reports are studied. Following this, we prepare for the record a written report which details the traffic controls in place, roadway conditions at the time of the accident, and any other factors which might have a bearing on the matter. A determination is made as to the adequacy of existing traffic control devices. Any indicated improvements or additions are made as soon as possible.

The third manner in which traffic problems are recognized is through our contacts with the public. There are several methods

of communication: personal notifications from the people; numerous letters and correspondence; and, lest we forget, there is the trusty telephone! Whatever the case may be, we investigate every complaint, suggestion, request, or what have you, received from the citizenry. In many instances, the complaints or suggestions are not valid, nor the particular request feasible. However, in certain instances, we are made aware of a traffic condition which definitely needs attention. In other words, we can also be guilty of "not seeing the forest because of the trees."

A problem of major proportions is that of traffic control through maintenance work areas and roadway construction zones. However, this problem is not unique to the Metropolitan area. A recent state-wide composite report for accident experience in construction areas and detour routes covers the previous four-year period. This includes only state highway routes. There were 1,768 reported accidents with 40 persons killed and 779 persons non-fatally injured. This represents a total economic loss of $4,140,660.

Any time you have to work in the traveled lanes of a highway, you have a potentially dangerous situation. However, the high speed, heavy volume freeways are by far the most hazardous. Working hours on the freeway systems in Denver are limited to off-peak periods. Generally, this is considered to be between the hours of 8:30 A.M. and 3:30 P.M.

Lane closures present one of the major challenges in freeway work areas. We use the standard type signing sequences; i.e., "ROAD WORK AHEAD," "LEFT (RIGHT) (CENTER) LANE CLOSED AHEAD," "MERGE RIGHT (LEFT)." The advance warning signs are followed by a taper of cones or barricades, which physically close the lane. Going by the book, this taper length should be equal to the lane width times the approach speed. Or, when closing a 12-foot lane in a 50 mph speed zone, the taper length should be 600 feet. In many cases, the field conditions (closely spaced interchanges, on and off ramps, acceleration and deceleration lanes, etc.) will not permit setting up these optimum taper lengths.

Still another item of concern is our continued efforts to keep pavement markings in acceptable condition throughout the year. As you well know, adverse weather conditions, with salt and sand applications, do little to enhance the life of paint stripes. Yet, we feel that pavement markings are, perhaps, the most important traffic control device on freeways. Any semblance of lane control will provide a safer operation. During the past two summers, the Division has installed approximately $100,000 worth of permanent type pavement markings on the freeway systems in Denver. This includes both thermoplastic and cold plastic type materials. The highway sections covered include some of the heaviest traffic volume areas in the District.

In the field of traffic signal control, we have the usual problems—keeping coordinated signal systems in sequence, installing new signals at intersections, where warrants are met, and lamp maintenance, together with the inevitable mechanical and electrical malfunctions. (There followed a series of slides on the application of traffic devices and ings.—Ed.)

DEVELOPING A STATE SAFETY PROGRAM

By HARRY HATCHER
State Safety Coordinator, Madison, Wis.

Like most public employers, Wisconsin was late in coming to recognize the importance of a safety program for state employees; this in spite of the rigid safety code standards demanded of private employers. Since the initiation of Wisconsin's employee safety program, however, the state has experienced such a graphic reduction in injuries and such a savings in man hours, medical costs, and disability compensation that we now realize no public employer can afford *not* to promote a positive safety program. We estimate our savings at more than a quarter of a million dollars a year.

Safety is not always an easy program to sell. It means convincing employees that the way they have always done things may not be the best or the safe way. It means that safety rules and procedures must be established and enforced. It means getting the cooperation of management and employees all down the line in reporting accidents and unsafe conditions, and even in thinking in terms of accident prevention. A safety program costs money to initiate and maintain, but the cost is small compared to the cost of injury in dollars, time, and suffering.

The scope of jobs in government, particularly at the state level, makes mandatory a special emphasis on safety. Those who are not aware of the kind of services the state provides may view safety as not particularly important for bureaucrats sitting behind desks. Actually, state government is involved in more jobs, more types of jobs, and more hazards than most industries.

The State of Wisconsin, for example, has 33,000 employees in about 1,200 types of jobs in 2,000 job locations. (Part-time seasonal help boosts the figure to 45,000 employees.) Because of the varied job locations, there is often no environmental control or immediate supervision.

The state operates many office buildings, 42 farms, hundreds of laboratories, several hospitals, prisons and correctional centers, vocational schools, universities, hundreds of kitchens, warehouses, loading docks, dozens of parks and forests and fish hatcheries, and the third largest telephone system in the state. The nearly 5,000 state-owned vehicles include snowmobiles, ice boats, and maintenance trucks as well as airplanes and motor boats.

The state employs construction workers, electricians, foresters, boiler operators, enforcement officers, highway engineers, doctors, teachers, people who sit behind desks, etc. for the 1,200 different kinds of jobs in state service.

Because of the variety of jobs, our employees are injured in quite varied ways: a veterinarian for the Department of Agriculture hurt his back trying to take the temperature of a sick pig; another man was gored by a bull on an experimental farm; a boiler blew up during repair, injuring two men; five men died in two plane accidents; more than one employee a year die in motor vehicle accidents. Dozens are injured by patients and inmates. A light fixture in a college library fell on one girl, and a window fell out, cutting the face of another. Employees contract poison ivy in the parks and shigella and hepatitis in the hospitals. They are stung by bees and bitten by dogs. Several police officers were injured in self-defense class, and more in high speed chases. Tractors and grass cutters have rolled over on operators. One man fell through a ceiling while he was servicing air conditioning equipment. One man fell out of a tree while cutting off a limb. Several fell when ladders broke, others fell while climbing on chairs, walking down stairs, or by slipping on wet floors or ice. One man was injured when he was knocking down a wall and a chunk of concrete hit his head. A bolt flew out of a snowblower and entered one man's head; a grinding wheel exploded and tore into an instructor's shoulder. Fingers are caught in file drawers and burned on coffee pots. And so it goes—nearly 4,000 accidents per year (2,100 compensable) and a cost of about $2 million annually.

Determined to improve the safety program for state employees, Wisconsin hired a full-time Safety Coordinator in January, 1967.

His challenge: "We don't have any answers —only problems. You find the solutions."

The first approach was to establish a program, Wisconsin Safety 70, designed to reduce accidents to 70 per cent of the 1966 level by the end of 1970—a less than 10 per cent reduction a year. This was to be done in five areas simple in philosophy, complex in implementation, but effective: safety education; personal protection; machine guarding and maintenance; supervision and control; and records (inspections, investigations, analyses). In March, 1967, Wisconsin Safety 70 was on its way, and at the end of nine months the accident frequency rate for state employees dropped from 8.7 (nearly nine accidents per million man hours worked) to 8.1. At the end of 1968 this frequency dropped to 7.5—a 14 per cent reduction in less than two years!

Safety education is of prime importance in beginning a new program, and it is almost the magic ingredient in safety. This got underway on all fronts: defensive driving for all state employees; training for supervisors and foremen; training for specialized employees (maintenance, etc.); administrative policy statements for all employees and all agencies; and monthly articles in our employee newsletter.

The Defensive Drivers Training began in March, 1967, and 15,000 employees have now had this eight-hour course. Governor Knowles was the first governor in the nation to take the training. He has issued a directive that all employees must take the course and follow up with a two-hour refresher course after two years.

A manual, *Safety Dynamics for Supervisors,* was prepared by the safety coordinator, and this eight-hour course has been given to 1,000 supervisors and foremen. A dozen one-hour "Instant Safety" training programs were prepared for maintenance and office people on such topics as eye protection, safe lifting, electricity, use of safety belts, office safety, housekeeping, and hand tools. More than 2,600 employees have been given these short courses. An *Employee Safety Handbook* was written and given to every employee to make all aware of the general safe work practices. More than 1,000 posters are distributed each month, matched by one-page safety memos on subjects pertinent to a particular agency, such as ladders, lawnmowers, axes, fire, compressed gases, driving, machine guarding, welding, and housekeeping.

Personal protection is a necessary part of any effective safety program. The first step was to direct that all employees working in occupations hazardous to the eyes be provided with safety glasses at state expense. To date, 6,000 employees have been protected, with more to be provided with safety glasses as needed. It's already paying off. The National Society for the Prevention of Blindness presented Wisconsin with the first Wise Owl Charter ever awarded a state for its eye protection program, and a plumber received a Wise Owl pin because he was wearing his safety glasses at the time molten solder blew into his face. Governor Knowles said, "The use of safety glasses undoubtedly saved him from serious eye injury. This one fact alone is enough to justify the cost of the entire program." Eye injuries were reduced in one year from an annual toll of 160 down to 62. Has this saved money? If you think only of dollars, one lost eye costs us $25,000.

Hard hats, gloves, masks, and other protective devices are also provided where needed. A hard hat saved the life of the man who was struck by a falling tree limb —he suffered only two broken teeth. Foot protection is needed badly; the state is experiencing 145 foot injuries a year, costing approximately $8,500 plus 500 days lost time.

The directive (which is expected to be in effect soon) on safety shoes gives an insight into the variety of state jobs that are hazardous to the feet. "Foot protection shall be required on the following jobs: farm, heavy machinery operation, machine shop work, handling heavy barn stock, construction, logging, timber cutting, brush cutting, operation of lawnmowers and grass cutters, loading-dock work, warehouse work, trenching, plumbing, pole climbing and pole installation, weights and measures work, power plant work, highway construction surveys and work inspection, demolition and remodeling (where walls are being knocked down), inspection of building construction work, wading in streams and lakes and any other job where the employee is exposed to any hazard which reasonably may be expected to cause injury to the foot."

Machine guarding is complicated only because the state facilities are so numerous and

so widespread geographically. Nearly every agency has shops and laboratories: the Division of Highways, with maintenance shops and soil testing laboratories; the Department of Administration, with shops in the state office buildings; the Department of Health and Social Services, with maintenance shops and laboratories in hospitals and prisons and with vocational shops for inmates; the Department of Revenue, with laboratories for testing the quality of petroleum products shipped into the state; the universities with complexes of shops and laboratories; and many, many others.

This problem was enhanced because, although the state has a Bureau of Purchases and Services, each agency can buy small tools and machinery if the cost does not exceed a certain limit. Another complication was that the state has a constant multi-million dollar building program in progress, and equipment in the power houses, machinery rooms, and boiler rooms was being installed without guards.

The solution?

A concentrated inspection program by the safety coordinator showed literally hundreds of grinders, couplings, belts and pulleys, saws, fans, and compressors that must be guarded.

The Bureau of Purchases now requires that all equipment and material acquired must conform to the state safety code, and the Bureau of Engineering wrote into their specifications that all machinery and other equipment (steam pipes, etc.) must be installed in strict conformance with the safety code.

Because the state operates some type of facility in about 2,000 locations over the state, the Department of Industry, Labor, and Human Relations has launched a two-year program to bring all facilities up to the safety code. New specifications are being written for state-owned machinery, such as farm tractors that will require the use of the Slow Moving Vehicle emblem, canopy or roll bars, rear view mirrors, and turn signals. Safety precautions such as safety feet on ladders, better maintenance of equipment, top pumps on gasoline barrels to replace the old gravity spigots, more and better fire extinguishers, and the use of grounded outlets and grounded cords on machinery and power tools all have helped us drop that frequency rate.

Supervision and discipline was needed not only to control the purchase and use of safe equipment but to keep up the inspections and the training. Two points are important here: Supervisors had not been given education in safe practices, and "discipline" meant punishment to many people. The term that fits better is "Supervision and control," and the first step was the education of supervisors and foremen, which is being done by the safety coordinator and by key instructors from the Department of Industry, Labor and Human Relations.

Not only do they get an eight-hour course on Dynamics of Safety, they also are taken on inspections of facilities and on accident investigations. Often job procedures are changed, new equipment or materials required, and additional education suggested for employees. "Control" means inspections, maintenance, better reporting, knowing when and what to train, and changing job methods. We have found new ways of doing many things—dispensing hazardous chemicals, extra protection for the employee, use of different products, a safer way to do a job.

Some examples: One man suggested a different piece of equipment to make it safer to wash windows in old multiple story buildings that cannot be equipped with safety belt hooks. He was given $50 through the state suggestion system. In a laboratory where ether was stored in a refrigerator, there was an explosion (at night, luckily) when the controls kicked in, causing a spark to ignite the ether fumes. The explosion and fire did more than $1,000 damage to the laboratory, but if the girls who worked days had been present they would have died. Refrigerators with controls outside the box are now required for storage of flammable liquids.

An order was given that the state would no longer use carbon tetrachloride for fire extinguishers nor as a solvent. It was simple to find substitutes, but game wardens who had used the chemical to defat animal and bird skins for specimens requested help for their particular problem. We found a chemical which can be used with a detergent to do that job.

Men who are sensitive to bee venom are desensitized at the University of Wisconsin Hospital, because we nearly had two deaths from bee stings.

Records are vital for the proper and sensible continuance of any accident prevention program. You have to know where the action is and what that action is. A new accident reporting procedure was begun with added emphasis on two things: Supervision must try to determine a means of preventing a recurrence of the accident, and all accidents are to be reported even if no injury occurs. This last item is important because previously only compensable injuries were reported. This left a big gap in our information since an injury is compensable only if there are more than three lost days, or if a part of the body is lost, such as a finger. We need to know property damage, the unsafe act, the hazardous equipment, and the many other things that were not being recorded.

The new reporting system is paying off because now we are getting information we did not get before. For example, the following would not be reported under the old system: the explosion in the laboratory; a tractor accident that broke the tractor in two when the driver turned left without checking traffic; a boat that blew up and burned when the operator forgot to blow the bilge after fueling; a truck that was wrecked after an employee backed it over a cliff; chemical burns from a germicide when an employee was splashed while not wearing protective clothing (we found the product too strong and have changed to another); a small fire in a waste basket at one of our institutions for mentally handicapped children; and a man who fell through a ceiling (there was no platform for maintenance men working on air conditioning equipment). Because no one was injured badly enough to apply for workmen's compensation, these would not have been reported previously.

The report form is designed so that data processing can be used to wring out more information and show us trends in areas such as age, training, and time of day and year, weather, location, occupation, and many other pertinent facts.

While sometimes the [illegible] figures are impressive and are meaningful to those who want to think about them and interpret them, we are also pleased with a few simple facts: We are reaching our goals of accident reduction, of education for supervisors and personnel, of personal protection and machine guarding, of investigation and inspection and reporting.

Wisconsin Safety 70 is paying off. Accidents were costing us $2 million a year; the 14 per cent reduction in accidents that we have experienced means a saving of $280,000—and more this year and more next year and the next.

We have much to do—more comprehensive programs for farm and laboratory safety, much more on total campus safety (student quarters, teaching areas), hazard control in offices and hospitals, pre-employment physicals, noise control, hazardous chemical control, and much more.

So what is in store now?

You can't begin a safety program and sit back and let it ride, because there are always new people, new jobs, new processes, new chemicals, new procedures, new equipment. This calls for a continuous safety program which is constantly being updated. The old concept must be combined with new approaches, new training, and new directions to zero in on the problem areas that show up in the analyses of the programs and the accidents.

We are concentrating now on the environment: the design and construction of buildings and facilities, the use and maintenance of buildings, and the equipment and the materials used. We find that in many instances we have built in booby traps to catch the employee in the regular routine of his job and injure him or destroy equipment. The man who fell through the ceiling was attempting to service air conditioning equipment that had been put out of sight above the acoustical tile. The bad part: We had not planned for oiling the equipment nor for setting the thermostat, and the maintenance man had no way of reaching the machinery except to crawl on his knees along two beams. He slipped and fell through. We have corrected this situation now.

Unknowingly and unthinkingly, members of management responsible for the design and construction of facilities have at times forced unsafe working conditions on employees. A state law, our Safe Place to Work Statute, reads in part: "Every employer shall provide a safe place to work and shall provide safe work for the employees. . . ." That is *our* intention.

Once management concentrates on hazard control for the situations with high potential for accidents, a great deal can be done to reduce accidents. We took action on hazardous machinery, equipment, materials, and chemicals. We then took action on hazardous job procedures.

One hazardous situation was the method used for taking fish census; men wading in a stream pulled a fibre-glass boat containing a 230-volt generator. Wires led to long poles which the men held. They dipped the electrode on the end of the pole into the water, shocking the fish and causing them to float unconscious to the surface where they were picked up, counted, and classified.

Our safety coordinator pointed out the hazards in this procedure because an employee might slip and fall into the water. Our Division of Conservation had been doing this job in this manner for ten years and fortunately no one had been hurt, but that is hardly a recommendation for continuing an unsafe procedure. So it was directed that a tape pressure switch be mounted on the rods, connected in series, requiring eight ounces of thumb pressure to operate the shocking apparatus. Now, if one man slips and drops the pole, the power is cut off and there is no danger of being electrocuted. Since this is the first safety equipment of its kind, our Department of Natural Resources is making information on it available to other jurisdictions that might be in need of it.

There are other examples of equipment change and material change, but now we have gotten into a whole new area of environmental safety—the buildings themselves. People have fallen on stairs that had no handrails. They have walked through glass walls that looked like doors but were not. Our employees found it nearly impossible to wash windows on high-rise buildings because they couldn't open the windows. We have new facilities with sharply sloping lawns that cannot be mowed with regular grass-cutters. We either have to plant them with ivy that doesn't have to be mowed, or attach ropes to a small mower and waste a man's time as he lowers the mower down the steep slope and pulls it back up, exposing himself to additional hazards of back and foot injuries.

We have elevated walkways with no handrails; open pits in front of electrical panels and switches; open stairwells in a building for small, mentally handicapped children; dock areas that cannot be gotten to with a truck, forcing employees to unload out in the driveway and carry equipment inside; door knobs installed so close to the jamb that you cannot turn the knob without crushing your fingers; huge marble slabs facing a building that were not installed properly and fell off; flammable liquids storage areas with no "blow-out" walls; sound-proof rooms with no emergency signals of any kind for the employees and students inside; boiler rooms with no fireproof insulation; incinerator vents dispersing smoke into an air conditioning intake; and the list grows—all designed, constructed, built-in hazards that can cost much money in medical and compensation bills.

We are beginning to understand that if you cannot sit comfortably in your chair, if you cannot get adequate light and heat, if you cannot get ventilation because there is not adequate air-flow, then we can expect accidents and reduced efficiency. If maintenance employees cannot service the equipment that you must have to keep the building operating and to keep your job continuing, then we have failed in the design for proper, economical, accident-free use of the building. If the lawn cannot be mowed safely or the windows washed or the sidewalks cleared or the lights changed when they burn out, then how can the work of the state be accomplished in the manner in which it should? And if we make it difficult for the maintenance people to function, then it will also be difficult for us to use the facilities, and costs go up—in manpower, in lost time, in medical and compensation bills.

Previously, we put the responsibility on the employees to be careful, alert, and aware, and we blamed them when they were hurt. Now we know: we must design equipment, tools, facilities, machinery and work environments so that they are pleasant, comfortable, easy to work with, and as accident-proof as possible.

If the department head has an electrical outlet protruding from the floor in his office, he will eventually fall over it. (One secretary fell over a telephone cord and broke her leg.) If the Governor's private conference room has no handrail on the stair (as was the case in our Capitol building), he may have an accident there. If there is no guard

on the fan, someone will get a finger in it and lose the finger, as has happened to us. We cannot always control the human element, but we can control the environment to a large degree.

Upcoming is a new six-hour training course, "Dynamics of Safety for Management," now being prepared by our safety coordinator. It will point out the need for a safer environment for our employees. It is directed at the decision-makers—those who decide on programs, new buildings, new equipment and processes and procedures; those who handle the budget and spend the money and establish training and jobs.

We believe it pays to get everyone involved. We know we have to involve everyone in our total safety program because no one is immune. The General who was head of our Department of Military Affairs was killed in an airplane accident this year. So was a volunteer fire fighter, in a forest fire. No one is immune, so no one can be left out of the total, comprehensive effort.

We have employed a fleet manager to coordinate the purchase, use, maintenance, specifications, and disposal of our nearly 6,000 vehicles, planes, boats, and other motorized equipment. The potential savings here goes beyond the safety aspect and gets into proper management.

Our safety coordinator has been asked to chair a new study committee to establish emergency evacuation procedures for all state facilities so we can get employees out of the building in the event of a tornado or fire as fast as they get out at 4:30 P.M. every day.

Our goals were set when we began this safety program: a 30 per cent reduction in accidents and costs in four years. In less than two years we have had a 14 per cent reduction, and we are saving our state a good chunk of that wasted $2 million accident cost. Perhaps you can do likewise.

SAFETY AND SUGGESTION SYSTEMS

By RICHARD D. BYROM
Div. Safety Repr., Transmission-Chassis Div., Ford Motor Co., Livonia, Mich.

The impact of the suggestion box, like the ballot box, should be better understood and appreciated by industry—there is a real penalty for failing to do so. Suggestion programs and their administration are big business. In the Division that I represent, consisting of seven plants primarily engaged in the manufacture of transmissions and chassis components, our employees, during the twelve months of 1969, submitted 57,826 suggestions and management proposals of which a large percentage had some safety connotation. As impressive as these figures are, our experience is just average when compared with other Divisions of the Ford Motor Company. If there were no other considerations than the basic mechanics of just handling that much paper, the size and the scope of the program would be tremendous.

In any objective review of a program we must recognize that there are always two sides to the coin, and the safety relationship to the suggestion program is no exception. It has always been my feeling that we hamper the growth of our programs because of our reluctance to "tell it like it is." It grieves me to think that safety activities are not properly taking advantage of suggestion systems as a program aid.

Suggestion programs, properly administered, afford the safety engineer a unique opportunity to utilize individual employee experience. I use the word "unique" since the suggestion program is the most universally successful attempt I know of to utilize the largest untapped source of safety program assistance—individual employee experience.

Perhaps the principal weakness in organized safety today has been the failure to implement programs which are specifically designed for employee participation. This failure to include the employee in the planning and direction of what is, after all, his safety program not only has excluded thousands of years of composite experience and knowhow, but has resulted in the development of employee attitudes which are not consistent with today's safety program efforts. Too often, without recognizing it, we have supported the notion that management can cloak the individual employee with safety through the expenditure of money and the establishment of physical environmental conditions. With some help from us, the employee has come to believe that safety can be provided as simply as paying for a suit of clothing, a fact that could not be further from the truth.

In the beginning, our safety problems were so obvious that we were able to proceed without the active assistance of the individual employee. In fact, we were inclined to resent his suggestions as an intrusion. But I believe that most of us have found that, as we have progressed over the years, those problems which were deemed of little consequence just a few short years ago are of major importance today. Despite remarkable mechanical and environmental progress in industry, we continue to have accidental injuries which appear to be as serious in nature as anything experienced in years prior. In effect, we have reached a point in the development of our programs where the active participation of the hourly employee is necessary if we are to continue to reduce the incidents of accidental injury. Although I still see material printed which supports the idea that 80 per cent or more of industrial injuries result primarily from willful employee unsafe practices, our experience has never supported this philosophy. Objective reviews of the incidence reports that come over my desk indicate that physical factors, to a large degree, continue to be a principal factor in industrial injury. Since employee safety suggestions represent a kind of employee participation and ordinarily deal with the environmental aspects of his job or work place, the suggestion program, properly administered, can make an important contribution to accident prevention.

I have no way of knowing the climate to be found in other plants or industries, but I feel that I can reasonably assume that the basic problems are similar. Our plants are growing in size. It is not difficult for me to look down the road and envision individual

facilities with 10,000 or more employees under one roof. The old line foreman working his way up from the tool room is a rapidly diminishing breed. Many of our foremen today lack the intimate knowledge of the machines and equipment that his predecessor had. Through no fault of his own, he cannot be expected to have developed that sixth sense so fundamentally a part of the industrial situation just a few years ago. Tremendous demands are being placed on the line supervisor's attention. It is not unusual for supervisors to be transferred from one department to a dissimilar operation as production needs require. At first glance, it would appear that we have irrevocably lost direct communication with the operator and his machine except for the information that comes from the analytical computer, and yet the necessary information is still there, neatly tied up in the experience and knowhow represented by our employees.

One employee communication tool available to us now is the suggestion program. For the most part, the suggestion program people have done a good job, one which in many areas the safety representative could copy. In some plants I have had occasion to visit, the bulletin boards, display areas, etc., exhibit more imaginary material on a current basis than has been provided by the plant safety engineer, nor do the suggestion program people blush at the establishment of material awards for employee participation. These awards run in some companies from a minimum of $20 to a maximum of $6,000 in cash and a $3,000 automobile.

So far we have only touched upon the plus side of the suggestion program. Unless the spirit of the program is jealously guarded and the program objectively administered, there can be a negative aspect. I am sure that in many plants original safety staffing did not include the probable effects of a high volume suggestion program. It is not unusual in some locations, where effective well-publicized suggestion programs are punctuated with periodic special incentive drives, for the safety engineer to be called upon to investigate hundreds of ideas during brief periods of time. For the old time safety engineer the suggestion workload is an intrusion and all too often he finds it overwhelming. In some instances the very number of suggestions can threaten the purpose of the program because the safety engineer finds it physically impossible to properly evaluate the individual idea. I have had occasion to review suggestions where it is obvious that the safety representative has used four or five stereotype sentences in order to dismiss an idea without the necessary evaluation.

This negative approach by the safety engineer is compounded by the fact that the employee often associates him with the suggestion program. There is, perhaps, a no more deep-seated discontentment than that felt by an employee who has received a negative response to an idea that he has submitted which indicates that his idea has not been thoroughly investigated. This type of handling of an employee suggestion can help create negative employee safety attitudes. What is badly needed is a middle ground between extremes of large value suggestion programs, supported by recurring promotion campaigns encouraging the "nickel" suggestion, and the inertia of the safety engineer who, in defense of his own defined area of responsibility, seeks to discount the value of the suggestion system.

Recent industry company-union negotiations have resulted in escalating company programs that fall into the category of "employee benefits" to very sensitive positions. If safety ever was something industry provided as a matter of conscience or just to reduce compensation cost penalties, that has been changed now. It is no longer considered enough to have a safety program; that program must produce positive safety results. The environmental aspects, such as housekeeping and ventilation, have come in for particular attention. The experienced safety engineer knows that the only sure way to prevent his program from becoming a political football program is to put forward the best possible safety program.

Many conditions arise within the plant that are known only to the machine operator, and unless he routinely participates in the correction of these hazards and becomes part of the overall safety program, permitting and aiding us in the solution of our problems, little further safety progress can be expected. I'm convinced that the need for employee participation in today's program is well defined. Aside from the safety meeting aspect of organized safety, the next most effective means of providing for employee participation (at the point of development

of most programs today) is the suggestion program.

The individual safety engineer must learn to make the best of the level of development of the suggestion program as it exists in his plant, and not seek refuge in the defenses we discussed earlier.

To this point, I may have sounded critical of the individual plant safety engineer. The safety engineer's task is not an easy one. The demands placed upon his time have grown to the point that relief is mandatory. Organized safety is utilizing every available communicating media to impress upon the line supervisor his responsibility for individual employee safety. In theory, when the line supervisor recognizes his responsibilities in this area, the safety engineer then may begin to assume the role that was originally envisioned for him—that of a program administrator. The development of the supervisor's response to job safety responsibility has not been as broad or successful as we thought it might be by this time. I suspect that the suggestion people have found the same to be true in this area. On occasion, a percentage of the suggestion workload being placed on the safety engineer is due to the suggestion people having encountered difficulty when referring suggestions to individual job supervisors and having to a degree abandoned this aspect of the program and forwarded many of these ideas to the safety engineer. The resulting estrangement does little to advance either of our programs. More complete screening of suggestions before they are referred to the safety activity is an important must. A narrower range of safety engineer responsibility must be envisioned by the suggestion coordinator. The suggestion coordinator must himself become more conversant with general plant safety policy.

In summarizing, permit me to observe that, at the Ford Motor Company, cooperation between safety and suggestion people has saved lives and countless instances of unnecessary suffering, improved working conditions, and created new jobs. It is only when you compare the progress made with the tremendous potential for progress that you become particularly concerned about the need for closer and more effective cooperation. As a safety engineer, let me say that the suggestion people have provided us, particularly in the promotional and imaginative areas, examples that we would do well to follow.

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National Safety Council

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March 21, 2001

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