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C. I. 78-1978 — 78-1993

1977 National Safety Congress Transactions

VOLUME 8 Construction; Public Employee

PLAINTIFF'S EXHIBIT
NSC-321

National Safety Council

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65th NATIONAL SAFETY CONGRESS

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Construction Sessions

TOVEX WATER GEL blasting agents A COMMITMENT TO SAFETY

By M. M. CHAMPION
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Several years ago a decision was made at Du Pont to discontinue the manufacture of dynamite. Du Pont's safety accomplishments had placed it foremost in industrial safety among large corporations, and the infrequent mishaps in dynamite plants dictated dynamite's end in this company.

This rather momentous decision was a commitment to safety and was separate and independent from another decision. This second decision was to move ahead with the further development and sale of a full line of water gel explosives. Since beginning with a few water gel applications in huge open pit mines, very promising research was producing encouraging results toward water gel products in diameters as small as the smallest dynamite. Men with as much optimism as they had faith in ultimate success decided to proceed with the water gel program as a phased-in replacement while phasing out dynamite. The program was approved by the executive committee due to the superior safety aspects of this new type of explosive. Since their decision to cease dynamite operations was safety-based, it is natural that their decision to proceed with water gel was likewise safety-based and justified. And so the two decisions became one single effort.

Several very busy years have now passed, not without problems and not without considerable effort. Conversion of our business for the benefit to explosives users and ourselves was the word of the day. Our technical field people concentrated on selling the idea of conversion from dynamite to our water gel and then demonstrating its capabilities and suitability as a complete replacement for dynamite. The product line was named Tovex, because the Tovex water gels used for several years in large hole blasting had earned a good name.

Water gels were invented around 20 years ago as a result of a deliberate search for a way to use the very soluble, inexpensive ammonium nitrate in wet conditions. This invention caused dynamite over four inches in diameter to largely disappear in the 1960's. Since ANFO dissolves immediately and is too light to sink in water, it has not been a good wet hole blasting agent. When making water gel, the approach is to dissolve all the ammonium nitrate that will dissolve in hot water, add a sensitizer, and then thicken and crosslink it for the desired consistency.

Let's take that one step at a time. Ammonium nitrate and often some sodium nitrate are converted to supersaturated solution. In this form they are not able to absorb more water as they do in their dry forms. These solutions of oxidizer are too insensitive to detonate in solution and need to be sensitized to be useful as explosives.

Originally the sensitizers were high explosives such as TNT or smokeless powder. In pellet or flake form, these government surplus explosives were added to provide detonating capability throughout the early water gels. These sensitizers caused the ammonium nitrate and sodium nitrate solutions to detonate

and, therefore, release their energy in rapid decomposition. Of course, these solid sensitizers would not stay evenly suspended in the original solutions, so the solutions were thickened to suspend and disperse them. The thickener was Guar Gum, a vegetable product which hydrates and therefore thickens a solution.

Many of you know that an oxidizer such as ammonium nitrate or sodium nitrate needs some carbon to burn for an efficient explosive reaction, so carbon in the form of an oil, fine coal, or other form is also added. Now the mixture is in a heavy syrupy form, but not yet gelled to a springy, rubbery state.

The final step is cross-linking. This is accomplished with a small quantity of cross-linking chemical which causes the molecules to form long chains which grab on to other chains. This gives the water gel its final consistency as desired, whether stiff, firm, and rubbery, or thinner material that can be poured or pumped but is still resistant to dilution. The first water gels made with high explosive sensitizers were good performers in very large blast holes, but were not sensitive enough for smaller holes. They were not cap-sensitive, in spite of their high explosive content, and could not be detonated simply with dynamite primers. So it was necessary to use special primers cast from military type materials such as Composition B, TNT, or Pentolite. These primers detonated the water gels efficiently.

Soon some manufacturers were using fine aluminum for sensitizing in place of the TNT and smokeless pellets. This worked also, but as developments proceeded, more sensitive gels were made so that small holes in the 3-1/2-inch diameter range and smaller were loaded with water gels also.

The final stage is the development of gels that were cap sensitive so that the product sizes typical of underground mining and jack hammer holes could be made by some manufacturers. This technology came much slower and took several more years to develop. A breakthrough in sensitizer was needed. This came when Du Pont researchers discovered how to use monomethyl amine nitrate as a sensitizer, instead of metal or high explosive pellets. When used to produce cap sensitive products for two-inch and three-inch diameter products, the blasting results were excellent in quarries and construction, and a successful family of Tovex products entered this market, replacing many millions of pounds of dynamite.

In 1972, Tovex grades in one-inch, 1-1/8-inch and 1-1/4-inch sizes were successfully introduced in underground mines. The last phase had begun. We had gradually closed dynamite plants at Birmingham, Alabama; Louviers, Colorado; Du Pont, Washington; and Martinsburg, West Virginia. This last location made the last Du Pont dynamite January 14, 1977. Tovex plants were put on stream at Birmingham, Alabama; Seneca, Illinois; and Martinsburg, West Virginia to replace the dynamite capacity.

All of this could not have been accomplished unless the water gels had performed well.

Tovex gained acceptance, sometimes reluctantly, but solidly. Operations that had experienced accidents were very interested in safer explosive. But these are a small minority. A majority of all operators, we found, are also interested in safer products for blasting, and the use of Tovex spread steadily. In mines and quarries and construction, operators often showed great patience and determination to make the change even in the face of occasional performance problems of the early days. Their faith in us matched our faith that their decision would be to accept Tovex in place of dynamite they had used for many years.

Not everyone was overjoyed at changing from a product they were familiar with, knew how to use, and depended upon. Not all new products that operators try work well, and many customers were uneasy about Tovex. But Du Pont lost very little business in this process. The issue of this revolution in the

explosives industry is no longer in doubt from Du Pont's standpoint, and there is less doubt everyday that dynamite will be totally replaced eventually.

Now let's talk in more detail about the properties of Tovex water gels. Since the major difference from a performance and safety standpoint is far less sensitivity, successful use of Tovex has meant that blasting results equal to those of dynamite must be obtained, even with this lower sensitivity. For many operations, no problems at all interfered with this requirement. In some, however, a little more care in using the product was necessary.

In the context of Tovex's low sensitivity, dynamite is unnecessarily sensitive. This has several effects on safety. It means that machinery impacts may detonate dynamite when it is run over by track equipment or drilled into. It also means that a separation of the loaded column is often compensated for by the sensitivity of dynamite, since it propagates across a far larger air gap or column separation. A pile of dynamite on the ground, ready to load, can be detonated by bullets, impact from machinery, etc. and, if it shoots, will explode other piles in the area many feet away. Tovex is not detonated by these same machinery mishaps and, if it did, would not propagate the detonation more than a very short distance. But this lower sensitivity also means that if there is a separation in the column, the entire hole may not be detonated when the cap is fired. Viewed this way, dyanmite's greater sensitivity means that dynamite is more forgiving of questionable loading methods except dangerous treatment, while Tovex is much more forgiving of accident possibilities which may lead to tragedies.

Of the problems along the way that at first seemed serious, most have disappeared or been resolved with research of simple, effective measures. One such problem was the lowered sensitivity at very cold temperatures. All explosives become less sensitive when cold, including dynamite. When dynamite becomes cold enough, it will not shoot from a detonating cap. This happens below the temperatures ordinarily experienced in use. In water gels, this insensitive point is much higher than with dynamite. Many grades were at first only sensitive to cap initiation above 40°F. More recently the temperature tolerance has been lowered to 20° and lower in many grades, and further lowered to perform well at 10° and colder by the use of a small Detaprime booster sleeve on the cap. Actually, in use, the product temperature quickly comes to rock temperature, which for all but a few areas in upper Minnesota, Maine, and the very highest Rocky Mountain areas is over 40°. So the so-called "temperature problem" has not been troublesome for most applications. Where winter product temperature gets as low as 20° or less and the product is detonated while still that cold, the booster, costing only a few cents, is a simple, effective solution.

Now let's look at some detail of safety tests. Tovex is impressive in a bullet test. In this test, a 30-06 steel-jacketed (ball ammunition) rifle bullet weighing 150 grams, with a muzzle velocity of 2,700 ft./sec., is fired into a Tovex water gel sample backed by a 3/4-inch steel plate. The sample and plate are both at 90°F and at a distance of 75 feet from the muzzle. Samples must not detonate. Dynamite most certainly will.

It can be easily imagined how this appeals to certain officials concerned about terrorist activities. And, of course, it represents a point impact exposure more severe than industrial impacts.

Another impressive test is the Hot Bar Test. A sample of Tovex is dropped onto a hot plate kept at 480°F. Material must not rapidly decompose or detonate in four out of four tests.

In a thermal stability test, Tovex is held for 24 hours in a thermal bath at 250° and must exhibit no exothermic reaction; that is, the sample temperature must never exceed the bath temperature due to heat generating reactions.

In the Hot Tip Test, a sample of Tovex is lowered onto a plate heated to about 1900°F. Detonation must not occur in four out of four tests.

Finally, in the case-to-case propagation test, a full case of Tovex is detonated 13 feet from another full case, and receptor case must fail to detonate in three out of three tests when held at 90°F.

Passing these tests distinguished Tovex from dynamite.

A further idea of the sensitivity-to-impact comparison can be seen from a standard dynamite drop test. Typical dynamites detonate 50 per cent of the time when a sample is struck through (a striker-pin arrangement) by a 4.4-pound weight falling 15 inches. Tovex does not detonate when hit by a 40-pound weight falling 15 feet (the limit of the test equipment).

These are convincing test results. For the operators, one of the most popular properties of water gels is their inability to cause headaches. Many powdermen typically experience the painful headache and sometimes nausea of working with nitroglycerin dynamite. Water gels don't cause this discomfort and are well liked for that reason.

Though not directly related to headache, blast fumes (the toxic gaseous products of explosive detonations) are also much reduced compared to dynamite. In tests conducted by Mine Safety Appliances Co. for the U.S.B. Mines in two underground mines and in the Bureau's 1,350 cu. ft. test chamber, the CO and nitrogen oxide levels for Tovex were 2-1/2 times lower than those for semi-gelatin dynamite. Visible smoke volume is also much less than with dynamite blasts. However, we recommend that you wait the amount of time specified in the state of federal regulations before you re-enter the working place.

The tests for impact, heat, and propagation sensitivity described earlier are Du Pont tests, felt to be meaningful tests and demonstrations of the products safety. We don't know how other manufacturers test their water gels. We assume that they may be equally impressive. But it is appropriate to say that water gels can vary more than dynamite from manufacturer to manufacturer at this early stage in their history. Uniformity in consistency, sensitivity, and other properties is a more difficult technology, generally, than with dynamite.

The sensitizing ingredients, as well as methodology, differ between manufacturing companies. Therefore, the properties (safety, especially) of one should not automatically be assumed for all water gels. Operators should inquire specifically about the properties they are interested in from the manufacturer they are in contact with.

It has not been possible to spur the change to Tovex by offering it at a lower price than dynamite. Unfortunately, the cost of the products do not warrant a lower price. In countless cases, the move to Tovex competed with dynamite at lower prices. But, often, compensating factors prevailed to make it an economic advantage for users. For many it has produced better economics due to more versatile loading, fuller hole utilization, labor savings and comfort, and blasting results comparable to dynamite. It has produced broken rock and ore just as effectively as dynamite on any basis that is used—pound for pound, cartridge for cartridge, or dollar for dollar.

The safety properties already mentioned have meant that pumping of appropriate water gels is safely feasible. This saves loading time, insures full utilization of the drill holes, and no need for tamping. In other cases, Tovex cartridges have been pneumatically loaded in long up-holes by a Tovex Cartridge Loader.

Most, however, is loaded very much like dynamite, dropping the cartridge (plastic "chubs") down the holes, slit and tamped where the job calls for heavy loading, dropped without slitting in other jobs. Miners load horizontal holes with a tamping stick, like dynamite, tamping as usual, chub cartridges that are designed for easy tampability. Holes are usually better filled with this soft material than with dynamite.

While Du Pont and Du Pont of Canada are the only dynamite producers we know of to change totally to water gel, most others have water gels on the market and constantly improving. At the present time there are in the United States water gel products on the market made by at least 10 manufacturers, at least four of whom have never produced dynamite.

Du Pont subsidiary or associated companies in Canada, Mexico, Brazil, and Australia are making great strides with Tovex products. Water gels are widely offered by C.I.L. in Canada and I.C.I. in England. Elsewhere, Tovex licenses have been issued to firms in Japan, Norway, Chile, South Africa, France, Italy, Switzerland. Tovex plants are under construction in several locations. Negotiations for further Tovex licensing are under way in other areas.

It has been an interesting development for the most interesting reasons, human safety. This commitment to safety should have an even more interesting future.

THE LMFBR — DO WE NEED IT AND IS IT SAFE?

By HENRY PIPER
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Liquid metal fast breeder reactor.

As I pondered over how I might answer the question that my speech title asks, "The LMFBR—Do We Need It and Is It Safe?" I concluded that my entire speech might well consist of nine enthusiastic words: "Yes, we need it and yes, it is safe," stated with a strong feeling of conviction. But, I also recognize that the breeder reactor is a national controversy. While there is strong support, there is also dedicated opposition. Fortunately, there is general, although not total, agreement that there is cause for concern about the adequacy of electrical generating capacity in both the near and distant future. The major differences come about when we consider how we are to meet the nation's electrical energy needs. A minimum of research will show that we will have to rely on the combination of several options to assure that our needs will be met.

As we examine our options, we should apply a consistent set of qualifications to determine the viability of the candidates. The criteria to assess the technologies for generating bulk quantities of electricity should include: (1) resource availability; (2) technological feasibility; (3) environmental impacts; (4) economics; and (5) conservation. In this presentation we will touch only on resource availability and, particularly, conservation of human resources. I will merely state that, economically and environmentally, the energy system under discussion is superior to the other candidates.

If we examine the numerous candidates against these criteria, many cannot meet the test. The candidate resources or concepts for producing electrical energy most often mentioned or advocated are: coal; oil; gas; hydro-electric; geothermal; tidal; ocean gradients; wind; biomass, fusion; solar; nuclear; and nuclear breeding. Several of the candidates listed above cannot survive an assessment with respect to the criteria mentioned earlier. But even if they are marginal candidates, their development should be pursued at an appropriate pace. We cannot afford the luxury of tossing aside any viable candidate if we realistically expect to meet our future energy needs. Progress is being made in the conservation effort and it is important, but we must be realistic about the overall impact of conservation, whether it is a voluntary process or one that is imposed. We must recognize the potential impact of gross conservation on the economic stability of this nation and whether it is necessary to snuff out the light of hope that the poor and oppressed have for an improved standard of living. But we must be realistic. With each of the resources we have on our list there are certain limitations.

Let's examine each of these and discuss the realities concerning them. First, wind, tidal, geo-thermal, and ocean-thermal gradients are energy sources with unique problems and unique areas of applicability. Even the most dedicated proponents have concluded that these sources can add only imperceptibly to our total energy mix by the year 2000 and perhaps beyond. The concept of biomass employs the use of agricultural processes to produce alcohol or its equivalent as a fuel which may be used to replace oil. This area of research is quite immature and it is too early to predict the impact, but it does not appear that it will have a discernable influence on the total energy mix (year 2000) and will be expensive to utilize. Hydroelectric power has traditionally been one of our strong contributors. In recent years, however, its percentage contribution to the production of electrical energy has declined steadily because the best hydroelectric sites have already been developed. The limited number of potential sites that can be economically developed are mostly located in the Pacific Northwest. It is estimated that hydro-electric power will contribute only about three per cent of our total electrical capacity by the year 2000. Many scientists envision fusion power as the great savior of mankind, and indeed it may well be, in the far distant future. The fuel source is virtually inexhaustible, but there is little chance that it will make a meaningful contribution in this century. In fact, until scientific feasibility is realized, the fusion research will require a large input of energy with a zero output.

Solar, although the recipient of good press, can't be depended upon to provide any substantial relief to our power crisis. Let's look at an interesting point here. There is a great deal of sunshine—much power is provided via the solar sources, but it is very diffuse. All of the power incident upon one square foot of U.S. dirt in one year is worth only $4.30 if completely converted to electricity. Can you imagine the investment necessary to process this small amount of power?

Let's look now at our non-renewable fossil resources such as natural gas, oil, and coal. These resources have many uses that are of more importance than burning them to produce electricity. These include pharmaceuticals, synthetic fibers, herbicides, fungicides, plastics, and many more products on which our economy has become increasingly dependent.

In any event, domestic gas and oil supplies will be essentially exhausted by the end of this century, and the world supplies will expire early in the 21st century. What remains of these resources should be conserved for the unique uses to which they are best suited. Coal seems to be very abundant, but it too has limitations. At our present use rate it would probably last us about 500 years (the estimated resources we have in the U.S.); however, if the coal is used to replace the dwindling sources of gas and oil, it may last for as few as 80 or 100 years. This places us in a dilemma as far as energy sources in the next 20 to 100 years is concerned. But even if we had sufficient coal to carry us, the various environmental impacts associated with mining, transporting, and burning coal make it an unattractive solution to the overall energy problem. So what is left for us to do? The only other resource that we have which produces energy for us in a reliable way is uranium. Uranium is not an inexhaustible source of power either. In nature, uranium exists in two forms—U235, which can be used to fuel a reactor, and the more abundant form of U238, which is not a reactor fuel. The various forms of uranium are referred to as isotopes.

Unfortunately, out of every 100 pounds of uranium mined, only 0.7 lb. is U235; therefore, a large quantity of uranium has to be mined in order to achieve enough U235 to fuel a reactor. Actually, the percentage of the U235 isotope must be increased to about four per cent to be usable as a fuel in a conventional water cooled reactor. This means that enrichment plants must be available for this purpose. Such plants have been operating for about 25 years in support not only of the power reactor industry, but also to support the production of nuclear weapons materials. As a result of this enrichment activity, a large quantity of the U238 isotope has been accumulated. Although our approach to the development of nuclear power has in the past indicated little concern about our uranium resources, they are indeed finite. The generally used number to represent the total of our known, probable, and speculative uranium resources in the U.S. is 3.8 million tons. At the rate which we anticipate building nuclear reactors, this amount of uranium will be sufficient to fuel conventional nuclear reactors that

are committed through the year 1990. This means that utilities intending to build conventional nuclear power plants after the year 1990 would not have an assured fuel supply to last over the lifetime of the plant that they intend to build. Obviously, with the very conservative nature of utility companies and the fact that they are controlled by public service commissions, nuclear plants simply would not be built past the year 1990. There is a very logical and practical solution to the problem which comes about from certain activities that take place in a reactor. In a nuclear reactor of a conventional sort that we have today, a neutron is introduced and this neutron collides with a fuel atom. This collision may result in splitting the atom and thereby releasing a great deal of heat energy. At the same time, the split atom releases two or three (averages 2.7) neutrons. Remember, we had one neutron coming in, and we have 2.7 neutrons coming out of the reaction. We need only one of those neutrons to maintain a reaction; therefore, we have 1.7 neutrons from the reaction. Most of these neutrons are wasted.

The breeder reactor offers tremendous potential. Its potential lies in its ability to be the greatest energy conservationist that mankind has ever discovered. The breeder generates heat which is used to produce electricy, but it does more: it produces more fuel than it consumes. It does not violate the laws of thermodynamics. It transforms essentially worthless materials into an extremely valuable one—fuel for a nuclear reactor.

As I indicated earlier, the process of enrichment of the U235 leaves a large quantity of the uranium isotope U238. This isotope has the ability to absorb a neutron and become a different element, called plutonium, which can be used as a reactor fuel. So, if we are able to take the two "waste" products of conventional nuclear power reactors, the 1.7 excess neutrons from each reaction and the vast amount of U238 that we do not use, we can create new fuel—plutonium 239. As an item of interest, the U238 which is already mined, processed, purified and stored as tailings or "waste products' from the enrichment process represents an energy resource equal to all the recoverable coal resources in the U.S. And when one considers our total uranium resources in the U.S. with an integrated breeder industry, we have enough fuel to last us 37 centuries.

In a recent speech, Representative Mike McCormack effectively described the situation. The following is a paragraph taken from that speech. "It is simply not credible to talk of conservation while throwing away our largest resource of energy. It is unrealistic to talk of reducing our vulnerability to oil-exporting nations while attempting at the same time to stifle the one domestic source of energy which could give us energy independence. It is insincere to talk of minimizing the economic impact of energy production while avoiding the cheapest source of energy available. It is not consistent to talk of environmental protection while ignoring the cleanest source of energy available. Finally, it is not practical to talk of enrolling people of this country in a campaign of sacrifice unless we undertake to reduce the impact of such sacrifice and to give the people hope for the future. It makes no sense to suggest that the U.S. is offering leadership to the world if the other nations of the world cannot accept us as either reliable or credible."

It is clear that Congressman McCormack was referring to the breeder reactor. Do we need it? Emphatically, *Yes!*

If we should examine the potential of the breeder reactor against the list of qualifications listed earlier, it comes out with high ranking in each category and probably the highest overall score of any other existing or new concept for producing bulk quantities of electricity.

What is the role of the CRBRP and the overall LMFBR development program? The U.S. and other countries, notably UK, France, Germany, Japan, and the USSR, have been working on the development of the LMFBR for about 25 years. The technology has developed to that state that it is now prudent and proper to build a demonstration plant to show this is a commercially viable method of producing electricity, while at the same time increasing the fuel resource that we have. Other countries are ahead of us in this regard. Nevertheless, the purpose of the Clinch River Breeder Reactor Plant is to provide the basis for making a sound, rational decision about the commercial viability of this approach. The CRBRP is designed to produce 380 megawatts of electricity, and by today's standards this is not really a very large plant. In developing a new technology, smaller sizes are introduced initially and progressively increased to the larger plants which would be used for the commercialization of this approach. The CRBRP is the logical next step in size for this stage in development.

However, I would like to concentrate my remarks on how the breeder stacks up in the conservation of human resources or, stated another way, the safety of the breeder. This is a subject that seems to provoke emotional reaction, but it can be dealt with logically and rationally. First of all, there is some level of risk associated with essentially everything that we do. There is some risk involved with production of electricity whether it be by conventional means or by a nuclear reactor. We must be careful, in arriving at a judgment, that we examine all aspects of risk to the public that a functioning plant or the support activities for the plant would produce. Often ignored are the hazards associated with mining and transportation requirements to support the operation of the plant. There are others.

Before I elaborate on why I am convinced that the LMFBR is a safe concept, I will describe the CRBRP—its design features and the approach to assuring that it is a safe plant.

The reactor is housed in a reactor vessel which contains liquid sodium. Sodium is a metal which melts at about 208°F (about the boiling point of water) and boils at about 2700°. It has excellent pumping and thermal conductivity characteristics which make it highly effective as a heat transfer medium. The heat that is generated in the reactor is removed by the circulating sodium and is transferred to a second sodium system through an intermediate heat exchanger. This isolates the primary sodium, which becomes radioactive, from the steam generation cycle. The secondary sodium then transfers its heat in a sodium-to-water heat exchanger to produce superheated steam which is delivered to a steam turbine to convert the heat energy into electricity.

Because we recognize that there is potential for consequences from unprotected events, we have approached the design of the CRBRP by involving three separate design levels.

The first level is to assure that the plant is soundly and conservatively designed so that it can be built, tested, operated, and maintained in accordance with stringent quality standards and conservative engineering practices and with a high degree of freedom from faults and errors.

The second level of design provides protection against incidents or malfunctions that may occur during the service life of a nuclear power plant, in spite of the assurance offered by careful plant design and construction. All of these are simply good engineering practices. However, there is a third level of design which is unique to nuclear plants. This level provides prudent measures beyond the levels previously mentioned by incorporating additional systems and features in the plant design to protect the public even in the event of highly unlikely accidents.

There are two fundamental ways that our plant could have an accidental excursion that might lead to measurable consequences beyond the site boundary. These are: (1) to be unable to shut the reactor down or (2) be unable to remove decay heat after shutdown. A unique characteristic of nuclear reactors, unlike other heat sources such as gas or oil, is the

residual heat produced by the reactor after shutdown. This heat production capability diminishes rapidly, but is nevertheless present. This leads to the need to assure heat removal capability. Since it is recognized that these two fundamental problems can exist, we have been careful to provide a highly reliable reactor shutdown and heat removal system. In fact, we supply two shutdown systems, either of which is capable of shutting the reactor down. In the case of decay heat removal, we provide numerous ways of removing the heat from the reactor. Through the application of highly reliable and redundant safety systems, it is highly unlikely that an accidental excursion will occur. However, to provide additional protection to the public, a containment system has been added, even though we have precluded the occurrence of an event which would release significant amounts of radioactive material. This containment provides further assurance that the public is protected. Even if such an unlikely event should occur, the activity that might be released from the core would be contained within this building and, therefore, not released to the public.

Once the design has been set and various features provided for protection of the public, it is necessary to evaluate the effectiveness of the design. For the CRBRP, a study was made that is unprecedented for a particular reactor. A risk assessment was performed to evaluate the risks to the public from accidents that could occur, even though stringent measures have been taken to minimize such probability. In this study a broad spectrum of events was evaluated and the probability of those events happening and leading to consequences, as well as the consequences, were calculated. This was accomplished by performing a systematic study consisting of the following basic steps.

1. First, possible sources of radioactive material were screened to evaluate their potential for contribution to CRBRP risk. This screening process focused attention on core-related accidents as being the most significant potential contributors to risk.

2. A comprehensive list of accident initiators was formulated and the probability of important accident sequences emanating from these initiators was quantified. Event trees and fault trees were employed in the development of these accident sequences and probabilities.

3. The accident sequences leading to core involvement were evaluated and generic classes were defined.

4. Release categories defining radioactive material releases from containment to the environment were established for the various postulated sequences.

5. The radioactive material releases to the environment associated with each release category were evaluated and the effects on public health, particularly acute and latent fatalities associated with these releases were calculated.

6. The occurrence probability of each release category was calculated. These probabilities were combined with the health effects for each release category to develop a representation of the risk associated with the CRBRP.

Such a representation has no meaning, however, unless something is provided as a comparison. Therefore, I would like to compare societal risks that we normally accept to the risk that is imposed by the CRBR. Figure 1 provides such a comparative representation. The National Safety Council keeps very careful figures on automobile deaths; however, auto deaths are usually indicative of single individual involvements, or maybe two, and very seldom are there three or more. If this were plotted on such a figure, it would appear three orders of magnitude above the present upper limit of the figure. Other events such as floods, earthquakes, tornadoes, aircraft and other types of transportation accidents, mining of coal, and so forth give rise to larger consequence events. Accordingly, these are more appropriate for comparison. Even though we realize that these numbers are not precisely comparable, they do provide a measure of comparable risks between one undertaking and another, and it is clear from Figure 1 that the risk from the operation of the CRBRP is small compared to risks we accept on a day-to-day basis.

FOR THE U.S.

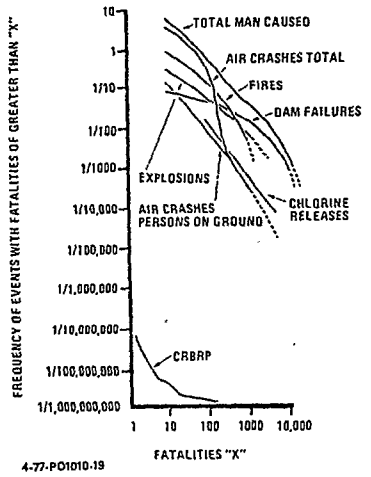


Fig. 1

Another appropriate comparison is that between alternate means of generating electricity; not arguing whether we need the power, but only looking at alternate means of production. Recent studies have shown that when the entire fuel cycle is considered—mining, milling, handling, transportation, and utilization, the burning of coal for the production of electricity result is 10 to 100 times more adverse health effects, fatalities, than does nuclear. The conclusion here is that the process is safer than the currently accepted methods of energy production. Is it safe? Yes, emphatically!

Conclusion

This nation has ignored reality and resisted a return to logic in facing the energy crisis. Simple solutions do not exist, and such continued self-deception will serve only to delay the development of potential concepts until it is too late.

This nation and the world has squandered almost all of our valuable non-renewable natural gas and oil resources, and we seem to be working hard at doing the same with our remaining fossil resource, coal.

This nation has the talent and capabilities to do something for future generations that is based on sound planning and foresight through the application of the best available scientific, engineering, and economic facts.

This nation should be unwilling to permit the potential and the momentum of the breeder reactor program to be frivolously tossed aside. Of the numerous, often mentioned candidates, the breeder offers the greatest hope as an economic, safe, and reliable supplier of electricity. Therefore, the breeder should continue as the nation's highest priority for development, and we must proceed with vigorous pursuit of the LMFBR program.

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ONS

DESTRUCTIVE TESTING OF CRANE BOOMS

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The presentation of these test results is intended to provide additional loading data for failure analysis by all persons interested in mobile crane usage, and thus promote effective, safe application of these versatile machines in industry. The FMC engineering management particularly, and company management generally, have wanted to run such a series of tests for as long as ten years or more. A company must have compelling reasons for such a steadfast commitment to such a project—we did. Further, growing influence for establishing crane ratings from sources outside our company, indeed from the industry, placed further emphasis on "getting the job done."

The specific questions we hoped to resolve by this work are as follows:

1. Establish the actual, ultimate strength of our lattice type crane booms under known, controlled loading.

2. Establish a valid correlation between the predicted and the actual ultimate strength of our lattice type crane booms under known, controlled loading.

3. Establish the mechanism of failure of lattice type crane booms; that is, failure of the overall boom as a beam column versus failure of the unsupported chord length within the total boom.

4. Demonstrate fully to ourselves and the crane-using industry the effect of side loading such structures, particularly long booms.

5. Establish that the high-strength alloy quenched and tempered steel tubing that we purchase has at least the buckling strength we estimate from the SAE J987 critical stress curve.

6. Establish whether or not the strength margin (N) and tip deflection limitations suggested in SAE J987 are good engineering criteria for limiting the capacity of a boom.

7. Determine if the proposed SAE Recommended Practice, "Latticed Crane Booms—Analytical Determination of Stresses and Critical Loads," method of establishing overall structural competence, at maximum ratings, is a good engineering practice.

Conclusions Deduced from Tests

1. The actual, ultimate strength of lattice type crane booms can be determined under controlled loading conditions, using the methods we employed. Such testing is very costly, requires very careful planning, excellent mathematical analysis in advance, excellent experimental stress analysis techniques and instrumentation, the complete cooperation and dedication of many skilled and experienced people, along with good weather and a full measure of good luck.

Fortunately, we had this combination in adequate measure; we suffered no injuries to people and no damage to equipment other than that expected.

Our boom strength analysis was based on the material presented by Vroonland[1], and the experimental stress analysis techniques used were those proposed by Brolin.[2]

2. Table 1 shows two points very clearly. First, the actual ultimate stress, at the points measured, was very close to the predicted ultimate stress or exceeded it. Second, in every case the actual ultimate load exceeded the predicted ultimate load. These data, we feel, are significant and impressive, but not nearly so much as the curves plotted. As the boom approaches failure, the slope of these curves increases extremely fast. Small changes in load make dramatic changes in boom tip deflection and chord stress.

TABLE 1

Results of Tests to Ultimate Failure

Boom Length, ft (meters)	*Predicted Ultimate Stress, psi (mN/m²)*	*Actual Ultimate Stress, psi (mN/m²)*	*Predicted Ultimate Load, lb (kN)*	*Actual Ultimate Load, lb (kN)*
80	85,500	98,850	171,387	176,800
(24.4)	(590)	(682)	(761)	(785)
160	85,500	84,750	51,193	53,710
(48.8)	(590)	(584)	(227)	(238)
200w	85,500	87,000*	28,769	32,145
(61.0)	(590)	(600)	(128)	(143)
200w/o	85,500	87,000	27,428	28,410
(61.0)	(590)	(600)	(122)	(126)

*By extrapolation of curve to failure load.

It is gratifying indeed to achieve such respectable correlation in this fast-changing stress and deflection region, and it is comforting to know that in the slightly above-rated load region the correlation is even better. In many instances the predicted and experimental values are superimposed in this region.

Our years of testing and mathematical study long ago established excellent correlation in the rated load and less than rated load regions; therefore, these tests did not repeat any of this work.

3. To our knowledge, the technical, friendly argument of how a lattice type crane boom fails has been going on for at least 15 years. Undoubtedly, the same controversy was discussed 50-100 years preceding this investigation. Hopefully, the results we present here will help to eliminate or reduce the future need for discussion of this matter.

The results in Table 1 show clearly that the individual unsupported chord span fails at a value of stress equal to or greater than that which we would predict from the SAE J987 critical stress curve.

The data show these failure stresses as well as the stresses as the last loading condition before failure. These data establish fully that "a boom does not fail (utter collapse) when any chord stress exceeds the critical stress at the KL/r of the entire boom!" The boom fails when the critical stress of the individual, unsupported chord span is reached.

The critical stress for the unsupported span is two to four times the "critical stress" for the entire boom, provided the individual unsupported chord span (KL/r) is much smaller than the entire boom, KL/r; specifically, when the individual unsupported span is in the 20-60 KL/r range and the boom in the 80+ KL/r range. A further limitation on this truism is that we restrict its use to the modern 100,000 psi (689 mN/m²) minimum yield strength, steel-chord boom.

We are readily willing to concede that if the boom chords were made of mild steel, the factor of 2-4 might not hold, since the critical stress for this material does not change greatly throughout the entire KL/r spectrum.

We added a "superlong" boom (KL/r of 123) to our original planned test to explore further the elastic behavior of such a structure. We did not take this boom to collapse. It was loaded with hook load and side load as well as with hook load only. We felt that with 12 ft. (3.65 m) of tip deflection, we had adequately demonstrated that elastic instability can occur and is observable; it is also a little frightening. We are thoroughly convinced that if the boom had been taken to collapse, its eventual failure would be just like the others; that is, the stress would continue to increase until the individual unsupported chord span reached its critical value; then it would buckle and that would be the finish.

4. Side loads beyond design values are bad news! This has been stressed to operating personnel through seminars and service books and in individual sessions for years. We felt that it would be worthwhile to show its real effect here also. The results on a 160 ft. (48.8 m) boom with 0, 1, and 2 per cent side load show a dramatic change in tip deflection and stress with increasing side load. These curves show fully why a crane

should be carefully leveled in both directions and swung carefully when making heavy lifts. The closer the crane is operated to rated capacity, the more particular the skilled operator and job superintendent is and must be.

5. We use the SAE J987 critical stress versus KL/r curve for design and test purposes. The curve we use is that for the 100,000 psi (689 mN/m²) minimum yield strength steel modified to consider a 15,000 psi (103 mN/m²) residual stress.

Our own purchase specification addresses itself to the issue of residual stress but does not require a thermal-stress relief operation as a distinct, separate mill operation.

Our estimated critical stress was 85,500 psi (590 mN/m²). The actual stresses measured on the high chord (average of two gages) was 84,750 psi (584 mN/m²), 87,000 psi (600 mN/m²), and 98,850 psi (682 mN/m²). Further, we admit that the gages we monitored at failure were displaced from the actual failure location in three out of four tests by a considerable distance. The gages monitored during the 80 ft. (24.4 m) boom collapse were only one panel (span) away. However, this critical stress was 98,850 psi (682 mN/m²).

These data, considerable thought on the possible influence of residual stress and its distribution in a round tube, residual stress information supplied to us by our tubing vendors along with the measured properties of the tubing removed from the failed boom sections lead us to conclude that the curve is probably wrong but conservative! The data suggest the possibility that the real curve is flat until it intersects the Euler curve and that the K factor on this construction may be approximately 0.85-0.90.

6. We find that the actual 160 ft. (48.8 m) boom with its actual published rating has an "N" of 2.18. The load ratio exceeds 1.60 before failure when "N" equals approximately 1.0.

Assuming that we would allow tip deflection to limit, we would find that for a 160 ft. (48.8 m) boom, the deflection could be approximately 38 in. (0.97 m). This would require about 40,000 lb. (178 kN) with a two per cent side load. This is a load ratio of about 1.20, and "N" would be about 1.72. The failure load on this boom was 53,710 lb. (238 kN) with a two per cent side load. The load factor would be 53,710/40,000 = 1.34.

Using "N" = 1.6 as the limiting value, we find that the load ratio is approximately 1.27, which says that 42,400 lb. (188 kN) could be the published rating based on this limit only. This value results in a load factor of 53,710/42,400 = 1.27. The tip deflection under this condition would be approximately 46 in. (1.17 m).

With this particular test boom and machine combination, the tip deflection limit controls and results in a rating that must be exceeded by 34 per cent before the boom fails, including the two per cent side load. The "N" factor of 1.6 results in the necessity of a 27 per cent "overload" to fail the boom, including side load of two per cent.

This brings up the questions: "How much safety (under failure load) do you want?" "What is adequate reserve strength?" "Is 27 per cent and/or 34 per cent too risky?" "What is good practice?"

Let us examine some current and possibly old rules for adequacy in comparison.

We believe that the ratings of many European cranes are based on 75 per cent of stability and the requirement that the boom and machine must withstand a 25 per cent straight-pick overload. In this instance, let us assume the "rating" was 42,400 lb. (188 kN). The stress is approximately 30,000 psi (207 mN/m²) with "0" side load. The "overload" pick would be 53,000 lb. (235 kN). The stress would be approximately 37,000 psi (255 mN/m²).

The stress in the boom was approximately 52,000 psi (359 mN/m²) under the 42,400 lb. (188 kN) loading with two per cent side load. Failure occurred at approximately 84,750 psi (584 mN/m²) at the point measured. This indicates the "highest possible" SAE J987 rating, 42,400 lb. (188 kN), would pass the European requirement.

Using the SAE boom tip-deflection limitation load of 40,000 lb. (178 kN) results in all values being more conservative. The "European proof test" pick of 50,000 lb. (222 kN) results in a stress of 34,000 psi (234 mN/m²). There is no doubt that the 40,000 lb. (178 kN) SAE J987 rating would pass the European requirement easily and be a more severe test on the structure!

Currently, ANSI B30.5, Section 5-2.2, Paragraph 5-1.1.1, states:

(a) "Prior to initial use all extensively repaired or altered cranes should be tested by or under the direction of an appointed or authorized person.

(b) "Written reports shall be furnished by such persons showing test procedures and confirming the adequacy of repairs or alterations.

(c) "Test loads shall not exceed 110 per cent of the rated load at any selected working radius."

In view of the slow change of stress and deflection with a straight pick loading, we question that this requirement is adequate to prove competence after such work has been performed. This would be particularly true when the rated load is limited by strucutral competence. When this is the case, it is so noted on the capacity plate.

It appears that rated load plus two per cent side load in both directions, or at least 25 per cent straight pick overload, is needed. We are concerned that latent damage might go unrevealed with such a 110 per cent straight pick test and cause trouble under rated conditions while swinging or hoisting. We believe further study should be given to this matter.

Note: These tests were performed to compare our calculated values to test values, and slight differences do exist between our test procedure and a strict application of SAE J987 to these booms. Nonetheless, we feel the application of these results here are worthwhile and valid.

7. For many months now the mathematical experts from the crane industry (PCSA) have been working separately and jointly with SAE (Ad Hoc Committee of Subcommittee XVII) to develop a mathematical method for establishing general or overall competence of a lattice type crane boom. This document was out for ballot in early May 1972. Since this document was in nearly finished form, we wanted to "plug" our data into it and see if our boom and ratings would be satisfactory. Table 2 gives these results.

We see from Table 2 that, in general, the allowable maximum ratings in the proposed SAE Recommended Practice are somewhat higher than current L-BS ratings. The L-BS ratings were shown earlier to be somewhat conservative with respect to the allowable rating under SAE J987 rules. Still, when we compare the allowable rated loads under either system with the actual failure load, they provide adequate strength margin against failure and lie well within the linear portion of the stress and deflection versus load portion of the curves.

TABLE 2

Crane Boom Criteria

Boom Length ft (meters)	*Actual Ultimate Load, lb (kN)*	*L-BS Load Rating, lb (kN)*	*Maximum Load Rating by Proposed SAE Recommended Practice, lb (kN)*
80 (24.4)	176,800 (785)	94,558 (420)	112,000 (497)
160 (48.8)	53,710 (238)	33,298 (148)	40,600 (180)
200w (61.0)	32,145 (143)	17,068 (76)	20,000 (89)
200w/o (61.0)	28,410 (126)	16,900 (75)	19,600 (87)
230 (70.1)	— (-)	12,433 (55)	14,000 (64)

Our understanding of the proposed SAE Recommended Practice mathematical competence rating system is that the maximum allowable rating is based on one of two criteria: Scr÷1.67 at the K (L/r) of the unsupported span (Scr from SAE J987) or the ratio of the

proposed SAE Recommended Practice (ultimate buckling load) ÷ (rated load) must be equal to or greater than 1.75. There is no computed tip-deflection limit value in this method of checking competence. The ultimate, total boom, column-buckling load in this system is a value calculated without a purposely applied side load. This "industry" approach to the problem gives values reasonably close to our own "house" values, and both give adequate margin against failure.

Hopefully, the day is approaching when it will be practical to rate a crane boom against ultimate load rather than against ultimate stress, which is current and past logic and practice. We are confident that the entire industry would favor this new system when fully developed.

Future Projections and Recommendations

Where should we (crane manufacturing industry) go from here? We feel that the results presented herein are timely and accurate, and have valuable significance for ourselves and the crane industry throughout the world. We also admit that everything did not happen as perfectly as it was planned and that additional questions are raised as a result.

It is our recommendation and hope that other builders of mobile construction type cranes will perform additional tests such as these and present their results to the world through such organizations as SAE. If this is done, we believe the individualist "art" of crane design can be replaced with the worldwide "science" of crane design. When this is accomplished, the full utility of these versatile machines can be realized on a worldwide scale.

Should others accept this challenge, we suggest that the following areas be explored:

1. Investigate similar modern structures that will, hopefully, corroborate our data.
2. Investigate similar structures with both lower and higher strength chord material.
3. Investigate structures that differ in design detail construction to evaluate its influence. Such structures as crane booms made of structural angles would be good candidates.
4. When running such tests, either utilize more gages or spread them out over a great length of chord. Hopefully, this may get closer to the actual failure location.
5. Include additional straight pick loads (overload compared to rated load) for additional data due to this type of load test. This may help establish a sound basis for this type of competence testing.
6. Explore the elastic instability area in the large K (l/r), total boom, region for the purpose of personally seeing the phenomenon occur.

Review of Test Preparation and Safety Measures

As with most good testing, it seems that 40 per cent of total test time is spent in preparation, 20 per cent in accumulating the data, and 40 per cent in reducing, plotting, writing, and wishing you had done several things differently. This project was no exception.

The following list summarizes preparatory work for performing these tests.

1. Establish the expected failure load for the booms.
2. Check all components in the system for adequacy.
3. Select the machine that would handle the booms at failure loadings.
4. Select the "catch" or "safety" crane and establish its necessary configuration.
5. Check its adequacy under expected loading and unexpected loading.
6. Plan the sequence of testing the booms.
7. Mathematically analyze each boom for expected failure location.
8. Establish the parameters to be measured during test.
9. Establish what was to be measured before test.
10. Predict the weather.

11. Schedule the test for machine availability. Four machines required.
12. Schedule the test crew force and assign specific responsibilities to each.
13. Arrange for and establish photographic needs.
14. Plan each step in the test sequence and design data forms for ease of use.
15. Establish and promulgate extra safety rules for the testing area during the testing.
16. Design and build special force-measuring transducers.
17. Build special long-tip-deflection measuring scale.
18. Establish method and means for measuring initial boom straightness.
19. Establish what would be measured after tests were complete.

These comprise at least the major problems that required adequate thought and solution before testing.

During the test (item 8 above), the following parameters were measured:

1. Tip deflection.
2. Chord and lattice strain at selected points (approximately 45 channels total).
3. Main pendant force (both sides).
4. Midpoint pendant force (both sides).
5. Boom foot out-of-levelness (due to deflection under load).
6. Side load force.
7. Radius of load.
8. Approximate wind velocity and direction.
9. Test loads (preestablished)

The following list of items were measured before testing began (item 9 above). Note: All items used in the test were standard production units. No attempt was made to select items on any basis; however, the following measurements were made to avoid surprises, if possible, and to be able to evaluate their importance if such did occur.

1. Straightness of each chord span on each section.
2. Wall thickness of each chord span on each section.
3. Live mast actual length.
4. Length of all pendants.
5. Center-to-center distances on bridles and bails.
6. Straightness of each boom before testing.
7. Midpoint pendant length adjustment.

After testing, we selected chord and lattice samples from the sections that actually failed, for mechanical property verification. In addition, considerable metallurgical work was done on the connection lugs and lug-to-chord welds, for quality control verification and other possible future needs (item 19 above).

We are sure that after reviewing these lists, you will agree that we attempted to cover all eventualities. The planning was worthwhile, since (as mentioned previously) no unexpected surprises occurred and no injuries were suffered.

We have provided herein some startling new information about these complex structures. Our hope is that others will accept the challenge and further develop this science in the years ahead. We acknowledge again that such work takes much time and the cooperation and skill of many engineers. We are grateful to many people in our organization for the opportunity to participate in such a test program and to present the results here. Special thanks must be given to our management, our test crew, our design sections, our engineering computer section, and our photographic department for their total cooperation and participation.

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Public Employee Sessions

A REPORT ON THE USE OF TACHOGRAPHS IN MARKED POLICE VEHICLES

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Metropolitan Nashville-Davidson County covers 533 square miles and has a population of approximately 500,000 residents. Primary law enforcement obligations are entrusted to the combined Metropolitan Police Department of Nashville and Davidson County, which was formed in 1963. The Department presently employs a force of 900 sworn officers responsible for manning a fleet of 150 marked police vehicles. Like most urban police departments, our Department has found that supervision of field personnel presents numerous difficulties. Sergeants are unable to adequately supervise the patrolling patterns of officers in most zones. Whether the cars remain in motion during most of the shift or sit idling for hours is nearly impossible to determine. When cars are not in motion, citizens become justifiably concerned that police protection is inadequate.

Misuse and negligent abuse of police vehicles also present a serious problem. In 1974, a total of 324 accidents involving police vehicles were reported. During 1975, 341 accidents injured 75 persons and cost the Metro government over $200,000. Roughly 40 per cent of these accidents could have been avoided through more responsible driving on the part of police officers. In the past, charges of negligent driving had to be investigated by a superior officer. One or more days suspension without pay was the usual consequence if negligence was proven. This crisis-oriented approach has not eliminated negligent driving nor has it reduced accident rates.

The problems of inadequate supervision and abuse of vehicles are not uncommon in situations which require job performance to occur at a time and place remote from direct observation. Trucking firms and bus companies faced similar problems but found a solution in a recording device called a tachograph. The tachograph was developed to ensure safer and more economical operation of vehicles. The 5-inch by 8-inch cylindrical recording instrument connects by electrical leads to the vehicle's engine and transmission. Inside the tachograph, a paper chart rotates at the rate of one revolution per 24 hours. A number of styli brush against the chart surface and etch lines on the paper. These lines provide a continuous, time-based graph of such vehicle functions as road speed, driving motion, total miles traveled, engine speed, and the operation of auxiliary equipment.

In recent years, police and security personnel have become aware of the possible benefits provided by tachograph recorders.[1,2,3] Aside from the supervisory assets, tachographs proved to be a useful public relations tool in handling citizen complaints and as court-admissible evidence in accident cases.

Tachograph recorders were first used in Metro Nashville Police Department vehicles during a study on preventive patrolling.[4] Four tachographs verified that the patrol cars were actually moving and that speed was held under 20 miles per hour. The electronic tachograph units (Model TCO 15-2) were purchased from the ARGO Instruments Corporation, Long Island City, New York.

Our Department's experience with tachographs during the preventive patrolling study proved that the instruments could provide reliable, precise records of a number of previously unattainable vehicle functions. Further research was proposed to specifically examine the merits of the tachograph recorder as a supervisory tool and an accident prevention device. A Tennessee Highway Safety Project Grant entitled "Mechanically-Aided Accident Prevention" was funded through the Metropolitan Nashville Police Department. Funds from the grant provided additional tachograph recorders and supplied the technical assistance necessary for the development and experimental analysis of each phase of the tachograph project.

During August, 1976, 19 vehicles of the Traffic Section were equipped with tachographs. Traffic Section vehicles were selected for the study due to the severity of past Traffic Section accidents. All tachograph units were installed by Metro garage personnel. Approximately two hours were required to wire the electrical and mechanical connections and to mount each tachograph unit inside the trunk. Traffic Section officers were instructed to place a blank tachograph chart in the recorder at the start of the eight-hour shift. At the end of the shift, the officer removed the chart from the tachograph, filled in his name, car number, the date, and mileage, and placed the chart in a collection box at Central Headquarters. All charts were transferred daily to the principal investigator of the project. For the first three months, no feedback was given to the officers concerning the content of the charts. During this period, a concurrent study examined the effects of passenger observers on vehicle speeds, amount of non-movement time, and number of citations issued.

The informal feedback phase of the project was initiated three months after the tachographs were installed (November, 1976). Traffic Section sergeants were trained to examine tachograph charts for excessive rate of speed, excessive duration of non-movement periods, and inappropriate use of emergency lights. Each chart and daily activity sheet was reviewed and initialed by the officer's sergeant before the charts were sent to the principal investigator. When abnormalities appeared on a chart, the sergeant was responsible for discussing the irregularity with the officer and providing corrective feedback so that the problem would not reoccur.

Marked officer-driven vehicles from all three sectors of the Patrol Division were equipped with tachographs which began recording vehicle functions in February, 1977. The 142 tachographs for the Patrol Division were acquired through funds appropriated by the Nashville City Council. At the time of the funding decision, police personnel opposed to the use of tachographs voiced an opinion that "spying" on the officers was not necessary. The councilmen rebutted with the question, "If an officer is doing his job, why should he be afraid of a tachograph?" Since the officers were unable to respond to the question in any satisfactory way, the City Council acquired tachographs for Patrol Division vehicles in order to increase supervision.

Officers and sergeants of the Patrol Division followed procedures similar to the informal feedback phase described for Traffic Section personnel, except that tachograph charts were sent to the Inspections Section rather than the principal investigator. In mid-February, the Inspections Section also began to receive charts from the Traffic Section. All charts are currently being reviewed on a daily basis by Inspections personnel. Any charts which show unexplained deviance are sent to the assistant chief of field operations. From the assistant chief's office a copy of the chart and an explana-

tion request are sent to the officer and his sergeant. If the incident is unexcusable, one or both men are given at least one day's suspension without pay.

After the Inspections Section reviewed tachograph charts for approximately two months, the need became obvious for a structured form on which the officers could record daily activities. The activity sheet was essential as a supplement to explain the vehicle functions recorded by the tachograph. Our Department is currently in the process of implementing activity sheets in each Patrol sector. Aside from providing a log of activities, the form also serves as a daily check on the accuracy of the tachograph clock and as a reminder of the information to be entered on the chart.

A second refinement of the tachograph project has focused on the supervisory functions performed by sergeants. Other departments have indicated that the degree of success in maintaining an effective tachograph program is highly dependent upon the quality and consistency of the sergeant's supervision.[2, 3] With the assistance of Traffic Section personnel, our Department has developed and tested a formal evaluation and feedback system designed to maximize tachograph utilization.

Sergeants, on most days, provide officers with informal feedback as previously described in the report. On the average of twice a month, the sergeant formally evaluates an officer's activity sheet and tachograph chart from the preceding shift. A 10-item checklist is used by the sergeant to expediently evaluate specific aspects of the officer's performance. The completed checklist is reviewed with the officer and corrective feedback is provided by the sergeant when necessary. If problems are resolved, or if none existed initially, formal evaluations occur at the minimum rate of twice a month. Formal evaluations provide both an objective measurement of performance and an opportunity for frequent recognition of an officer's routine activity. When final testing is completed in the Traffic Section, the formal feedback system will be implemented in the Patrol Division.

Although the Nashville tachograph project does not have an extensive history, a careful analysis of various police vehicle-related measures has provided information on the effectiveness of the program. Reports from the Department's Safety Office contained data on the frequency and severity of accidents involving police vehicles. Only accidents in which the officer was actually driving the vehicle at the time of the incident were counted. Driving speeds were obtained directly from the daily tachograph charts. Monthly vehicle mileage was provided by the Equipment Section. The figures on damage claims attributed to police accidents were supplied by the Metropolitan Legal Department. Anecdotal information was contributed through informal conversations with various officers involved in the tachograph project.

Results

Reduction of Physical Injury. Accident reports categorize injuries, ranging from a complaint of pain with no visible injury to death. Complaints of pain with no visible injury comprised about 44 per cent of the injuries shown in the figure. Approximately 25 per cent of the injuries involved bruises, abrasions, swelling, etc., and 31 per cent resulted in bleeding wounds or distorted members. No fatalities occurred during the data collection period, which ranged from May, 1975 to July, 1977. The Traffic Section contains 18 marked vehicles, the Patrol Division includes approximately 140 vehicles, and 30 marked vehicles comprise the Canine Section.

Prior to the installation of tachographs, the personal injury accident rate for the Traffic Section was nearly twice as high as the Patrol Division, but with approximately the same frequency and variability as the Canine Section. The introduction of tachographs in the Traffic Section is divided into two phases—No Feedback and Feedback, When no feedback was provided to the officers, personal injury accidents remained at a high rate (1.3 accidents per 100,000 miles). Accident rates dropped to the lowest non-zero rate (0.6 accidents) with the introduction of feedback and reduced to zero in the last two data points. When tachographs with feedback were introduced in the Patrol Division, personal injury accidents were reduced to the lowest rate in two years. (0.25 accidents per 100,000 miles), with a continued low rate of 0.3 accidents during the final interval. Additional data must be collected to substantiate the reduction in physical injury accidents in the Patrol Division.

Compared with the physical injury accident rate for the Canine Section, both the Traffic and Patrol units appear to have benefited from tachographs in conjunction with feedback.

Reduction of Frequency and Severity of Accidents. The implementation of tachographs and the use of feedback appear effective in reducing the frequency of accidents from a baseline rate of 2.8 accidents per 100,000 miles to an intervention level of 1.4 accidents per 100,000 miles. In addition, the severity of damage also tended to decrease considerably. Only two accidents were estimated to exceed $500 in damages during the first six months of tachograph use in the Patrol Division.

Reduction of Officer's Driving Speeds. Information was obtained on the average maximal speeds attained by Traffic Section officers during three separate two-week intervals; this was shown as average maximum speeds without emergency lights and speeds with emergency lights. Each interval sampled road speeds under different tachograph feedback conditions—no feedback, informal feedback, and formal feedback.

As compared to the no feedback condition, both informal and formal feedback appear to reduce non-emergency maximum speed; however, with formal feedback, the reduction is nearly three times greater. Under emergency driving conditions, formal feedback was the only condition which was effective in reducing maximal speeds.

Mileage and Officer Activity Rates. The installation of tachographs appeared to have no clear effect on the amount of miles traveled by police officers. In considering the average monthly mileage for officer-driven vehicles in both the Traffic Section and Patrol Division, a slight reduction in miles driven appears as a possible trend in the Traffic Section. The lack of any appreciable effect of tachographs on mileage is not surprising, since vehicle speeds have been reduced through the use of tachographs and feedback systems. Increased vehicle movement combined with reduced rates of speed would, plausibly, cancel out the effects of tachographs on mileage.

Activity rates (i.e., number of reports, tickets, arrests, special assignments, etc.) in both the Traffic Section and the Patrol Division appear to increase after tachographs were installed. Thus, the miles that are driven with tachographs result in more activities produced by the officer. Increased vehicle movement and decreased rates of speed would seem to be related to increases in rates of activity.

Estimates of Cost Effectiveness. This report indicates that tachographs, in combination with consistent specific feedback to the officers, affect a variety of vehicle-related functions. Each of the measures presented are important not only in terms of safety and improved supervision, but also for financial benefits reaped by the Metro Police Department. Precise cost reduction information will be available as the program continues, but at the present point, estimates based on the preliminary trends will be discussed.

A reduction in the Patrol Division's physical injury accidents from a ratio of 0.44 accidents per 100,000 miles to 0.25 accidents provides benefits to the department which seem less important when measured simply in dollars and cents. Previous injury costs have averaged

roughly $300 per accident. The considerable reduction in physical injury accidents saves the department approximately $10,000 per year.

Property damage accidents occurred in the Patrol Division at the average rate of 2.8 accidents per 100,000 miles prior to the use of tachographs. When tachographs and feedback were introduced, the accident rate dropped to 1.75 accidents per 100,000 miles. The data also reflect the amount spent in repairing or replacing police vehicles damaged in accidents and the amount spent in accident claims filed by citizens who incurred damages in police vehicle accidents. Prior to the installation of tachographs, the Department spent an average of $17,000 every three months to repair damaged vehicles. With tachographs installed, repair costs have dropped to an average of $5,500 per three-month period. Projected annual savings on repair costs should range between $35,000 to $45,000.

The use of tachograph recorders in police vehicles appears to provide a highly cost efficient means of decreasing accidents and increasing supervision of personnel. Although the benefits discussed in this report are not inclusive of all measures of detectable financial savings, the results are impressive. The initial $40,000 spent to equip police vehicles with tachographs is projected to save the Metropolitan Nashville government an estimated $45,000 to $55,000 on physical injury and property damage alone.

Officer's Reactions to Tachographs. Most of the initial officer resistance to the use of tachographs stemmed from a misunderstanding of what the tachograph would actually measure and how the information would be used by the department. The notion of tachographs as an "iron sergeant" has dissipated as officers become aware that the machine does not require drastic changes in routine job performance. When problems are detected, the corrective feedback provided by the sergeant or the Inspections Division is generally less severe than repercussions would have been if similar problems had surfaced prior to use of tachographs.

Machine tampering presented occasional problems when the tachographs were first installed. The Department responded to any evidence of tampering with a firm line. The first major incident of destruction and tampering resulted in a 15-day suspension without pay. Officers quickly learned that any form of tampering is readily detectable and that the department was serious in eliminating problems associated with tampering.

When tachographs are discussed with a group of officers, most of the comments still tend to connote negative reactions. When the same officers discuss the tachograph program individually, the comments are surprisingly neutral or even positive. As one officer stated, "I put the tachograph chart in the recorder at the start of the shift and forget about it until the end of the shift." Other officers have commented that the tachographs have helped to prove that accidents were not attributable to officer neglect.

In summary, the tachograph program appears to be an acceptable and cost-effective method for reducing the frequency and severity of accidents involving Metro police vehicles. The provision of formal feedback to the officers has been shown to be an important component in conjunction with the tachograph records. The Metropolitan Nashville and Davidson County Police Department will continue to refine and extend systems which appear important to maintain an effective and beneficial tachograph program.

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LOSS CONTROL SEMINAR

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In 1970 I published an article in the *National Safety News* called "OSHA OMEC-DIPIC and You," and although those catchy little words don't mean much unless you read the article, the impact of the article is a critique of OSHA. In that critique, I talk about the fact that OSHA is taking the wrong direction—they're spending too much time on the hardware and not enough time on the people and now, many years later, the cost of OSHA being about 119 billion dollars a year, not too much has changed. The real impact of accident prevention that everybody looked for really didn't happen. It is just in the last few months that OSHA is beginning to turn around and say that there are some people problems and some training problems and maybe we have been spinning our wheels in the wrong direction. I'm certain that you will read a lot more about that in the immediate future. At first, everybody thought that OSHA law was going to really have a very, very significant impact. As far as I'm concerned personally, all it did was give us a great deal of publicity, open people's eyes to the safety problems, and one thing it did definitely was get us involved in the area of occupational health, which has been totally neglected. Here again, we have to be careful in the field of occupational health that we don't zero in on just the mechanical problems; you can talk hours and hours about how to fit a respirator and how to buy a respirator, what kind of filter we should use, but most important is getting the man to wear that respirator. That's really what we're going to talk about here.

This loss control seminar is one that I have presented in various parts of the country at various lengths. We're going to present some of the highlights, some new, some old, some as review, that have to do with the real, "nitty-gritty" things that count to make a safety program effective. I think this is of special interest because the President of the National Safety Council, and many others, have said for years that the public employee safety organizations are probably 20 to 30 years behind American industry in safety. Even OSHA law totally excludes 11 million people. Even today, with the state plans that we have (I think there are less than 24 states that have a state plan), that means that in the remaining states the public employee is totally exempt from the OSHA law. That doesn't even make sense! The point is, if the managers of those employees knew anything at all about the principles of safety management, they would realize they don't need an OSHA law to force them to have a safety program. Good common sense and good management dictates that they do need a good safety program not only because of people problems, not only because of injuries, but also because of costs.

Worker's compensation laws in this country are going crazy. Oregon has the highest worker's compensation rates in America; for a logger in the State of Oregon the compensation insurance is $32 per $100 a payroll, and for housewrecking, it's $100 for every $100 a payroll. Now how can any manager in his right mind ignore the principles of loss control when you consider those costs? If it hasn't hit your state, it will!

There are some people who believe that worker's compensation shouldn't be called worker's comp, it should be called social welfare. We have gotten welfare mixed up with worker's comp in many states. If you can pay compensation payments for a congenital disease, then something's got to be pretty bad. It's just unbelievable to read the reports and look at the referee award. You scratch and say to yourself, "What the heck does this have to do with work?"

That's a separate problem that we ought to sometime spend a whole session on. The words that I like to use that most people don't like to talk about is "worker's comp fraud." It's a very interesting and fascinating subject. If you look into your own state laws, you might be amazed at what you're giving away. In our state, the subject of worker's comp got to be almost a state of emergency. It was our Number One priority in the State of Oregon Legislature. We did make a significant change in the whole operation of the worker's comp system and all of you are going to face the same problems in the near future. The thing that I want to bring across to you is that safety isn't something you're going to get out of a meeting or out of a book. It's a system, it's a procedure, it's a dynamic way of making change, and it's going to involve technique and training.

Every time I think of the word "technique," I think of this story. As you know, in most parts of the country, it's deer hunting season and elk hunting season. It's a story about a housewife who often wondered what her husband did on these hunting trips. She said, "Dear, I'd like to go with you this time." He figured this was the day of affirmative action so he said, "Come on along." He gave her some training, outfitted her with all the heavy clothing, bought her a gun, and off they went—the lady and four men up to the mountains to hunt some elk. They got to a clearing and the husband said to his wife, "Now, Mabel, you sit here on this stump. Since this is your first trip, we're going to help you. We're going to go out into the woods and stir something up that will come right by this clearing, then we'll be back." After they were gone about ten minutes, they heard a shot and some loud noise. They ran back to the clearing, and as they got closer, the heard a man say, "Okay, lady, you can have the elk, but let me have my saddle back."

I sometimes think we do the same thing with safety training. We give a guy a procedure he can't understand, or a rule that he can't read, or a system that doesn't function, and we say, "Go forward and be safe." The most important message I can deliver involves the most neglected aspect of safety, and that's communicating with the guy on the end of the shovel, or the guy on the end of the respirator, or whoever it is that's been injured in your organization.

What we have to do with safety is think about it like any other kind of business. In any other kind of business, where there are production demands, if you're making a product, somebody tells the people in that organization what they want, what it is they're trying to do—that's communicated in many ways. There's an assignment of responsibility—somebody is told to do it so that the organization can get the parts out the door. The person who is doing it, who is acting as a manager, has to have some authority granted to him. That person is then told to do what is necessary to get the job done within certain confines. If you have to do a certain construction job, you know how many dollars you can spend, you know how fast you can get it done, you know what the limitations are. Finally, there must be a fixing of accountability; someone in management has got to say at some time or another, "I'll measure to see if you're doing it."

Measuring work performance often requires negative actions. The word "discipline" in government is a dirty, rotten, filthy word, and it's the one that is not used enough. I recently introduced a fleet safety program into the State of Oregon, and it has some very tough discipline aspects. We have a point system that involves strict discipline for traffic violations. One day, I was talking about our fleet program to a large group of federal government people who have hundreds of people in safety and

thousands of documents. I looked one of them right in the eye and said, "What do you do when you catch a guy speeding three or four times in a federal car?" He said, "Well, we send out several memos and nothing happens." Again, the bottom line is, what are we to do to a person to get him to change or make him do what is safe? Sometimes we have to use that dirty word, "discipline." The supervisor of the worker who is disciplined has got to be held accountable to someone. This is one of the big weaknesses in safety programs throughout the United States.

What's supposed to happen? I think the answer to managers in safety who say they're too busy to be involved in safety programs is, "Hogwash!" That's the biggest problem in government safety programs and safety programs all across the country. When you let a manager say, "I have to get the production out," or, "I'm too busy to bother with safety," you immediately have a safety program that's beginning to die. If any of you know anything at all about people who work for DuPont, I don't care what their job is in management, safety is on the same line with production and quality and quantity, and any manager who doesn't understand that is not going to work at DuPont. Now, do we do that in government? The answer to that in most cases is, "No!"

One of our big problems in safety organizations is that we do a lot of talking and a lot of writing, but we sometimes do not get the management action necessary to make change. Many companies have found this out. They've gone crazy with the OSHA law, they purchased all the fancy equipment, they had all the inspections, and their accidents are still where they were before OSHA, and they're wondering what's wrong. They're following all of the codes, but they just haven't got enough safety experience to know that because an exit sign is too high or too low from the ground, it isn't going to have a thing to do with whether or not somebody's going to get hurt again. They haven't involved themselves with the people problems.

You've got to take a look at your safety program and see if you have *action* mixed into that program. You may have reams of paper very cleverly designed on how to make inspections, but what happens to that piece of paper and who is going to make something happen and get the discrepancies fixed, moved, or redesigned? That's where we fail in too many safety programs.

What you have to ask yourself is, "Where is safety in my organization? Will the voice for safety be heard, or will safety plead for support, or will it be backed up by top management?"

It's a myth to believe that the OSHA law will reduce your accident claim costs. It's not a myth; a better word is "joke." The only answer is a comprehensive loss control or risk management program that involves managers at every level. You can read about and observe all the millions of words in the OSHA law for all the good it's going to do unless you do have a comprehensive management-directed program. Safety programs will not be effective if treated as a humanitarian impulse welling up from below and begging for support.

Do you think we could get the drunk drivers off the roads in this country by saying, "Please, don't drive when you're drunk?" The only way we're going to get them off the road is the way they do it in Norway and Sweden; in those countries, if you get caught drinking while you're driving, you get six months hard labor. It's not like it is in our prisons, where they have colored TV and recreation and painting classes. In some foreign countries, you get a hammer and rocks and you make little rocks from big ones. The next time you get behind the wheel of your car, you think about that hammer and those rocks.

There are some psychologists who don't believe in discipline. As a matter of fact, there's a guy who raised a whole generation, called Dr. Spock, and they found out about that technique, too. So, your safety program has to be

humanitarian, but it also has to spring from the top with some firm demands and some firm accountability, or it's going to be just another "Archie Bunker-type" safety program. This is the safety man who spends all his time hanging up posters and showing films, and his idea of a safety program is to have a safety film once a month and change the posters on the bulletin board, and that's it! That's exactly what he's got, too—nothing!

I think the big problem in safety is that we've got to get some new ideas into the heads of people. Once in a while, we have to flush out some minds, take a look at what we're doing, get rid of some of the old techniques, and try some new ones. There are new ideas that you can pick up all over this city within the next couple of days. The big thing to do is to take new ideas home and put them to work and see how they function in your organization: Of course, I realize what's going to happen: when you come to your organization with a new idea, you'll run into a phrase called, "I hate to change," and after you fight that battle and get some new ideas across, then you can begin going through some of the accidents like some of the major corporations have been doing for 30 years. I keep citing DuPont because they have consistently had one of the finest safety programs in the world and they use management techniques like the ones I'm talking about.

It's important for every safety man to go to work as soon as he gets back on this organization structure, so that he finds out where he's coming from and how effective that point is. In my responsibility in safety, we have seven universities and, as you know, universities are pretty big operations. Everything goes on, from football games to research, and every once in awhile we assign a safety man to that organization and he wonders why he can't get anything done. He often reports to the head of the physical plant; now, what do those professors care about the guy in charge of the janitors and the maintenance mechanics? All his effort is wasted; whereas if he reported to the president's office, he might be able to get somebody's attention. This is a highly neglected subject in the field of safety. I see too many safety people reporting to personnel offices; they should report directly to top management so that everybody in the organization knows that the safety man represents the voice of the boss. Where you are in that organization is going to make a big difference as to whether or not your safety program is all talk or lots of action.

This isn't new, but a supervisor is responsible for getting things done through people—that's the American Management Association's definition of a manager. He doesn't do the job himself. He's responsible for men, material, and machines and equipment, and it's what that supervisor does with those three things that makes the difference as to whether or not you have a real or imagined safety program.

We could talk for an hour on the first ingredient—men. One of the biggest defects that I find in government safety programs is that they pay no attention to the human being's physical condition. When I started with the State of Oregon eight years ago, the bureaucrats were quite upset with me because I tried to get the Personnel Division to use a medical questionnaire. There are thousands of municipalities that will hire anybody that comes in off the street, not knowing what that body is capable of doing. We now have a very unique system in Oregon which agrees with all the Affirmative Action people and the Hire-the-Handicapped law and have developed some specific questions which are asked before a person is hired. As a matter of fact, as part of our fleet safety program, we also do a complete check of the applicant's driving history before we finally hire the person. Every traffic violation is recorded on a computer in our Department of Motor Vehicles. Let's assume that you got a speeding ticket. The ticket is paid and is entered into a computer and there's a code which

signifies the reason for the citation. Each one of those codes is attached to a point system. If we're hiring a new person but find out that those points total over 40, we simply refuse to hire him if his duties would involve driving a state car. We just say, "You are too much of a risk, come back a year from now and clean up those 40 points and we might consider hiring you." Now that kind of accident prevention, which is done before you put the unsafe driver behind the wheel, is the kind of management control that is necessary in many areas, including the physical condition situation.

You are all aware of the importance of proper selection of safety equipment; not buying the stuff simply because it's from the lowest bidder. It's got to be equipment that fits and works and will be used. No matter how many NIOSH approvals you have on a respirator, if it doesn't fit, the man won't wear it. I went through that with hard hats in our state; we were buying our hard hats from the lowest bidder. The only problem was that every time the maintenance man on the street bent over, the hat fell off. After awhile, he wouldn't put the hat back on. So, with a lot of trouble, I convinced the Purchasing Department to spend 18 cents more per hat and we now purchase one with a headband that goes down beneath the occipital bone and the hats stay put. The workers now are wearing hard hats. I don't have to tell you how little that 18 cents is compared to the cost of a concussion or even a fatality which could result from an injury to the head.

Safety professionals can get involved deeply in purchasing problems; even something as common as selection of safety glasses may require top management action to make a change. Keep in mind that we were buying hard hats from the lowest bidder for 25 years before I came on the scene. They didn't really need me to make the change; they needed someone to look at why the men weren't wearing the hats. This whole business of risk management involves basically five key points, and if you're going to be a hero to your boss, you're going to have to be more than just an Archie Bunker-type that hangs up the cartoon posters and shows lots of film. You've got to be involved with people, buildings, equipment, time, and money. As we mentioned in the beginning, you'd better get involved with all of these if you want a safety program that's going to be meaningful.

First, inform every new employee of hazard potentials before he starts the job, not after the lost-time accident. We do not have enough safety orientation in government, and I don't care if new employees are pushing brooms, driving hot pursuit state police cars, or what, there has to be a safety orientation.

I once worked in a plant that was having a tremendous number of accidents involving janitors. Usually, companies pay little attention to janitors because they're considered "common laborers," so to speak. Well, one day a nice old lady in tennis shoes who was working for us got pinned against a wall by a waxing machine. Did you ever handle one of those? We decided we needed some professional training programs, and before a janitor was allowed to go to work on our facility we had them to through a 12-hour safety orientation program. That training practically eliminated the accidents, which occurred because there are too many supervisors who assume that the person can automatically perform a task.

Even a simple job like cleaning toilets had a great deal to do with accident potential; they use muriatic acid and strong chemicals, and by introducing those people to safety techniques, we reduced the number of accidents. So, this business of new employee orientation is an extremely important precaution and can make a significant difference in your total loss control program.

I know we had those problems when I was in the aerospace field. I worked at Aerojet General for ten years and we built some of the engines that put men on the moon. We had Ph.D.'s of every variety;

we had top-notch scientists from all over the world, and you can imagine what our orientation problem was like.

All employees have to be involved in safety; this isn't a thing for just a special few, and it doesn't make any difference what they do or what their role is in management, they have got to be involved. That's very important, because a lot of managers think that the way to solve the safety problems is to hire a safety man to do all the work. Then nobody else is responsible for anything and the first thing you know, they've got the safety man doing all the inspections, and the supervisor is just sitting back and saying, "We've got a safety guy; his job is to prevent accidents." Accident prevention is the supervisor's job, not the safety man's job. That's a tough point to get across when you're setting up an organization.

You should also make sure that you have a meaningful accident investigative program that results in positive action. Too many of our investigation programs are glorified papermills that fail to get management's attention. I can think of one corporation that used a fantastic technique. The vice-president of this corporation told every division manager (remember, some of these division managers were pretty big wheels with thousands of people working for them), "From now on, whenever anybody is injured in your organization and is hospitalized, I want a report in my office, within one hour, of a hundred words or less from you telling me what you are going to do to see that it doesn't happen again." I don't mind telling you that those division managers hated, absolutely hated, to write those reports to the boss. And that word went all the way down into the organization.

I found that in some government organizations a fatality isn't anything that's really serious, it's just another accident! Well, I'll tell you one thing: at the telephone company or at DuPont, if there is a fatality, some manager is wondering if he's going to have his job the next day, so that message of investigation has to be one for managers to understand, and they have to know that the safety person can assist, can help, but it's primarily a management job!

Training is a subject we can talk about for five hours—it's probably the single most neglected thing in safety today. The real challenge is delivering the message to those people on the other end of the shovel or the wrench.

Reviewing emergency action plans is another loss control function. We sometimes forget about that, because we don't have a flood every other day, and when it happens there are no plans and it's kind of tough to get people to work on these programs continually.

In our state hospitals, where we have retarded children, we have fire drills on every shift every month, and the employees get sick of fire drills, but we know they know what to do—that's what is most important. What do you do when you have an accident? How do you get the guy that's unconscious out of the bottom of a manhole? Do you have a specified plan for doing that job and other hazardous ones as well?

There are thousands of words in the textbooks which discuss job safety analysis, but most important is to go back into your organization and see if you have a formal program for it that is really functioning. I think that every safety manager should take a look at every hazard and list it according to potential and severity. Each hazard should be called to the attention of management. Without complete backing from management, the hazards will continue to exist. Once during my experience, a state fire marshal inspected one of our buildings and said we had to sprinkle the whole building. You know, fire chiefs love sprinkler systems. Some think it's the answer to all problems—sprinkle the world and you've got all the fires controlled. When they give you these magic words, it might turn out to cost $100,000. In this type of situation, management has to make some decisions. While you're

thinking about what to do about resolving sprinkler installation problems, what are you doing about the safety? I once faced such a situation, and I told management that they would have to have fire drills twice a month until the sprinkler systems were installed. That didn't cost very much money, it was something the people could do. But basically, that's the role in the field of loss control: find the hazards, prioritize them, evaluate them, determine the risk, and remember that sometimes there may be very little risk involved. That's where you have to be very careful when OSHA is involved. Just because a compliance officer writes up 15 citations doesn't mean you have to get excited about them; there may be a one-in-ten-million chance of somebody being hurt by one of the specific citations. For example, the OSHA law says a fire extinguisher shall be X number of feet off the floor, and you could get cited if it's four feet off the floor as opposed to five feet. Now what's the chance of anybody getting hurt in that particular situation? So you have to take a hard look at each hazard so that you can supply management with the facts necessary to make a fiscal decision.

Unfortunately, we have too many people in government who subscribe to the "it hasn't happened yet" theory. Do you know how some cities determine when to install a stop light on a busy intersection? I actually talked to one city about that, and the engineer looked me right in the eye and said, "We put a stop light in after there have been four fatalities; so far we've only killed two." Well, I'm afraid safety people can't work that way. Unfortunately, you have a really big selling job when dealing with all the managers who believe in the "it hasn't happened yet" theory! We can't eliminate every loss exposure, but the probability can be reduced, and that is the real challenge for the safety professional.

In my opinion, we have to get away from OSHA mechanical standards and get involved with the people problems. Speaking of people problems, you should all be involved with some kind of a medical restriction and job physical requirement program. In our state, we have our jobs broken down into three different health classifications. If it's Health Classification 1, then that person has to be physically capable of working in inclement weather, or working under stress, and so on, so that he or she is a person that can do just about anything physically necessary to do the job. We also have other classifications, depending upon the job. Those things aren't going to happen by osmosis; you're going to have to determine what physical requirements are necessary and then hire people based on those specifications.

How many of you work for an organization that uses a pre-employment medical questionnaire and medical restriction controls? These are systems that make certain that people do not get back to work unless they're physically capable of doing the job. We use special forms which are completed by the physician and are designed to tell management what that person can or cannot do. If you have forms for that purpose, take a second look at them and find out if they pin the doctor down enough; remember, the problem is that the doctor and the patient have a relationship that is entirely separate from his relationship with you as an employer. Generally, the physician doesn't give a darn about you; he cares only about his patient, so you have to make certain that your restriction forms are clearly defined, like, "This patient can lift no more than 15 pounds," or, "This person should not stay on his feet for more than X number of hours per day," and so on. In other words, the questions have to be pinned down so that they protect you as the employer as well as protecting the employe.

A major element in control of claim costs is what I call the "early return to work program." One of the biggest problems in government is that when an employe is injured, we don't do very much to get him back to work. I like to call that second aid. First Aid is the

treatment following injury; second aid is what do you do to help that guy get back to work. It might be something as simple as having a procedure which requires your supervisor to call an employee within 12 hours of an injury, to visit him at the hospital, if necessary, to call him when he's at home and let him know that there's work available to him. With compensation costs the way they are, early return to work is essential. In some states, it's just as easy to stay home as it is to work, because the net compensation income is very close to what would be received while at work. Getting that person back to work early does a couple of things; it reduces the costs in the short term, and it may reduce the costs in the long term because you may be getting somebody out of the physical doldrums and return him to the workforce before staying home and collecting compensation checks becomes a way of life.

In the area of communication, it's most important that you not allow supervisors to disregard employee complaints; there should be some kind of a system—whether it be a formal suggestion system or a safety meeting system, that will allow the employee to air his problems with the boss, and besides, if they're doing this, they're not calling in the federal inspectors and complaining, because I'm sure you know that the OSHA law is biased toward the workers. If you have an open communication system with your workers and listen to them, you'll be surprised at what these people can turn up in the way of useful information.

Also, make certain that no supervisor fails to use known safety procedures, and there may be places where you need some extra safety procedures, such as when entering a tank or other confined space. We need more systems and procedures; not sophisticated aerospace-types, but simple systems and procedures that your employees can follow. Let me give you an example. How many of you have noticed that every time a telephone truck stops, the driver puts out a yellow cone behind the vehicle? Have you ever noticed that? Do you think they're crazy? Nobody else does that but the phone company. Let me tell you why they do that. About 30 years ago, a telephone serviceman backed a two-ton truck over a little girl and crushed her in the driveway of her home. At that time, the President of AT&T said, "That will never happen again!" And do you know something? It hasn't. Any telephone man who fails to look at the back of his truck and pick up that cone may be out looking for a job; that's a procedure, and it works, and it's got to be followed. That's only a very simple example. How many more situations do you have where you can set up procedures that people have to follow? That's where management control comes in; that's what makes a difference between a real safety program and those that are purely papermills.

Regarding the subject of high claim costs, I was asked just prior to a meeting, "What can you do to cut down on the number of back cases?" You all know how much back cases cost; insurance companies put reserves of $10,000 on most of them. Back strains (alleged and real) represent the highest on the list of claim costs in just about every state. Eliminating these costs is a very complicated subject. In fact, it's one we could easily spend a couple of hours on and then just scratch the surface. Let me tell you about just one management control technique that works. We required every supervisor to report back sprains and strains on a special report form within one hour following the injury. Sounds like a vast papermill, but actually it worked to let employees know that management was really interested in back problems. The quickly completed report asked employees the who, what, where, when, and why questions. One thing accomplished was to cut down and eliminate late reporting. At one time, we performed an analysis and discovered that back injuries increased every deer hunting season. Isn't that interesting? Finally, with back injury claim situations, you have to get involved with the treat-

ment, what's happening to the person, how long is the doctor going to administer treatments? I don't know what happens in your state, but in Oregon the patient can go doctor shopping. If they don't like one doctor, they can go to another one and, during this time, they're collecting compensation for weeks and even months. Finally, when the insurance carrier says, "We don't like what the doctor is doing, we want to send the injured to a specialist," in Oregon they can even ignore the specialist and go back to the original doctor. So, in many cases, the business of controlling backache is up to God and the doctor, not the safety engineer. Remember, though, that there are many things that the safety director can do to prevent injuries from happening in the first place. One of them is safety orientation, and another is very close analysis of the work situation.

The term "direct costs" refers to compensation payments and medical expenses. Your insurance rates are determined in several ways, but basically throughout most parts of the United States, you all have a manual rate for a specific industry or occupation which is designated by the national rating authorities to cover the average loss and is designed to cover the good, average, and bad risks. For example, in a logging operation, for secretaries who just type out the invoices, you might pay your insurance carriers 60 cents per $100 a payroll year. At the same time, you could be paying $32 per $100 a payroll for each one of the loggers. That's because the basic rate for secretaries is a lot lower because the hazard potential is lower. So, the manual rate depends upon the hazard potential, and it varies throughout the United States and from job to job.

There is also a term called "experience rate;" I don't want to get into the details, I just want to brush over it. The insurance carrier takes a look at your record, and if you're buying insurance in 1976, he'll go back and take a look at 1975, 1974, and 1973 to determine what to charge you in 1976. If your experience is good in the past three years, then you get a better rating and you, therefore, have a lower rate. As you improve your claim cost experience, you automatically lower future insurance costs. You know, it really bothers me as a taxpayer to think that thousands of school districts in this country have no safety programs. They all want more money, but many throw money down the tube because they do not have functional safety programs. I often wonder how much our school costs could be lowered if they had good safety programs.

Under worker's compensation laws in most parts of the United States, an insured worker loses the right to sue his employer; instead, he accepts the benefits which are determined by your worker's compensation system. Under this system, the compensation carrier must pay all medical expense and weekly compensation. On the other hand, somebody injured on your property who is not an employee can sue your pants off, and that is covered by liability insurance. Again, a manager who does not have a safety program is not very bright if he doesn't consider the potentials for lawsuits, and as you know, nowadays they sue everybody for anything, and it's a pretty expensive game to play. The employer has got to pay the cost of the benefits, regardless of who was at fault. In most states, if one of your carpenters gets ten witnesses and says, "Okay, fellows, I am now going to demonstrate how to cut my finger off," and this carpenter is at work and he does chop his finger off in front of ten witnesses, you're going to pay the claim, regardless of fault; that's the way the laws are written in most states and it's up to you to prove if it was not work-connected, and you can do this by appeals and by dealing with the people who make the claim settlement.

You may argue about this, but I disagree with most texts in this subject. The safety textbooks say that 85 per cent of the accidents are caused by unsafe actions of people and 15 per cent are caused by unsafe conditions. I really think a closer

figure for the State of Oregon, where we have 50,000 employees, would be about 99 to one; 99 per cent of my accidents are people problems, and I'll bet that 99 per cent of your accidents are people problems too. Actually, very few of your day-to-day accidents are people problems too. Actually, very few of your day-to-day-to-day accidents could be eliminated by close adherence to the OSHA law. This is why I wrote the original article criticizing OSHA; they were barking up the wrong tree, and they still are. We've got to get involved with the people problems. It's a big area, no matter what that percentage is, where you have to concentrate and where you need management control. That's the big challenge.

Like the iceberg, the hidden costs of an accident are all not visible on the surface, but they're there, they're very serious. The aggravation, the complaints, the neuroses, the things that follow an accident can cost you a bundle of money. I'm certain that most of you have seen the charts which describe the hidden costs of an accident. I think the best way is to paint you a clear picture of what the hidden costs of an accident would be:

Picture a large factory which contains a room with 150 sewing machines complete with girls working at the machines who are producing bathing suits. Let's assume that Mabel, who installs the zippers, is talking to her girlfriend on the next machine and inadvertently gets her finger caught in the machine and the needle penetrates the bone. She is stuck in the machine and is screaming with pain. Would you like to guess what happens to the other 149 sewing machines? Every one of them stops. If you're paying those people $3.00 an hour, that's a lot of money. Now, in the process of getting her finger stuck in the machine, she probably ruined the garment she was working on; that's a few dollars. She may have also broken a gear in the machine, maybe a gear that can be replaced for $3.00 but that machine is going to be out of commission for two or three days till they get the part from the dealer who may be 1,000 miles away. You know, whenever you want a part, you can't find it. What about the time in investigating the accident? What about the report writing? What about the training time? Let's assume that Mabel was the best zipper putter-inner in the plant; skilled people are hard to find. You might get somebody to take her place, but that person goofs up every third zipper—that's a cost! You can't instantly find trained people to do a job, so sometimes the cost of an accident can be thousands of dollars to every one dollar that's a direct cost. The hidden costs of an accident are unbelievable, and don't you dare believe the textbooks that say they appear in a four to one ratio. Sometimes the indirect costs are 1,000 to one.

Remember that when there is a serious accident, it affects the entire organization. Not so much the public employer, because he's providing a service, and if he has to close down the sewer system for one day, he closes it down! A lot of people scream and yell, but they're not going to quit and take their sewage somewhere else; they're stuck with you. But it doesn't help an organization to have a record of constantly poor service. In the private sector, when you have something down, it costs thousands of dollars and some of the customers will not wait until you can reopen your business. They'll go somewhere else. So, the hidden costs of an accident are absolutely astounding. I'm always shocked to hear that some managers don't realize how many dollars are involved in this business of accident prevention.

Let's take a look at this business of accident investigation for a minute; I want to get back to it because it's so important and I find that it's so poorly done in many organizations. Think for a moment about this hypothetical situation: There's a foreman transporting a worker across town in the back of a pickup truck that doesn't have a tailgate. The foreman hits the brakes to avoid a cat and he throws the worker out onto the street. Now would you believe that when

that man hit the street, one of these five things could have happened? Maybe he had no injury at all, maybe he had a minor sprain, or he could have fractured a leg or even fractured his neck, or he could have hit his head just right and had a brain concussion and died. All five potentials are the result of one failure by the foreman to observe an established safety rule.

The point is that when you investigate that accident, what are you going to do to discover the cause? In one case, the worker gets back into the truck and returns to the shop for a bandaid. His boss would have said, "Boy, you could have really hurt yourself that time—you were lucky!" and that's the end of it. In another situation, the supervisor who was really accident-oriented would say, "Okay, we had an accident involving an employee who fell out of a truck. Effective immediately, if I ever catch anybody transporting an employee illegally, somebody's going to get a week off without pay. We will never transport an employee in an open truck again!" A company with a good loss control program takes a look at everything that happens so that they can reduce probability of accident occurrence. They've got to show concern for every injury, whether it's a serious one or a minor one, and let people know that they care about what happens to people. By the way, your employees like to know that you care about them, too. In short, a minor injury ignored today could lead to a fatality in the future.

In loss control, you want to think about what you can do to prevent the accident from happening in the first place, so you want to think about back-up safety systems. For awhile, I was the safety engineer at a large aircraft manufacturing plant. Did you know that there are seven ways to lower the landing gear on some airplanes? That's not because the engineer was stupid, but six of them are backup systems and finally, the co-pilot can get down into the hole and crank the wheels down by hand. That's expensive, redundant safety, but there are lots of situations in your job where you can install redundant systems and procedures to protect the man and equipment. Not all safety backup systems are expensive.

When do you buy a smoke detector? After the fire? When do you install a sprinkler? After the building burns down? When do you purchase safety glasses? After the loss of sight? Accident and loss control is not a mystery. The basic principles have been printed in textbooks for 30 years, but the problem is that we don't have enough people who push for the real management concepts of accident control. There are too many safety people who are all hung up in safety glasses, safety shoes, posters, and films, and they are not concentrating on management controls. I know talking against films and posters at the National Safety Congress is something that borders on being sinful, because they sell a lot of posters. I think posters are great, but they have to be used right, and we have some safety people who spend a.l their working time on films instead of taking a look at hazard potentials and taking action to eliminate them.

If you have an accident that costs the organization a thousand dollars, and if the profit margin on what you sell is one per cent, you have to do $100,000 worth of business to make up for that thousand dollar loss. This all leads to what's wrong with government safety programs, which I'll sum up in a capsule—"Most managers in government don't care about money because it keeps coming in from taxpayers and they're not concerned about profit and loss." Some school districts are finding out that the public does care about money, and they're turning down the bond issues and some schools have been closed. I think that's great to wake them up to the fact that they're wasting money—yours and mine—if they fail to install safety programs, just as I think OSHA is wasting our money because they're spending all their effort on the mechanical part of safety. (This means that companies have to lay out funds to

correct cited mechanical parts when the real problem may be a people problem.) OSHA is getting $119 million a year; I would like to see $100 million go to training and education and $19 million go to enforcement—Just the opposite of what they're doing now. A real challenge in government safety programming is to get management's attention to the cost potentials.

In the area of safety communications, I say you should eliminate "do-nothing" committees; we have too many of these. Instead of having safety committees, I favor accident control groups where everybody is involved, not just one person in a department. Here is how these groups work: Accident Control Group I includes top administrator and his immediate staff. Accident Control Group II is the middle manager and his staff; Accident Control Group III is the line supervisor and his entire crew. Now, if you look at most of the textbooks, they tell you to take one man out of each department and put him on a committee, but what about the rest of the department? What makes you think that the committee person selected can deliver a message to the rest of the group? Using the accident control plan, you're going to have a better communication system, and because everything flows from top to bottom and from bottom to top, you won't have a bunch of committees running around that can't do anything. Most safety committees talk a lot, they look at films, they write minutes, but they can't make a single decision to solve problems. Under the accident control system, the person in charge of each group has the authority within his scope of responsibility and accountability to make change, and if he can't solve the problem down here then he takes it up the ladder and gets the answer. Again, don't waste time with a bunch of committees running around who can't make decisions.

Discipline—we've mentioned that nasty word before. You should have a systematic discipline program that's fair, that's acceptable to both union and management. Everybody knows what the discipline policy is and how it works. Frankly, I disagree with psychologists who say you should not discipline employees. These are psychologists who never got their noses out of the textbook and have not worked in the real world. There are too many of them around who haven't learned that you can't constantly pat people on the back, counsel with them and rap with them and beg them; some people refuse to understand anything but discipline. A successful safety program must have rules that are backed by a written system of controls.

Finally, let's talk about a hidden subject which presents a major loss control problem. We have 11 million alcoholics in this country that are known, and for every one of these, there are a lot that are borderline. Safety people don't spend enough time trying to prevent accidents by finding people who have a drug or alcohol problem. It's a subject people say very little about, but it's time we developed more programs that are geared for helping people with such problems. We must fact the fact that alcohol is a drug—it's worse than marijuana, heroin, morphine, cocaine—than all of the street drugs combined—and some organizations have found that by having programs dedicated to doing something about the drug problem, that they save people's lives, money, and certainly prevent accidents. It's important to repeat that alcohol is a drug which immediately affects the brain. Fifty per cent of our deaths on the highway are the result of alcohol, but I never hear any figures about how many accidents occur in industry as the result of alcohol. There are no figures, and that's because many people don't want to talk about the problem.

I am frequently shocked to hear people talk about beer as though it was harmless. Some people believe that only hard liquor has the drug alcohol and, of course, you all know better. Beer is a drug because it contains alcohol, and too much of that can cause problems at work, and you've had some of those problems. If you drink

a lot of beer, you drink a lot of drug. It's a whole different approach, thinking about alcohol as not something happy and relaxing but as something dangerous and toxic. If you need a drink to be social, that's not social drinking. We have lots of people tied up in this system of alcohol as a social drink. I wonder how often do we think about accident potentials at work as a result of the happy drug, alcohol?

People in your organization have all kinds of problems, sick kids, divorce, teenage kids, job satisfaction—you name it. We need more programs in government that deal with these kinds of personal problems, because a worker who is thinking about his sick child or a divorce or finances does not have his mind at work. Employee assistance programs are preventing lots of accidents. As a matter of fact, the Hughes Aircraft Co. reports that their program saved over $2,000,000 since they started it. The big thing about employee assistance programs is that they are usually based on starting out with a company policy that says we are going to do something about people problems and try to help them. Then the next phase is to train your supervisors to look for poor work performance. You don't want any supervisor being a diagnostician; this is a personal problem. A documentation program is necessary. Let's say, for example, that an employee missed every Monday morning for the last ten Mondays, he's sicker than he's ever been, he's later than he's ever been, his work quality is off, there are mistakes. In other words, when the work performance drops, there's a reason for it, and it might be alcohol, drugs, sick children, finances, who knows—who cares? All we do in these programs is confront the employee with the poor work performance and say, "Look, you've got a problem. We want you to go to the closest mental health clinic, counselor, or what have you and get some help." And the boss says, "I don't even want to know what your problem is, don't even tell me about it; all I'm interested in is your poor work performance." You also tell the employee, "If you don't get that help and if your work performance doesn't improve, we're going to fire you." I want to tell you something and listen to this figure very carefully. In 80 per cent of the cases, the threat of losing a job will get the employee to seek help. Eighty per cent of these people can be cured with early intervention, and there are very few cities and counties and states that have employee assistance programs. Just remember there are no class distinctions where alcohol is concerned—it involves presidents of corporations and janitors, alike.

Accident prevention is a technique; it isn't going to happen by itself, and when I think about the word "technique" and the need for skillful application of management principles, I have to tell you a story that I heard several years ago that has to do with skill and technique. It's about the Emperor of Japan who, after World War II, wanted to show his appreciation to all the countries who helped rebuild Japan's financial empire. He had this vast state dinner at the palace; it was the finest dinner ever done, silk tablecloths, gold utensils, the finest food available, a show—everything! And after this marvelous dinner, the Emperor told the people, "As a final effort of our show tonight, I would like to have a demonstration by some of the most skillful people in the world, and in our culture the Samurai swordsman is a person who handles a sword from the time he's able to crawl and walk, and he's an absolute expert on how to handle the sword. I now have a demonstration for your pleasure of the No. 3 Samurai swordsman in all of Japan: And with that, they spread a white silk cloth in the middle of the room. Everybody got up and stood around the cloth and swordsman came out all dressed in his beautiful robes, gold-handled and jewel-encrusted sword, and he opened up a small jeweled box and a fly flew out. He whipped out the sword—swoosh!—in an instant he cut the fly completely in half. The audience was amazed!

Then the emperor said, "I would like you to see the No. 2 Samurai swordsman in all the world." Then there was the same procession with the beautiful clothes and the jeweled box and he let the fly out and the sowrdsman went swoosh-swoosh!! When the people looked on the cloth they were amazed—he had completely quartered the fly in mid-air. They were absolutely astounded!

Finally, the emperor said, "I will now introduce the No. 1 Samurai swordsman in all the world." And he went through the same thing, he let the fly out, he whipped out the sword and went swoosh and the fly flipped just once and flew out the window, and all the eyeballs followed that fly. They just couldn't believe that the guy missed, because he was No 1. When the fly disappeared, the swordsman put his hands up and said, "Never fear, honorable fly will never father."

That's skill, and that's technique, and that's what we need in more safety programs in government.

FUTURE USE OF THE MOST DANGEROUS POLICE WEAPON, THE AUTOMOBILE

By RICHARD H. TURNER
National Academy for Police Driving

In 1967 my thoughts were engrossed with the problems of police driving and how to grasp the realization of death by automobile. A number of my friends had died in automobile accidents. There is no feeling on earth less helpless than attending a funeral of a friend or loved one who fought and died for nothing.

In the police industry we use the automobile as a tool. But is it a tool or a weapon? An early adaptation of weapons into tools was given by Isaiah when he said: "And they shall beat their swords into plowshares and their spears into pruninghooks. Nation shall not lift up sword against nation, neither shall they learn war any more."*

Unfortunately for many of us, the flow in our industry is reversed. The tool is called upon to be a weapon. Too often this weapon not only destroys the criminal element, but the law officer as well.

In our industry, for years the trend has been to sweep an accident under the carpet. After all, the officer involved knew inside that he was right, or wrong. I do not agree with this type of thinking. The time has come to evaluate accidents for what they are, and call a spade a spade.

Police vehicle accident statistics are not easy to come by. The problem is so widespread and complex that no central reporting agency handles nationwide statistics regarding injury and death of peace officers by automobile.

We are proud of our accident statistics in Texas. For example, the City of Dallas was recently cited by the National Safety Council for excellence in their low accident rate. Dallas had 17.19 accidents per million miles of police service. As proud as we are of these statistics, we must realize the other side of the coin—rarely does a day go by without a police accident.

My department, Hutchins, Texas, has a total force of five officers. Our last police accident was in 1974. Our chief stresses safety in all phases of police work. We have a stringent firearm program, as well as strict driving rules, and personal conduct. Training and retraining is the rule at our department, not the exception.

If we examine the cause of an automobile accident, we find too often that the driver did not know the limitations of his or her car under emergency conditions. Nearly all police car accidents involve full application of the brakes. If we examine Newton's First Law of Motion, we will see just how hopeless full braking is. The law states: "Every body continues in its state of rest or of uniform motion in a straight line unless it is compelled to change that state by forces impressed upon it." This law, when applied to an automobile, means very simply that a car with the brakes locked will travel in a straight line. Unfortunately, thousands of drivers each year meet death with locked brakes. The answer to the problem is not nearly as complicated as one might think. At National Academy for Police Driving we devote a major portion of every class to accident avoidance and crash procedures. Perception and reaction simulators designed and built by our organization are used to test the officers' reaction time under street conditions. A simple-looking device can give an officer confidence in his or her ability to avoid an accident by steering, rather than the heavy application of brakes. By steering, the driver has a chance of survival, even in a head-on collision.

*Isa. 2.4

An example of this teaching was displayed on the street by Patrolman Steven Byrd, Sulphur Springs Texas Police Department at 3:09 P.M., February 22, 1977. Officer Byrd was traveling code three to an emergency situation. As he approached an intersection, an automobile suddenly appeared from behind a truck, directly in front of Officer Byrd's vehicle. The scene was a typical T-bone accident, with one exception—Officer Byrd knew what to do. He had thought his way through this type of accident many times since he left the three-day training program on November 5, 1976, and performed his duty to perfection. We feel accident avoidance is a duty of a professional officer.

When interviewed on national television, Officer Byrd stood as living proof that training is the answer to reduced fleet accidents. The driver of the other car admitted to the chief that he had indeed heard the siren, and as soon as he was able to see the car he was going to pull over and stop.

Interviews by the chief and our organization convinced us that Steven Byrd had made a deliberate, knowledgeable move, programmed into his mind through concentrated thought about the potential accident and carried out on the street as a conditioned reflex.

At NAPD we believe driving is 90 per cent mental and 10 per cent physical. As proof, we offer the following example. You are driving south on Michigan Avenue in Chicago. As you approach Jackson, you decide to turn into Grant Park. The first step is to identify your position. "I am approaching Jackson." This thought process is followed by an analysis of the situation. "If I want to go into the park, I am going to have to turn left. If I turn right, I'll be going away from the park. Therefore, I'll need to turn left."

You are now aware of your position, and have analyzed the fact that a left turn is imperative. The next step is to reach a decision. "I will turn left at the corner of Michigan and Jackson."

The fourth and final step is to execute the move. In order to do so, our brain must tell our hands and feet to work together, slowing our car and properly reaching the point of actually turning.

As is plainly seen, only the very last part of the total process involves a physical action.

If we were to interview 100 people on the street and ask the question, "Is driving a physical, or mental action?" nearly every person would answer, "physical." Herein lies the heart of driver education problems as they are being taught today. How to drive is a teaching objective long accepted by our society. We see myriads of advertisements for driving schools saying, "Learn how to drive." Have you ever seen an advertisement say, "Learn *why* to drive"? The average driver training objective is to teach the student just enough to pass the license requirements in his or her state.

Driving is by far the most difficult repeated function in law enforcement. The police driver must, by the nature of his or her work, look away from the roadway a major portion of the time. Checking buildings at night sounds simple enough. But, what of the hazards a driver will encounter? The lowest ranking type of police accident might be running over a board with a nail in it. The result is a flat tire and a unit out of service. Not only must the officer watch each building, but the road as well.

We can traverse the industry to the most dangerous use of the automobile, the "officer assistance" call. When ranking forms of pursuit, the "officer down" call over our radio makes the recipient respond mentally, physically, and emotionally. I have never met an officer who did not become highly concerned over the plight of another officer. They may be on opposite ends of the earth as far as personal views are concerned, but let one get in trouble and they are all part of the same family.

As the call is received, the responding officer thinks of nothing but getting to the scene. In some cases, reason is thrown out the window. Far too many officers wreck on the way to assist another officer in need. By crashing, the second officer not only cannot respond to the needs of the first, but now causes someone else to be called to assist him, thus dividing forces.

The correct method of running an assist call is to note the location, pick a desired route of travel, then forget the other officer until arriving on the scene. I am well aware of the move, having been there myself. Only strict mental discipline will see the officer through. We again point to the mental aspect of driving.

At times, all patrol officers become involved in a chase. How the chase is handled and why a particular method is employed becomes paramount. At NAPD we teach what we call "the pursuit position." In the pursuit position, an officer places his vehicle where his nose is directly behind the outside rear view mirror of the violator car. This will place the police car approximately 2½ feet to the left of center with regard to the violator vehicle. This position has numerous advantages. First of all, the left side emergency light can be seen by oncoming traffic. Innocent drivers coming into the situation are alerted, and the driver of the violator car is being driven down a narrowing alley. All movement of a vehicle starts from the front wheels in contact with the road surface. From the pursuit position, the officer can observe the movement of wheels, rather than wait for the rear end of the car to move. The tenths of a second saved by the officer add to the safety factor.

Another important factor is the psychological effect on the violator. From his position it looks as though the police car can pass at will, thus signalling superiority.

The following letter was received by our organization from Officer Wayne Rudd, Paris, Texas, Police Department: "Since I have completed the course, I would like to relate to you how I feel about myself as a driver, both on and off the job, and also to let you know how I stand on pursuit driving. I have been involved in two pursuits in the past month, and these were the first ones since I had completed school. I 'won' both of these chases and did not do it by attempting to go faster than the violator, as I would have done before the course. I merely stayed with him until he decided he was not going to get away from me, and by intimidating him with the pursuit position. In both cases, both violators asked me why I didn't go ahead and pull in front of them. One of these vehicles that I chased down was a 1969 Dodge Polara with the 440 Magnum engine in it. I could not have passed it if I had wanted to, but the suspect did not know that; it was only the pursuit position which led him to believe that I could take him any time I wanted. It works!"

What Officer Rudd now does, as a normal procedure, is remain calm, handling all driving situations alike. Pursuit has become a normal function; run as slowly as possible, still getting the job done.

Pursuit itself is not dangerous. The induced elements create the danger. For example, if a police officer does not allow himself to be sucked into the thought pattern of the violator and drives his own car, the violator is incidental to the action. The police car must move safely through the total procedure, waiting for the proper moment to make a stop.

An interesting observation was made and brought to our attention by the Temple, Texas, Police Department, then six months later by the Fort Worth, Texas, Police Department. In both cities, officers were involved in pursuits. After the action, the tapes of their radio conversations were reviewed. The officers then went back in the log and pulled their last pursuit prior to attending the NAPD training program. Prior to training, their voices were high-pitched and often garbled, or over the sound of the siren. After training, their voices were calm. The only siren sound over the radio was during a special situation. Otherwise, the siren was stopped momentarily during transmission, then turned on after transmission. This particular procedure, it should be pointed out, will not work effectively in all situations. The point is this; the officers had presence of mind and operated in an efficient manner throughout the pursuit action.

What are we really trying to say? In our opinion, driver training of police officers has come of age. Accidents are being reduced by rates thought to be impossible. To appreciate the reduction, let's examine some statistics produced by Mainstem Corporation, Princeton, N.J. Mainstem is a gathering and reporting organization, selling their services to municipal and private fleets.

The data base from which I speak concerns 59 fleets operating 4921 police vehicles. These vehicles traveled 105,178,412 miles, using over 13,000,000 gallons of gasoline. The average car traveled 1781 miles per month, obtaining eight miles per gallon of gasoline, and costing $112.83 per month for maintenance and tires. These figures represent a large portion of any police budget. Although these figures are large, I doubt that any of you are shocked. The shocking figures pertain to police car accidents. Again, quoting from the Mainstem information: In 1976, 39.6 per cent of all 1976-year-model police vehicles were involved in at least one accident repair order during the year. It should be noted at this point that vehicles totally destroyed were not part of this survey. In 1975, 47.8 per cent of all 1975-model cars were involved in an accident.

To put more meat in the figures, let's examine the frequency of accidents, expressed in miles driven. The average police car will have an accident every 48,795 miles. At NAPD we make the statement that the average officer will face an accident situation about every three thousand miles. According to Mainstem's figures, after about 15 near misses, his number will be up.

These accidents cost an average of $398 each for parts. Again, let me point out that this does not include vehicles totally destroyed. They also do not include lost time, medical bills, or law suits.

What about death to my fellow officers? What does a death cost? This is both a difficult and a gruesome figure to grasp. In talking with police agencies and piecing figures together, we came up with approximately $175,000 per accident where a death was involved.

If these statistics represent the problem, what statistics represent an effort toward the solution?

We have our year-end statistics for the year from October 1, 1976, through October 1, 1977. We are proud of these statistics, but I must admit they also pose a problem. If I were sitting where you are, I would think one of two thoughts with regard to our statistics; they are either wrong or the guy giving them is crazy.

In the past year, we have trained 757 police officers from 81 agencies. You are obviously not interested in hearing the names of 81 agencies, but might be interested in some of the cross-section. Our smallest agency represented is Berryville, Texas, a one-man operation. At the other end of the scale the largest agency is the Department of the Treasury, U.S. Customs agents. Our neighbors, Dallas and Ft. Worth have both been sending officers to us on a regular basis. These officers, when comparing their accident rate one year prior to training, then one year after training, represent an amazing statistic: Their accident rate has dropped by 68.42 per cent. In other words, where we had three accidents in 1975-1976, we had one in 1976-1977. You now know why I made the statement about the figures.

Let's change the numbers for a moment. What if the reduction had been one-third what our statistics show? Would 22.8 per cent be a bad showing for these officers?

So we have a fancy set of numbers. What do they mean to your agency? Obviously, we are not a large enough organization to train the agencies and

cities represented at the National Safety Congress. What, then, can we do to help you? We feel the only answer is to develop instructors for each city, state, county, or federal agency desiring our courses. We will make our literature available. In fact, we have a new series of textbooks being prepared for not only the police function, but other types of municipal vehicles.

At this point I'd like to discuss our mobile concept. To date, approximately 50 per cent of the officers trained by NAPD have been at the site of the agency, not our home base. When we developed our courses, they were required to meet a number of criteria. One of the top priorities was to develop a program that was mobile. Mobility in itself was not hard to conceive, but how do you develop infinite course layouts for various areas? This was accomplished by developing a series of driving criteria for training, then building corners, etc., that would force the student to make the desired move. We then developed perception and reaction simulators to provide the student with meaningful evasive maneuver training. Of all factors taught, perhaps evasive maneuvers rank top priority as far as saving life and injury. These devices teach the officer to program his mind and body to perform as one in an emergency situation, as a conditioned reflex.

Another criteria for the program was that it could be put on at speeds averaging less than 30 miles per hour. Consider for a moment that you and I are on a large open area where we can drive a vehicle as fast as it will go. I turn to you and ask you to watch what I do, then you will be required to repeat what you have seen. I then drive the car 120 miles per hour, make three or four very sharp turns for the conditions, and make a rapid stop. What did you learn? Probably nothing; your main concern was your safety, not the driving lesson.

Let's change the stage and do the same basic maneuver at 25 miles per hour. You can now learn what is going on rather than hope we get back in one piece.

When I say low-speed training, do not confuse this with low stress training. We create a tremendous amount of stress. For example, when was the last time you saw a police officer who was not competitive in nature? Every move the student makes has a scoring system. It may be a stop watch, number of traffic cones knocked down, or efficiency of operation through a given maneuver. Peer pressure, applied under controlled conditions, is a very real thing.

Another phase of the program that we discovered in the early mobile schools was the forced learning situation. Since what is taught in the classroom portion must be demonstrated by each officer on the driving surface, participation is a must. When it comes your turn to be in the driver's seat, nobody but you can do the job. You can't get any help from your neighbor or your text material. Since each move is timed or scored, the officer knows he or she must meet a pre-set standard.

As a result, this program can travel anywhere in the world. All we need is a classroom and a surface on which to drive. The driving surface can be anything from an airport to a blocked off side street or a parking lot. We have never been asked to put on a school where we could not find a suitable place to drive.

It is our feeling that the best way to develop highly skilled instructors for your agency is to have them come to our home base near Dallas for initial training. After two weeks of intensive training, two of our instructors will then accompany your instructors back to your base of operation, where the four people will now start training your troops. Depending on the size of your organization, we may or may not be there for another three to four weeks.. After this second phase, we will then monitor the quality for you as outside consultants, and hold recurrent training for your instructors.

If you are a small agency, we will set up a school for your department, or a group of departments. We do not require that you send your officers to us. From a pure economic standpoint, it is a whole lot less

expensive for three or four of our instructors to come to you than it is for you to come to us.

Since cost is an important factor in any training operation, let's take a look at what it will cost you for our training. Our basic school is three days in length, or 24 hours. The cost at our home base is $115 per student. When we take the school on the road, the tuition cost remains the same. The only added cost is our traveling expense. We have this broken down by state, so we can give you a firm price for budget considerations. The average cost in the northern part of the country is about $186 per student. We require a minimum of 12 students and a maximum of 20 per class. If you have a large enough area in which to hold class, then drive, we will put 40 officers in the classroom, then set up two separate driving courses, utilizing additional instructors.

Included in the cost is all text material, including a textbook, workbook, timing and scoring records, a certificate of completion, and all other items for putting on the program. We provide traffic cones, the simulator devices I spoke of earlier, all course layouts, visual aids, etc., and the instructors. You furnish the facility for a classroom, a driving surface, and the officers and vehicles.

At this point, let's talk about the cars. The only wear factor from the course will be tires, and the amount of wear will depend on the driving surface. If we work on rough concrete, tire wear may run as high as 15 to 20 per cent per student. By contrast, on the average asphalt surface, tire wear is more in the area of five to eight per cent per student.

Obviously, vehicles and driving are all part of a closed pool system. By this, I mean they must interreact with each other in order to accomplish final objectives. Where does the future police vehicle fit in the scheme of things?

In past years, we were in a horsepower race. Each model year brought stronger, faster production automobiles. Since police departments have new, or nearly new year models, we could compete in pursuit situations.

We now find ourselves on the other end of the spectrum. Each year brings smaller, less powerful cars. As a result, we are just plain getting outrun in the streets. What are the solutions?

We feel that driving efficiency can make up for a large part of the problem. By driving in an efficient manner, the officer can stay with a violator until he gives up or until other units can be dispatched ahead of the pursuit. Unfortunately, this is not always realistic. Many pursuits are quick to break, and if the officer cannot stay close, the violator is gone.

One faction in our industry says, "We will not run pursuits more than ten miles per hour over the speed limit." The other faction wants to catch the violator then and there, at whatever speed is needed. We tend to sit somewhere in the middle. There are many pursuits that are too fast at the posted limit, much less than ten miles per hour over the limit. On the other hand, chasing a wanted felon with a car full of drugs warrants more speed on a country road.

The director of the Texas Department of Public Safety has expressed concern over the plight of his troopers with the slower patrol cars. In our part of the country, we have highways that are wide open. There are times when a high speed pursuit is needed. A new police car against a ten-year-old muscle car is at a definite advantage.

One possible solution might be to allow the motor companies to build a certain number of vehicles for police use each year that would be competitive in the street. This, of course, would take major legislation, since the feasible way to produce such a car would be with a ten-year-old engine. Since the engine would not meet the EPA specifications, our government would have to become heavily involved.

Opponents of this type of thinking will point out the minimal time actually spent in pursuit versus the total run time of the cars. Proponents will then point out the

fact that the average officer seldom, if ever, is called upon to use his handgun, and yet no one would think of sending an officer into the street without one.

Only time will tell us the proper solution. In the meantime, we can only learn to operate as efficiently as possible, and hope for the best. A major portion of our research effort at NAPD will be geared toward a solution to this trying problem.

Another current problem with police vehicles is building a set of specifications from which to solicit bids. In 1978, the problem is compounded by the fact that one company's full size car is another company's mid-size. For example, the full size Pontiac and Chevrolet will have a wheelbase of 115.9 inches in 1978. By comparison, the mid-size Ford LTD II has a wheelbase of 118.0 inches in the four-door car. In the Chrysler Corporation line, the full size cars—the Dodge Monaco, and the Plymouth Fury—now have a wheelbase of 117.4 inches. In 1978, these will be full size cars, whereas in 1977 both were mid-size offerings.

In 1977, we evaluated two American Motors Pacers. The basis for the evaluation was to find out if there was a place for the car in our industry. At first glance, chances seemed slim. However, we found the station wagon version to be an excellent canine car. Both models also proved desirable in C.I.D. and as surveillance units.

We are scheduled for a test on the Oldsmobile diesel. This may well be the power of the near future in our industry. Again, as in the AMC evaluation, we are going in with our eyes open. It is so easy to prejudice a test, yet so hard to do pure evaluations. A major part of my time is spent looking at that which does not exist, rather than just the facts as they present themselves. Perhaps the best example I can give of this comes from another end of our business, that of accident reconstruction. It is easy to form a snap judgment as to what happened in an accident case. However, until all known facts have been assembled, cataloged, and examined, no judgment is of any value. At this point, the real heart of the accident is still before us. We must then evaluate what could possibly have happened according to the laws of nature and the science of physics. Without a knowledge of these factors, we would be doing a gross injustice to those we serve. Accident reconstruction and vehicular testing are scientific undertakings, and as such must be carried out by competent scientists.

I'll be the first to tell you there is no such thing as a perfect police car. We feel there is a vast difference between the best car offered today and the worst. We have definite opinions, based on facts, to prove our point, and would be happy to discuss cars with you. We don't feel we should endorse any given car before the National Safety Council, but in private we will tell it like it is.

In closing, let me briefly touch on the other aspects of NAPD, and our future. Since our inception in July 1976, we have grown from strictly a police training institution to an organization of seven divisions, serving all facets of the driving market. We have programs for the average citizen, fleet operators, ambulance and fire equipment, and nearly anyone driving a car, truck, or heavy equipment.

Lastly, and most important to our survival, we thank our students and their agencies for having faith in us when we were unproven. We also thank them for conducting themselves in a manner that has allowed us to build the statistics we have presented to you today.

78 1984

A COMPREHENSIVE STUDY OF FIRE FIGHTER INJURIES AND INJURY REPORTING SYSTEMS

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Over the last decade we've seen many profound advances made in both the laws and programs designed to improve worker safety and health in the United States. For the most part the offered improvements were made with the best interests of the worker in mind. However, the favorable impact of the improvements from the standpoint of death, injury, and disease reduction is questionable. Given that some industries or particular crafts have enjoyed a reduction in injuries and diseases, a great many more occupations have seen little or no change at all.

The fire fighting profession is a perfect case in point. With all the advances made in the health and safety areas, fire fighters are still being injured and diseased at an alarming rate. An examination of the combined years 1973 and 1974 demonstrate this fact as a total of 190 fire fighters lost their lives during the performance of their duties. According to the International Association of Fire Fighter's most recent 1975 death and injury survey, 108 fire fighters lost their lives in on-the-job accidents and 88 from occupational diseases—and these statistics are only representative of fire departments with injury data systems detailed enough to participate in the IAFF annual death and injury survey.

Death and injury reduction to fire fighters is a major concern of the IAFF. Fire fighter deaths exceed those of the "dangerous" occupations. This shocking statistic has been, for the most part, the case for the past ten years. In 1975 alone, the fire fighter death rate exceeded that of both the mining and construction industries—two extremely hazardous industries. Some reasons for the alarming rise in fire fighter death and injury rates may be attributed to the nation's overall increase in the number of fires and emergencies along with new and additional hazards to fire fighters created by industry's technological advances in products and substances.

Today, almost 67 years after occupational safety and health entered the picture in the U.S., the total relationship between fire fighters' occupational diseases and exposure to certain specific toxic or stressful environments still cannot be determined with any degree of certainty. At the same time, factors in these environments can be assessed to have positive underlying etiologies resulting in such diseases.

In addressing the issue of fire fighter safety and health, the IAFF and NFPCA have assumed a posture of careful assessment of its fire fighters' injury, disease, and mortality problems, as well as engaging in specific projects oriented toward upgrading the state of fire fighter safety throughout the nation.

Over the years, the IAFF and the NFPCA have forwarded both expertise and funds to study fire fighter safety and health problems in an effort to define, evaluate, and recommend workable solutions to a most difficult set of problems.

One of the most blatant deficiencies encountered by the IAFF and NFPCA during attempts to upgrade safety and health for fire fighters is the lack of

accurate data on accident, injury, and occupational disease incidence and causation. These data are needed to establish directions and to determine priorities for research. Those who have initiated research without considering this deficiency have had adversaries questioning the validity of their findings. Contrary views and findings have usually been based on equal or similar informational deficiencies. Furthermore, without reliable data, it has been difficult to establish justification for the priorities placed on national fire fighter research projects.

The IAFF, recognizing the need for a more precise definition of the fire fighter health and safety problem, many years ago embarked on a study to collect and analyze accident, injury, and disease data. Included in the initial steps was the design and administration of an annual death and injury survey to be participated in by fire administrations throughout the nation. To date, the survey has been conducted for 19 years and, in one form or another, will continue.

In the course of collecting, classifying, and reporting accident, injury, and disease data from the IAFF's Annual Death and Injury Survey Report, it was suspected that many variations existed in the classification systems being utilized at the local level to produce the data. It could be said without considerable disagreement that there were, except perhaps in a very few instances, almost as many systems for recording, classifying, and reporting accident, injury, and disease data as there were fire departments in the United States. This situation posed a problem when attempts were made to draw meaningful relationships correlating data from one department to another.

The more the issue of obtaining reliable injury and disease data was considered, the more it became apparent that preceding any attempt to acquire meaningful data for use by the IAFF, the NFPCA, or anyone else interested in fire fighter safety, a careful assessment should be made of the systems which are being used at the local level to acquire, classify, and utilize fire fighter accident/injury data. It was also determined that any attempt to curb fire fighter deaths, injuries, and diseases would continue to be hampered by imprecise information about the nature and scope of the important causative factors involved. Furthermore, the IAFF recognized that conclusive accident/injury data would be imperative in determining and giving priority to specific fire fighter safety and health need areas for research. Such an idea was presented by the IAFF to NFPCA.

On June 15, 1976, the International Association of Fire Fighters (IAFF) was awarded a grant to conduct an extensive study of the methods, procedures, and systems by which fire fighter injuries and occupational diseases are detected, recorded, and classified, and how resulting injury information is stored, retrieved, and reported for informed decisions about the health and safety of fire fighters.

The study was conducted over a 14-month period to allow for a complete 12-month examination of 20 fire department injury data systems to learn how the IAFF and NFPCA could, in a timely and efficient manner, acquire information in response to a broad range of fire fighter injury requests.

Project researchers met individually with the directors and members of management and labor in each of the fire departments included in the study to develop a complete understanding of the philosophy behind their injury reporting systems, the specific objectives they set for the data they were acquiring, and the problems and inadequacies which could be identified as limiting factors to the generation of accurate and meaningful accident and injury data.

Project Objectives

The specific project objectives which guided the research were: (1) to assess a representative number of fire department injury data systems to determine to what degree these systems are producing data which adequately define the nature and scope of the fire fighter injury problem. In meeting this objective, the question of choosing a "representative" number of fire service organizations required considerable thought. The specifics pertaining to how the fire departments were selected for the study will be detailed later in this paper when the sampling procedure is discussed; (2) to identify human, physical, situational, and environmental factors associated with injury producing accidents; (3) to acquire information pertaining to the relationship between accidents and injuries; (4) to identify wherever possible such factors as decisionmaking, training, and education which may have a relationship to the injury situation. Upon meeting the project objectives, the IAFF and NFPCA would have a better fix on the answers to: How may relevant fire fighter accident and injury data be obtained? What are the capabilities and limitations of existing fire department injury data systems? How complete are injury data throughout the nation? Whether injury data compiled by different fire departments are compatible? If it became necessary, what would it take to design a system which could be used by fire departments throughout the nation which would be capable of yielding accident and injury data for more accurate decisionmaking?

The decided sampling procedure was based on an interplay of seven major variables: Geography (climate)—temperate, mediterranean, tropical and subtropical; Geography (land form)—mountain/alpine, range/desert, plains, fluvial, maritime; Population (10,000-100,000; 100,000-250,000; 250,000-one-half million; one-half million-1 million; greater than one million; Locale (metropolitan, urban, suburban, rural, subrural); Organization (paid, full-time); Shift (10 hr./14 hr., 9 hr./15 hr., 24 hr.); Specialization (specific fire intervention activities) e.g., high-rise, chemicals and hazardous materials, forest, marine, oil and gas storage, dense dwellings, heavy industry, light industry, tunnels and subways, airports; Member population (number) 25-100, 101-200, 201-300, 301-500, 501-1000, 1001-1500, greater than 1500.

In order to assure that the investigation and analytical process was consistent from department to department, the project research team addressed certain issues for inquiry at each site. Inquiry was focused essentially on eight broad topical areas:

1. The flow of information from the time an injury occurs to the time such information is prepared for entry into the data system. The specific areas of concern here are type of report used; who files the injury report; the report verification process; documents generated by the injury report; to what extent accident investigation procedures are utilized; how many different accident and injury reporting systems are used by each department; the manner by which "time lost" and "no time lost" injuries are recorded.

2. How report data are prepared for entry into the data system. The specific items of interest in this area are what criteria are used to classify data from the original report; data on original report which are not recorded in data system; whether accident data are collected in cases where injuries are not involved; how accidents are classified; whether case-by-case relationships can be drawn between a given accident and a resulting injury; are modes of fire fighter activity associated with accident and injury events; sensitivity of reporting system to fire fighter use, misuse, or nonuse of personal protective equipment; are situational and environmental factors classification schemes used; to what extent are these factors representative of the particular response area; whether the system could show interactions among human, physical, situational, and environmental factors associated with accidents and injuries; whether injuries and

diseases could be related directly to specific personal protective equipment as categorized by user (using equipment beyond specified parameters, improper maintenance, using equipment for purposes not intended, not using equipment) or equipment (inadequate design, component failure, component degradation although used within design parameters); how injury severity and frequency are determined; how "accident," "vehicular accident," "injury," and "disease" are defined by each fire department.

3. How accident and injury data are entered into the data system. Among the highlights of this area are the method of coding the classified information and the frequency with which data are entered into the information system.

4. Data system overall analysis—specific type of system employed (manual, machine, specific identifier or name of electronic system; data system objectives and purposes; suitability of system for fire fighter, administrative, and research objectives).

5. Retaining and storing data. The specific type of machine readable medium in which injury data are retained; frequency which injury data are summarized.

6. Analyses and reports. How often periodic reports and trend information are calculated and distributed; whether the classification of information in reports is sufficiently detailed to enable the pinpointing of problem areas; who in the organization receives data within the decision-making tree.

7. Gaining access to the data system. How access may be gained to the injury system; who authorizes access; length of time between request for information and delivery of such information; adequacy of system for specific requests; cost of using system; requirements for any national, regional or local organization to gain access to the system.

8. Products and effects of the data system. Among fire departments which have similar geographic, operational, etc., conditions, with which other fire departments does the particular department exchange injury information; length of time it takes to detect trends in accidents and injuries; how sensitive or useful the reported data are for the needs of specialized units within the department, e.g., training, maintenance, chief officers, safety officer, city safety director, etc.; what criteria are used in estimating direct and indirect costs of injury accidents; how data are used to determine the need for specific items of personal protective equipment; number of injuries and their causes where personal protective equipment played a primary or secondary role.

It was agreed upon at the onset of this project that perhaps the best way to "test out" the ability of a fire department injury reporting system to produce information pertinent to a specific request topic was to address such a topic in the form of the question: "In how many of the injuries occurring in a particular fire department did personal protective equipment enter as a factor—either directly as the result of protective equipment system, subsystem, component, or part failure, or indirectly as a result of the equipment not fitting properly, not being used, not available, or because of inadequate design?" Thus, departmental information systems were assessed on their abilities to produce these desired data.

In summary, the project researchers conclude that:

1. There is a general lack of universally applied definitions of accident, injury, disease, and vehicle accident, thus hindering accurate injury reporting.

2. There are variations among department policies for storing accident/injury data.

3. Variations exist among methods for preparing and verifying accident/injury reports.

4. Variations exist in comprehensiveness and format among accident and injury report forms.

5. Variations exist in methods of verifying and classifying data from accident/injury reports.

6. Variations exist among philosophies and methods of obtaining no-injury accident data.

7. A wide variation exists among accident classification systems which create difficulty in drawing correlations among data from department to department.

8. Generally, a one-to-one relationship cannot be drawn between a given accident and a resulting injury.

9. There exists a general lack of fire fighter activity classification which would provide for a more accurate correlation between injuries and the mode of fire fighter activity where such injuries took place.

10. Most systems are unable to demonstrate the relationship of injuries to the use, misuse, non-use, or failure of personal protective equipment.

11. Variations exist among situational, human, and environmental factor contributions to injury-producing accidents.

12. Variations exist among schemes for recording type of accident, nature of injury, body part, etc.

13. Variations exist among methods of recording accident frequency and severity.

14. Variations exist among coding methods and types of data systems used.

15. Variations exist among expectations from data systems.

16. Of the systems studied, the greatest percentage contain accident/injury data which are unsuitable for research purposes.

In the process of testing the departmental systems' abilities to produce specific data on topics of interest, PPE-related injury data were collected. Overall, reliabilities of these data are low. The researchers chose to concentrate on the most likely reliable injury reports—those that involved time lost injuries which were almost always verified. Still, these data include unknown errors and figures—findings and relationships must be considered as general only. Furthermore, the data produced can only be viewed in the context of the departments studied and cannot be used properly as estimates of departments nationwide.

Thirteen of the 20 departments were the source of specific PPE-related injury information. The overall findings were:

1. Of the 2981 injury cases examined, one-third (1091) involved PPE. The range of PPE-related injuries to total injuries was from 14 per cent to 51 per cent; the average was 33 per cent.

2. Over three consecutive years, the proportion of PPE-related injuries to total injuries was remarkably stable for a small sample of the 13 departments. Variations tended to range from one to seven percentage points.

3. Of 836 time lost, PPE-related injuries, sprains and strains were 23 per cent of the total. Burns were 19 per cent; lacerations were 15 per cent. Abrasions and contusions, respiration, and eye injuries were 12, 11, and 10 per cent, respectively. Exhaustion, dislocations, fractures, hernias, impacts, punctures and miscellaneous injuries accounted for ten per cent of the total.

4. Among 587 time lost, PPE-related injuries for which company-type indicators were available, 53 per cent of the injuries occurred to engine company personnel, 38 per cent to ladder company personnel, and about ten per cent to other types of companies' personnel. Engine company injuries occurred with greater frequency in every injury type except in exhaustion, lacerations, and punctures; ladder company incidences were more in these categories. Respiration, abrasions, and contusions were nearly equal between the engine and ladder companies.

5. Of body parts injured, eyes, lungs, and hands were frequently affected—11, 13, and 11 per cent, respectively. Injuries were distributed roughly evenly over the major body areas: head, body, arms and legs. Body area injuries were sustained mostly in the back and the lungs. Leg injuries were primarily from the knees downward—knees, ankles, and feet being the most injured parts. Head area injuries were essentially facial, including eyes; arm area injuries were largely to wrists

and hands.

6. Most PPE-related injuries (75 per cent) occur while fire fighters are operating at the fire scene. Another seven per cent happen in responding to alarms and eight per cent during overhaul. The remainder occur in returning from fires, quarters, drill, inspection, and emergencies. These injuries were variably distributed over the year, summer being the season for most injuries (37 per cent of the yearly total). Winter and spring have about equal numbers of injuries (27 and 26 per cent, respectively) and autumn has by far the fewest, ten per cent.

7. Seasonal variations in injuries were suggested by the data according to geographic region. Middle Eastern and Midwestern sites showed similar seasonal variations—most injuries appearing in the summer and winter months. A south central site showed similarity in the seasonal injury pattern to the more northern sites but had relatively even distribution of injuries over the year. Conceivably, the relative mildness of seasonal variations affected the even distribution. In contrast, a far-northern plains site showed nearly opposite distributions from the other locations. Fewest injuries occurred in the very cold winter months or the mild summer months, but most occurred in the changeable spring and autumn seasons.

8. Age and injury incidence was examined. Two observations were clear: (a) there are no consistencies in numbers of injuries across departments according to age categories. Three departments, for example, showed three different patterns; one had equal injury incidence in the 26-30 and 46-50 year brackets; another had most injuries in the 31-35 year category, but another concentration at 46-50 years; a third department had most injuries occurring to men less than 25 years of age. (b) There are few consistencies when injury types are shown in relation to department and fire fighter age.

The PPE-related injury data suggest that global data summaries need to be reduced to more refined categories in order for them to aid departments in examining their own injury problems. Enough variations were found among departments in time lost injuries that totals and averages represented few of them justly. Region, season, and fire fighting activity seem related and affect injury incidence. These relationships—and many others—can be seen only by data analyses which are more complex and refined than most current practices.

Recommendations

This study has demonstrated the diversity of information systems now operating. In order to gather accurate data, there must be steps taken to insure its reliability, that is, that the information assembled in different parts of a region or nationally, or even within a given department, is consistent day-to-day and across all persons filing the reports and identifying salient injury items. To this end the following actions are recommended:

1. A set of definitions of injury, disease, and accident must be published. These definitions will have to accommodate local, municipal, and OSHA concepts in order to be accepted overall.

2. A set of classifications for injuries, fire fighting activities, body parts, and situational and environmental conditions must be established and published. These classifications must permit municipalities, etc., to obtain data necessary for their purposes for insurance and compensation.

3. A uniform coding system for classified information must be established and published.

4. A uniform reporting system must be provided.

5. A verification process must be instituted. In order to increase the accuracy of the injury data, verification should be performed by someone other than the person filing the original report.

6. A strategy for training participating departments to use the reporting system must be developed.

Lastly, but as important as any of the other requirements, an incentive system must be developed to encourage departments to participate. Change of any kind is work. People and organizations will not change unless benefits to change are clear. It has been demonstrated that departments collect injury data for many different purposes. As a result, any reporting system that does not incorporate reporting needs of the local site or which increases the workload of reporting individuals is likely to fail in its purpose regardless of how well-intentioned.

78 1985

THE IMPORTANCE OF PRE-SCREENING EXAMINATIONS IN THE FIRE SERVICE

Fire departments

By JIM MINX
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We have all been aware of the increased risk to life and limb associated with the fire service. As you are well aware, in 1969, for the first time, the injury rate for fire fighters exceeded that of the injury rate for miners and individuals working in granite quarries. Unfortunately, the injury rate for fire fighters remains the highest for any occupational group in the United States.

In 1972, Local 1524 formed a Safety and Health Committee. One of the major priorities of this newly formed committee was the implementation of a thorough pre-employment screening program. In 1972 and early 1973, Local 1524 was working with various members of the Oklahoma University Health Sciences Center faculty on two other health related projects, and it seemed natural that our union would turn to the expertise of the Health Sciences Center to develop such a thorough pre-employment screening program. In 1973, discussion was begun with the faculty of the Department of Family Practice, Community Medicine, and Dentistry at the Health Sciences Center to explore the feasibility of a comprehensive pre-employment physical examination. In 1974, the mechanisms for such an examination were developed and negotiated into our contract with the city. The examination was first given in the winter of 1975.

The examination, which was developed by the faculty at the Health Sciences Center, was designed to meet and strictly adhere to the standards prescribed in the Recommended Standards for Fire Fighters. This examination is very comprehensive and takes each candidate about five hours to complete the entire examination process. The medical history is a comprehensive and detailed medical history which is designed to uncover any previous health or medical problems in the individual or his immediate family which are or may be indicators of actual or potential disease processes. The physical examination is a complete and detailed examination which evaluates the function of the major organ systems. The chest x-ray has been included to detect any previous pulmonary disease, just as the lumbar spine films are designed to pick up any birth defects of the spine or evidence of any previous severe injuries to the back which might predispose the individual to serious back problems during his service with the fire department. The audiometric examination tests the individuals for their ability to hear in the high frequency and normal voice ranges of sound. The visual examination consists of an actual check of the individual's ability to see as well as the individual's ability to see the important colors of red and green. The urine analysis is designed to detect early kidney disease; the blood count to make certain that the individual does not have any of the serious blood problems such as leukemia. The battery of blood chemistries is very complete and designed to detect abnormalities in the various body systems such as the liver, musculoskeletal system, and the cardiovascular system. The exercise tolerance test consists of monitoring the individual's blood pressure and heart rate and rhythm during a graded program of exercise in which the individual's cardiopulmonary system is maximally stressed. The exercise tolerance test has been shown to be much more reliable in determining heart problems than a resting electrocardiogram, which has been traditionally used in the past. Each

examination costs approximately $200, the cost being borne by the City of Oklahoma City.

To date there have been 152 individuals examined, with 31 of those individuals failing the examination, a 20 per cent failure rate. It must be noted that the actual failure rate is somewhat higher than 20 per cent as the city instituted a pre-screening program which consists of blood pressure and visual screening for the individual recruits before they are sent to the Health Sciences Center for the comprehensive examination program. This pre-screening program was designed to reduce the number of individuals washing-out of the comprehensive evaluation program because of blood pressure or visual problems. The pre-screening program is done by departmental EMTs, who are instructed by members of the Health Sciences Center facility in the specific performance of these pre-screening examination items.

When considering the reasons that those 31 individuals failed the examination, it must be remembered that no individual examinee was older than 30 years of age at the time of the examination. It must also be recognized that all of these individuals looked as if they were in excellent physical condition, and many of them were employed in the construction and building trades at the time they had applied to the Fire Department for employment. The largest single reason for rejection is elevated blood pressure. Twenty individuals failed the examination because of elevated blood pressure, a failure rate of 65 per cent on the basis of blood pressure alone. The examination team was able to document pre-existing back problems in one individual, resulting in a failure rate of three per cent; two individuals had serious visual problems, and one individual with a vision problem was able to obtain a waiver as a result of receiving corrective lenses. Four individuals who were rejected in accordance with the IAFF Standards were rejected because of serious hearing deficits within the normal spoken voice range. An individual was rejected because of an abnormality in the blood chemistries which indicated the possibility of congenital disease of the liver, and three individuals were rejected because of abnormalities discovered during the exercise tolerance test, a failure rate of 10 per cent as a result of abnormal exercise tolerance test. All of the foregoing tests were designed in conjunction with the IAFF Standard to not be a system designed to discriminate against minority groups.

The total cost for the examinations to date has been approximately $31,000. It is extremely difficult to estimate the potential significance of these examinations in terms of dollar savings to the city and to the pension funds. However, there are two cases which would have undoubtedly led to medical disability early in the fire fighters' career which I would like to use as examples of the very real and positive benefits of such a rigorous physical examination program.

The first case was an individual who was rejected from the service as a result of abnormalities uncovered during the exercise tolerance test. The individual in question developed a serious heart problem about five minutes into the exercise test. The individual's heart rate went up uncontrollably to a very high level and he simultaneously attained a rather serious abnormality in the way the heart beats. This problem was not detected during the regular history of physical examination, nor would it have been detected with a routine resting electrocardiogram. Our panel of consultants have assured me that this young man would have undoubtedly had a very short career with the fire service and that within a relatively brief employment span would have had to be retired as the strenuous work of the fire service would have aggravated this underlying serious heart problem.

The second case, which in and of itself justifies the $31,000 expenditure falls around an individual who, during the history, had denied ever having any

significant back problems and had a perfectly normal examination of the lumbar spine and extremities during the physical examination. However, a review of the spine x-rays showed that the individual had had a myelogram performed in the past. The myelogram test is reserved for individuals who have debilating back problems and are being considered, at the time, as candidates for corrective back surgery. There is little question in our minds that this individual would have developed a recurrence of back problems fairly early in his fire fighting career and would have undoubtedly enjoyed an early medical retirement as we would have been unable to show that he had previous back problems prior to employment.

The relationship between heart disease, strokes, and high blood pressure is well documented and has been well documented for a number of years. We feel that the 20 individuals who were rejected because of pre-existing high blood pressure have been spared superimposing a high risk occupation on a medical problem which markedly increases the individual's risk for heart attacks and strokes. It is difficult to put a cost-benefit figure on such an action, but there is little question in our mind that these individuals are much better off for not being subjected to the unusual physical and emotional stresses associated with a career in the fire service.

In the spring of 1977, three other municipalities in the greater Oklahoma City area have also adopted our pre-employment physical examination program. It is worthy to note that several of the individuals who had previously failed the Oklahoma City physical examination have inadvertently been employed by other departments which do not require the comprehensive physical examination program.

Local 1524, the City of Oklahoma City, and the evaluation team at the Health Sciences Center currently view the examination process as merely the first step in a logically planned sequence of medical evaluations which are ultimately designed to eliminate individuals from the fire service with serious underlying medical problems and to evaluate and treat individuals within the fire service who have developed chronic problems as a result of their service to the City of Oklahoma City. The faculty of the Department of Family Practice, Community Medicine, and Dentistry are currently developing an annual physical evaluation for all fire fighters which is designed to detect and refer for treatment those individuals who have developed chronic diseases or medical problems during their tenure with the fire service. We hope to be able to implement this system of detection and referral within this fiscal year.

We also feel that the information gained on the 152 individuals who have been examined to date will be reviewed periodically over each individual's entire career as a fire fighter and will, for the first time, give us information about physical changes which occur as a result of employment on an active municipal fire service. This will be the first longitudinal study of the health and medical problems occurring in the fire service that has ever been performed to our knowledge. All of us involved in the physical examination program to date recognize that we have only taken the first small step toward reducing the injury and death rate unfortunately so well known to us all. It must be recognized; however, that no individual or group of individuals working together can single-handedly answer all of the questions which remain in regard to the cause and effect relationship contributing to the hazards of fire service. I would encourage all of you to give serious consideration to implementing a similar program in your own department so that together we can collectively share the data and answer the questions much sooner than we would otherwise be able to do.

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DANGEROUS GASES INVOLVED IN WASTEWATER TREATMENT AND SEWER SYSTEMS

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The dangerous gases involved with wastewater treatment and the collector systems are usually simple gases and can be found everywhere in our environment. Whenever or wherever these gases have been allowed to accumulate, they present problems. Miners, farmers, sailors, utility men, and even the ancient Egyptian pyramid builders had problems with these gaseous products of fermentation, decay, and oxidation. We might collectively call these gases the "natural gases." At some time there also may be found in the collector systems a more complex gas or volatile substance from industries. But this discussion will deal mainly with the common gases often associated by people with automobiles and outdoor privies rather than with exotics from modern technology.

The dangers of these gases was first called to my attention in the Wisconsin DNR's bulletin, "The Certified Operator," which sent the warning message to all state operators by relating the story of a near fatal double accident in the STP at Prairie du Chien, Wisconsin. In the 1974 article, two operators, experienced men and familiar with their spaces, had without any warning nearly died entering an open pit. A few months later, two other experienced operators quite familiar with their jobs, at another STP in Wisconsin, and without any apparent warning, died in a similar accident in the presence of the same gas, hydrogen sulfide.

Since then there have been more industrial fatalities in Wisconsin and Illinois involving carbon dioxide, nitrous oxides, carbon monoxide, and some unknown gases. Most recently, in June of this year, in Waukegan, Illinois, two experienced men fell without warning and without uttering a word. The second man in this incident had entered the new and yet unused manhole to help the first man, whom he thought had slipped, and was himself fatally overcome.

In all of the incidents the rescuers did not really recognize the nature of the problem, and some of them were adversely affected during the rescue operations. To recognize and to minimize the dangers of entering any pit, manhole, or enclosed space requires, first of all, an understanding of the nature of the gases encountered. First aid and rescue are very important training, but having to practice on casualties is the last thing anyone ever wants to do. Knowledge and prevention are by far the best practice. Looking at the characteristics and source of sewer gases is where this discussion will begin.

Definitions

it will be best to first define some words and ideas as we will use them here. The first will be *bacteria.* Bacteria are tiny (microscopic) creatures which live in countless numbers everywhere. They thrive in sewage and are responsible for its digestion and degradation to simpler stable organic materials. They are heterotrophic, i.e., they require preformed organic molecules for food. Organic molecules contain carbon, hydrogen, oxygen, phosphorous, nitrogen, and sulfur all put together in differernt complex ways. Primarily, we call these foodstuffs carbohydrates (starches and sugars) and proteins. These are the same foods with which we are all familiar.

Oxygen availability in a system is described by the words *aerobic,* which implies ready access to the atmosphere, which contains about two percent pure oxygen, or *anaerobic,* which means without oxygen. Systems or conditions with no oxygen or very low levels are described as anaerobic systems.

The last definition involves pH, a measurement scale used to indicate the relative acidity of a solution. The numbers on this scale go from 0 to 14, with seven being absolutely neutral. Numbers less than seven are said to be acidic. Numbers greater than seven are alkaline (the opposite of acidic). Strong acids with a pH of less than one are destructive to living things as well as to metals and most everything else. Strong alkalies with numbers greater than 13 are destructive to living things as well as to most everything else. Pure water has a pH of 7.0.

The pH of any substance can be determined electrically or by a color change. An easy and simple test is to use blue or pink litmus paper.

Fermentations

The degradation of sewage is accomplished by many kinds of microorganisms, especially bacteria, which as a group thrive in sewage. Like animals, they need preformed foods to live, and like animals they throw off waste products after digestion. Besides the bacteria, fungi, protozoans, and other tiny creatures are all invoved in the degradation process, but we will collectively call these organisms "bacteria." They will produce under different enviromental conditions different kinds and amounts of waste products; especially noticeable are the gases. The temperature, pH and presence or absence of oxygen all play important parts in determining which gases are produced.

At temperatures above 4°C (38°F) and below 45°C (120°F) the bacteria do very well. Lower or higher temperatures than these restrict bacterial functioning. Generally speaking, within this range the higher temperatures produce greater activity. This is not only true in the digestors but also in the sewer mains and manholes as well.

The oxygen content is a second important environmental factor. Bacteria which can metabolize their foodstuffs in the presence of oxygen or aerobic conditions produce certain kinds of gases as metabolic waste and different gases under anaerobic conditions. Aerobic digestion produces carbon dioxide in a manner similar to human carbon dioxide production. Under anaerobic conditions these same bacteria will produce methane. Usually in any sewage, solids or liquids, there are areas where anaerobic and aerobic conditions exist simultaneously and both carbon dioxide and methane will form, although in varying amounts.

Bacterial gas production is also moderated by the pH of the environment. Bacteria cannot live at the extreme pH conditions, but can survive in a relatively wide range. However, they grow and function well only in the pH range between 4.0 and 10. Generally, raw domestic sewage runs about 7.5 in Racine and at a little lower pH in the digestors. It is not common, but with a pH value above nine, deadly ammonia gas will be produced. Again, as with oxygen content, conditions will vary within the same sewage and from location to location within a system, and a variety of pH-influenced gases usually occur at the same time but in different amounts.

Before proceeding it is necessary to define more words and concepts for our discussion. The word gas itself needs clarification. Everything that takes up space and that has weight exists as one of three states: as a solid, as a liquid, or as a gas. In a solid substance the individual molecules are tightly associated such that the whole solid is rigid and maintains its size and shape. A liquid has a much looser association or binding of its molecules and although the size or volume remains the same, the shape of the mass of liquid will change readily. Thus, a quart of milk has a volume of one quart and the shape

of the container which holds it. Spill the milk on the floor and it still has a volume of one quart, but now it asumes the shape of the floor. A gas has no associations between the molecules and has no definition size or shape. A drop of propane will quickly change to gas and the molecules will move rapidly in all directions. The odor of propane would be quickly detectable throughout a closed room. If the door is opened, the molecules will all eventually escape out into the atmosphere.

This outward movement of gaseous material is called diffusion. Heavier and slower gases will diffuse more slowly, and if they are produced rapidly they tend to accumulate gas pockets of gas before they can diffuse away. Lighter gases will be buoyed upward by the air, and if rapidly produced they can collect in pockets or bubbles along ceilings or high spots before diffusing away.

Sewer gases are those which are found in sewers. They may be formed there, transferred there from some other part, or added from some external source. The sewer gases include: carbon dioxide—CO_2; carbon monoxide—CO; methane—CH; ethane—C_2H_6; hydrogen sulfide—H_2S; ammonia—NH_3; nitrogen—N_2; hydrogen—H_2; oxygen—O_2 chlorine—Cl_2; gasoline; natural gas; and industrial chemicals. In general, sewer gases have the following descriptions: all are colorless; most are odorless; some are flammable; some are explosive; some are toxic; some are irritants; some are asphyxiants; some are lighter than air, some heavier; some may be a variety of the above. All can he lethal!

A detailed description sheet of each gas follows.

Carbon Dioxide

Carbon dioxide is a colorless, odorless, non-combustible gas which is 1.53 times denser than air. Carbon dioxide may leave a faint acid taste in the mouth. It will not support combustion.

Carbon dioxide is formed readily in sewage when there is plenty of fresh air (oxygen) available. It is a normal constituent of all sewer gases. It also forms in rock formations, and when present with nitrogen it is called "rock gas." In formation it may use the available oxygen supply, causing an oxygen deficiency. It is also the product of combustion.

Carbon dioxide is not toxic, but it can cause difficulty in breathing, vomiting, disorientation, and hypotension. A 10 per cent atmosphere of carbon dioxide is intolerable and can produce unconsciousness. It is an asphyxiant. Usually it is found where he oxygen content is low.

Treatment involves removal of the person from the faulty atmosphere. Artificial respiration and oxygen may be given if necessary. Call for medical assistance. Keep the patient quiet and warm until he receives medical care.

Carbon Monoxide

Carbon monoxide is a colorless, odorless, tasteless gas which is slightly lighter than air. It is extremely toxic. It is flammable and has an explosive range between 12.5 and 74 per cent.

Carbon monoxide can be formed as part of sewer gas, but is more likely to be found as a discharge gas from a running engine or from flue gas. It is found in manufactured gas used as fuel. It often results from fires.

A concentration of 0.02 per cent will cause a headache within three hours. Levels between 0.05 and 1.10 per cent can be fatal within three or four hours. A level of 0.2 per cent will be fatal within 30 minutes. If the concentration is high there may be very little or no warning prior to collapse. Symptoms start with a headache, which may then grow very severe. Dizziness, shortness of breath, vomiting, and collapse follow. Coma precedes death.

The carbon monoxide combines with the hemoglobin in the blood much more readily than oxygen and thus prevents the blood from carrying the life-supporting oxygen. This carbohemoglobin produces a cherry red complexion in carbon

monoxide victims. Unconscious victims require prompt and definitive medical treatment.

Car exhausts contain at least seven per cent carbon monoxide and as high as 30 per cent. Manufactured gas has a CO content between two and 15 per cent. Removing the victim from the atmosphere of carbon monoxide is the first emergency procedure. Artificial respiration and oxygen are usually required. Keep the patient warm and quiet until medical help arrives.

Methane

Methane is colorless, odorless, nontoxic, flammable gas which is lighter than air. It has an explosive range from five to 15 per cent in the air. It is formed readily in sewage, marshes, mines, or wherever there is exposed organic material. It is a large portion of fuel gases, natural gas, and manufactured gas.

Methane acts as a simple asphyxiant. In high concentrations without oxygen present it has a narcotic effect, producing dizziness, disorientation, unconsciousness. It is usually found with low or no oxygen concentrations.

Methane's chief danger lies in its flammability and explosiveness. Since World War I, 10,000 people have died from methane accidents, mostly from fire.

Treatment involves removing the casualty from the affected atmosphere. Give artificial respiration and oxygen as necessary. Call for medical assistance, and keep the casualty warm and quiet until help arrives.

Hydrogen Sulfide

Hydrogen sulfide is a colorless gas, heavier than air, and possessing the very objectionable odor of rotten eggs. It is a rapid and powerful systemic poison. It is formed among the products of putrefaction. Toxic symptoms occur in concentrations as low as 0.005 per cent. Concentrations of 0.1 per cent may be fatal in a few minutes. It is also flammable.

In very low concentrations, toxic symptoms are expressed as irritation rather than as systemic reactions. Susceptibility may vary among different individuals. Some suggestion is made that previous exposures may sensitize certain individuals to hydrogen sulfide.

The most common toxic effect is irritation of the eyes. Workers in tunnels, sewers, etc., may get a superficial reddening of the eye with burning and/or scratchy sensation after several hours or days of exposure ("gas eye"). Recovery is complete and spontaneous.

More intensive exposure (concentrations or time) may lead to respiratory tract involvement leading to runny nose, coughing, difficulty in breathing, and to pulmonary edema and death, depending on exposure.

High exposure may cause headache, nausea, dizziness, confusion, weakness in the extremities, and sudden collapse into unconsciousness without a warning cry.

Removal from the toxic atmosphere, artificial respiration, and oxygen are specific first aid measures. Professional aid must be sought. In non-lethal cases, recovery is complete. Usually a residual cough follows an accident and then slowly disappears.

Hydrogen sulfide forms in all sewage, sludges, and decaying materials if the conditions are correct. It is found in natural gases, marsh gases, and in places where methane is also usually produced.

Ammonia

Ammonia is a colorless gas, lighter than air, and with a very pungent, biting odor (may resemble dry urine). It is usually considered to be nonflammable, but can explode when mixed with air and ignited. It is a corrosive alkaline gas with extremely irritating properties.

Ammonia will form in most sewage waters if the pH is greater than nine.

Inhaled ammonia is not toxic but will produce irritation to the eyes, skin, and respiratory tract. In milder cases, conjunctivitis (reddening of the eyes) and laryngitis may result. In more severe cases, pulmonary edema, spasm of the glottis (throat), asphyxia, and death may

result. Contact with the skin can cause burns and blisters. Recovery leaves no serious after effects.

Treatment requires haste. After removing the casualty from the bad atmosphere, call medical assistance. Administer artificial respiration and oxygen if necessary. Give him nothing by mouth. Wash his eyes and skin with large amounts of water, if these areas are affected, for long as 15 minutes.

If clothing is saturated, remove clothing and wash skin with water. If burns have occurred, wash with water for at least 15 minutes.

Nitrogen

Nitrogen is a colorless, odorless, tasteless, non-flammable, generally inert gas. It is the main constituent of air, being about 79 per cent of the total. Nitrogen does not support life or combustion.

Nitrogen can be formed in the digestion of sewage and is a sewer gas. It also can be produced from bedrock along with carbon dioxide, and the mixture is called "rock gas."

Since nitrogen is physiologically inert, it is not toxic but can act as an asphyxiant.

First aid involves removal of the victim to fresh air. Artificial respiration and oxygen if needed. Call medical assistance and keep the victim quiet and warm until help arrives.

Hydrogen

Hydrogen is a colorless, odorless, tasteless, flammable gas which is much lighter than air. It has an explosive range from four to 74 per cent in air. It is spontaneously explosive when mixed with chlorine.

Hydrogen is formed in sludge gas. It is part of most manufactured gases and may leak from tanks.

Hydrogen is non-toxic, but will act as an asphyxiant. It can accumulate in pockets along high spots in ceilings or similar spaces. It is dangerously flammable.

Treatment involves removing the victim from the asphyxiating atmosphere to fresh air. Apply artificial respiration as necessary. Call for medical assistance and keep the victim warm and quiet until help arrives.

Oxygen

Oxygen is a colorless, odorless, tasteless, neutral gas, slightly heavier than air. It occurs in the atmosphere in a concentration of about 21 per cent. Oxygen will support combustion and is a necessary part of fire. Higher than normal concentrations will increase the danger of fire and explosion. Oxygen is a necessity to support human life. The depletion of oxygen is a life hazard.

An atmosphere containing only 16 per cent will not allow a candle to burn. At 16 per cent, humans can breathe but may suffer some breathing difficulty. A deficient atmosphere containing from 12 to 16 per cent oxygen will cause the pulse and the breathing rate to increase, as well as other symptoms. Symptoms of oxygen shortage include restlessness, confusion, fatigue, faintness, lethargy, cyanosis, and unconsciousness. At 10 per cent concentration a man may or may not be totally unconscious, but he probably would be unable to call for help. Oxygen shortages can damage body organs. The brain and kidney are especially affected. Death will occur quickly in an atmosphere of only seven per cent oxygen.

Oxygen levels are quickly lowered in sewers and in closed spaces both by absorption and by chemical reaction with organic rich sewage. Poor ventilation is always present. Any closed space should always be suspect.

An oxygen-deficient-atmosphere victim should be removed as quickly as possible from the area. Artificial respiration and oxygen may be used. Medical assistance should be called. The victim should be kept quiet, lying down, and kept warm. Watch for shock.

Chlorine

Chlorine is a greenish-yellow gas. It is 2.5 times denser than air and has a suf-

focating odor. It may leak from industrial cylinders and tends to accumulate in low places.

At four ppm in the air, chlorine can be detected by odor. At 30 ppm it will produce coughing and is irritating to the eyes. At 1000 ppm a few breaths will be fatal. Chlorine is not toxic. It is a powerful irritant and is highly corrosive in the presence of water. The eyes, nose, throat, and lungs may be involved. Symptoms range from irritated eyes to sore throat, to sneezing, vomiting, copious salivation, difficulty in breathing, general excitement, and pulmonary edema and death. Pulmonary edema may be delayed, and medical care and observation is essential. There are no systemic effects, and recovery should be complete.

A victim suffering from symptoms should be removed from the gas area, preferably to an area with room temperature (70°F). He should be kept warm and quiet on his back with his head and back elevated. Medical assistance should be called. Artificial respiration and oxygen should be used if necessary. Milk may be given for throat irritation in mild cases.

Gasoline Vapors

Gasoline vapors form readily from liquid gasoline and are from three to four times denser than air. They are colorless and odorless below 0.03 per cent. Gasoline vapors are flammable and explosive between 1.3 and seven per cent in the air. Gasoline vapor sources include leaks, spills, or discharges from storage tanks, garages, dry cleaners, and homes. Being so very heavy, the vapor hugs the bottom and remains in pockets for a long time.

Gasoline vapors are toxic, and at concentrations of 1.1 to 2.2 per cent will produce dizziness, headache, ringing in the ears, confusion, unconsciousness, and at a concentration of 2.43 per cent will cause death.

The vapors are also a respiratory irritant at lower concentrations, causing burning in the throat and lungs, bronchiospasms, and cyanosis. Gasoline vapors can damage internal organs.

First aid involves removal of the casualty from the gas atmosphere. Call for medical assistance. Give oxygen if it is available and artificial respiration if necessary. Keep the patient warm and dry.

Gas-Forming Situations

Those gases formed and/or found in sewers may or may not be present in any particular manhole. Some manholes are more suspicious than others, but all are suspect! A manhole safely worked in yesterday may be a lethal trap today. There are no absolute rules except the rule of caution. Knowing the dangers of the gases, how they are formed or brought in, and the procedures and equipment needed to minimize the hazards is the first half of sound safety procedure. The second half is up to the individual, i.e., applying this knowledge with correct actions.

A series of gas-forming situations in a sewer system will next be reviewed. Each will describe the environmental conditions, the most probable resulting gases, and the most correct actions to be taken.

Safety Practices

Careful attention must always be given before entering manholes and sewers, regardless of job or situation. Standard safety precauitons must be observed. Traffic hazards must be minimized and standard protective equipment used. This routine includes hard hats, rubber boots, safety goggles, foot protection, and rubber gloves.

On hand also should be a safety harness, gas-detecting equipment for both explosive and toxic gases, oxygen meter, portable blowers, rescue-breathing apparatus, fire extinguishers, and first aid kits.

Gas Testing

Before removing the manhole cover, a test for oxygen is first made by probing through a hole in the cover. If the oxygen

content is deficient, the gas-combustible tests may give erroneous readings. The explosive gas content should be checked in a similar manner.

If all is okay, remove the cover and make further checks at lower levels. Gasoline vapors, for instance, may be concentrated only at the very bottom. Repeat the oxygen tests, especially if the manhole is deep. Carbon monoxide, hydrogen sulfide, and ammonia (all potentially lethal) should all be checked, especially in the deeper wells.

If the work in a sewer is extensive and takes a long time, repeated gas testing should be conducted. Temperature and humidity may also become a problem and should be watched and considered.

Ventilation

All manholes five feet or deeper are potentially dangerous and should be ventilated before entering. Forced ventilation for at least one minute is advisable. Ventilation discharge hoses should reach the lowest levels in the well. Engines operating a blower should be crosswind from the opening. If the engine is downwind, explosive gases from the sewer may reach the engine. If the engine is upwind, exhaust gases may reach and enter the manhole.

Depending on the nature of the sewage, the flow rates, and the sources of sewage wastes, various gases may be suspect. These should always be checked and sufficient and continuous ventilation afforded if they are present.

Dangerous Spots

All enclosed tanks, chambers, deep tanks, pump yet wells, and low-lying, isolated rooms should be highly suspect of producing or containing dangerous gases.

Sewers which pass through industrial areas or near gas mains or gasoline or fuel storage tanks are always suspect of added dangers.

Sewers on flat grades with slow flow or long runs of more than 300 feet between manholes are producers of dangerous products of anaerobic decomposition.

Manholes in remote locations and difficult to reach tempt one not to bring along safety equipment. These manholes require that all available safety equipment be brought along.

Lighting

The safest method of illuminating a manhole is by using mirrors and sunlight. Approved hand lights for use in gas combustible areas are acceptable but have limited light and length of use. Approved explosion proof lights are also available.

Rescue

Rescue equipment should include nonsparking tools, safety belts, and respiratory equipment. Hose masks should fit well, have a good flexible hose, and have a clean fresh air source. A blower is not needed with up to 25 feet of air line. Up to 150 feet of air hose and six face masks may be used with a blower. The blower must be such that no oil is discharged into the discharge line.

Self-contained breathing apparatus are excellent for working in any atmosphere but are limited to about 30 minutes working time.

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TRAINING AS BEHAVIOR MODIFICATION

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We are constantly changing both our words and images of things. Perhaps we grow tired of using the same old words, or perhaps we really see the same thing differently and therefore give it a new word. Some psychologists and semanticists say that changing the word for something can change our image of that object. You're all familiar with the fairly recent changes in your own industry. Gone are the old "garbage collectors." In their place we have had "refuse collectors," and today we have "collectors of solid waste." The important thing here is that the collection job has not changed that much, but the terms and our thinking about the job have. I also have a gut feeling that as the terms changed, the attitudes of the people involved in the industry also changed. Of course, the solid waste industry today is infinitely more complex than it was 50 years, or even 10 years ago. It is an over simplification to say the terms in your industry have changed but the jobs have stayed the same. I am oversimplifying to make a point. In the field of psychology and personnel training, the words are also changing while the process remains basically the same. The old word was training; the new term is behavior modification.

You all know what training is. It's like school. You teach a person to do something. Formal training usually takes place in a classroom. Apprenticeship training may be a combination of classroom and actual experience. On-the-job training puts a person out on the job with someone already doing the job. The two work together, with the experienced person giving whatever instruction there is.

Now it is a truism that the simpler a job or task seems to be, the less training there is involved. When I was growing up, my parents told my sisters that unless they really applied themselves at school they'd grow up unable to be anything but waitresses. We boys were told that we would be unable to become anything but garbage collectors. So we grew up in a sexist world knowing there were at least two jobs one could do without any training: girls could wait on tables; boys could collect garbage.

Why am I giving you all of this seemingly unrelated information? Because it is related. The way you as managers and administrators look at the job of collecting garbage, refuse, or solid waste, will determine the quality and quantity of the training.

I am an "outsider," a consultant to your industry. Therefore, I will take the liberty to give you my bird's eye view of two years' exposure.

1. You are professionals. By that I mean you seem to know your job and you get it done. I might add you also get the job done with a high degree of efficiency.

2. You are good businessmen. You are showing a profit, upgrading your services, and meeting the challenges of a rapidly changing time.

3. Your personnel training is back in the Dark Ages. Industry-wide training in the solid waste business is almost nonexistent. Each company that offers any kind of training does so without taking advantage of what another company might have learned or developed. In other words, each time you have a training session, you re-invent the wheel. The only industrywide effort has been funded by the government and is a series of 2″x2″ slides, a 16 mm film, and an instructor's guide. The title of this government program is "Operation Responsible." It has not had extensive use.

4. You have failed to train the collectors. There is evidence that your lost-time injury rate is 13 times higher than the national average.

A summary of my observations would be that you have done an excellent job meeting the ever growing challenge of disposal and recycling of solid waste. At the same time you have chalked up an unacceptable lost-time injury rate.

I was approached by a small company that markets specialized training materials a little over two years ago to develop a training program for the residential solid waste collector. This company employed me in the belief that industry was ready for standardized training. Consultants have a real advantage, as you know. As soon as they get a job, they go out and get other consultants to assist them. What I have learned about the solid waste industry, I have learned from people in the industry. I have also spent many hours behind solid waste compactors observing the men work. It was not surprising to find a number of different views related to safety in the industry.

Let me give you a few examples:

1. Management all wanted a good safety record—it would reduce the workmen's compensation rate.

2. Top supervisory personnel wanted no lost-time injuries because it put pressure on them trying to get the job done with fewer people. In cases of extended lost-time, there was the hiring and training of replacement personnel.

3. Foremen were interested in safety from a personal point of view. They didn't want their men hurt and didn't want to investigate and fill out lost-time injury reports. But more important, the foremen wanted the job done. The job took precedence over safety because a job not done created waves; an injury only created problems. A job not done reflected on the ability of the foreman, and the injury reflected on the ability of the injured person.

4. The collector himself certainly did not want to be hurt or disabled, but he was usually on a quota system. Get the job done and go home. The sooner it gets done, the sooner you get home, all for the same pay. It was an incentive plan all right, but perhaps the wrong incentive plan if our goal is safety.

So there it is—everyone from top management on down "believes" in safety. I say this sincerely . . . they all do believe in safety. No one wants to be hurt nor does anyone in management want an employee to be hurt for the sake of saving a little time or cutting corners to get a job done a little faster. While everyone believes in safety, very few people are involved in doing anything about it. Each of you here today are the exceptions. You are here because you realize the seriousness of the situation and are charged with the responsibility to do something about those lost-time injuries.

The magic formula to reducing the lost-time injury rate is simple. You need only have safety conscious people using safe and reliable equipment. My part of this safety formula is developing safety conscious people. I leave the equipment problem to others, although I would like to add that solving the equipment safety problem is a great deal easier than solving the people problem.

Think about your last safety lecture, or the last training session you had with collectors. I will not try to describe it, but I will give you the results.

You taught. Unfortunately, we have been led to believe throughout our educational career that if you taught, the person you taught learned. We know this is not so, but we continue to act this way. We know it isn't so because in school we give exams to see how well one learned what was taught, and grade everyone accordingly. If we really believed people learned what was taught, there would be no need for examinations.

Let me repeat this very important statement. During the last safety lecture or

training session, the only thing you can be sure of was that you taught.

Your safety lecture or training session really had other goals. Some basic goals might have been:

1. An increased awareness of hazards on the job.

2. Ability to perform a specific act a little better and/or a little safer.

I belabor the obvious, but remember, I am new to your industry and my only expertise is in getting people to learn. So, considering your industry and the characteristics of the solid waste collector, what kind of program should be developed that would assure learning, not teaching? Behavior modification in place of simply training.

1. Our first consideration was to design a program the collector would use, alone or in small groups. It would not be a program that a supervisor would use to teach the collector. This was not a subtle difference, a splitting of hairs: it was a major decision. It meant that the program would be "self-instructional." Any collector could use it by himself and learn from it. There would be no teacher, no instructor, no supervisor. There would be learning, but no teaching.

2. Our next consideration was the impersonal nature of current self-instructional materials. This was solved in part by the use of multi-media. A person going through the lessons would be constantly stopped and expected to react to the information presented in some form of self-review.

3. Third, the training needed to be available 100 per cent of the time. In this way, new personnel could receive the training before going out on the job without any loss of time or interfering with the supervisor's schedule.

4. Fourth, we had to address ourselves to the lowest common denominator in terms of educational and reading ability. Again, the use of a multi-media program, combining audio illustrations and a simple, easy-to-use cartridge, solved the problem.

5. Finally, we realized there was an additional dimension to the problem of training. People can learn any number of things and then turn right around and do the opposite of what they have learned. We are all familiar with this trait and are probably all guilty of it in some form or another. Your collectors are no different. They learn something, but that learning does not change what they do. Therefore, any training program, to be effective, needs to be aware of and strive for one additional dimension: the learning should alter behavior. In other words, training, to be effective, must include behavior modification. It is not enough that the person learns; he must act on the basis of that learning. You can know and recite all the safety rules, but unless you obey those rules, knowing them is useless and the time taken to learn them is wasted.

So our last consideration was how could we design a training program that would modify the learner's behavior, that is, make the training meaningful enough to carry over on the job. You'll see how we did it. I will describe it in detail as we go over parts of the program. You can be the judge as to how effectively we have accomplished our goals. (There followed a demonstration of a training program. —Ed.)

You are faced with a real problem in the solid waste industry today. It can be stated quite simply: How do we reduce the lost-time injury rate? Your failure to do so will result in punitive workmen's compensation rates and increased governmental regulations.

We have established the need for training as one of the ways to reduce the lost-time injury rate. If you are at all involved in training, you should carry away with you three simple truisms with which to evaluate your own training efforts:

1. Teaching does not guarantee learning.

2. Self-instructional materials are a far more motivating, effective, and efficient way of learning than teaching type situations.

3. The motivation for learning must include the added dimension of behavior modification.

Perhaps asking you to remember three truisms is too much. If three are too many, here is the only thing you need to remember: Learning the "safe" way to do anything never prevented a single accident. Learning must lead to changing behavior.

78 1983

POSITIVE RESPONSE TO THE SOLUTION OF EQUIPMENT HAZARDS BY THE SOLID WASTE INDUSTRY

By PHILIP NOWERS
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The solid waste management industry, both public and private, faces no greater challenge in the years ahead than to sharply reduce the human and financial costs of its extraordinarily high accident and injury rates. Some idea of the seriousness of the safety problem in the solid waste management field is provided by recent National Safety Council accident data. These data, which group accident rates by industry, show that in 1975 refuse collection workers suffered 99 disabling injuries and fatalities per million man hours worked. While 99 injuries per million man hours may not appear to be of particular significance, it is only necessary to study injury rates in other occupations to put this figure into perspective. The National Safety Council injury rate for lumberjacks is 20; stevedores, 26; heavy construction workers, 13; structural metal workers, 16; and high explosive chemical workers, 4. The average for all industries in 1975 was 13. What this means is that refuse collection workers suffered five times as many injuries as lumberjacks; four times as many injuries as stevedores; ten times as many injuries as heavy construction workers; and more than 20 times more injuries than high explosive chemical workers. The average industrial worker in the United States suffered one injury in 1975 for every ten injuries suffered by solid waste collection workers.

There was only one "industry," according to the National Safety Council, with a higher injury rate than refuse collection. That industry is fire fighting, with an injury rate of 149. All other industries have a lower National Safety Council injury rate than refuse collection, without exception.

There are two important implications of this high injury rate. First, the impact is cumulative on the refuse collection work force. Continual exposure to such high rates means that an individual worker faces considerable probability of injury over a period of years. An EPA study suggests that an average solid waste worker, during a 25 year period, has a 23 per cent chance of being permanently disabled to some degree and a nine per cent chance of suffering an amputation.

The second implication relates to the employer and the fact that high accident rates translate directly into high workmen's compensation insurance premiums. Given the cost of medical care, these premiums have risen sharply, even for employers who have managed to keep claims to a minimum. For firms and cities without effective accident-reduction programs, premiums may rise to extraordinary high levels.

There is evidence to suggest that something can be done to correct this situation. Injury incidence rates computed by the OSHA method (basically equivalent to the number of reportable injuries per one-hundred employees per year) for users of the Injury Reporting and Information System (IRIS) show a wide range of rates within the refuse collection category. IRIS is an injury reporting system operated for the refuse collection industry by Safety Sciences of San Diego, California. During 1976, participants in the system reported a low of 0 and a high of 129 injuries per one hundred employees per year. The average OSHA incidence rate was 41, compared to 10.4 for all private industry.

Assuming that these data are confirmed as the IRIS data base expands, it is evident that injuries can be reduced significantly within the waste management industry. If one employer can get the accident rate down through appropriate management practices, then there is no reason why others cannot also. And the cost, while real, will certainly be less than the direct and the indirect costs of on-the-job injuries. It should also be noted that the majority of the participants in the IRIS system are public agencies rather than private firms. In many cases the private hauling industry has been more aggressive in pursuing safety goals than public collection agencies. Directly conscious of high accident costs because of the need to hire additional staff and because of their insurance rates, the private firm can take action which the public agency has, in too many instances, not yet discovered to be necessary. If a private firm can effectively reduce its losses from employee injuries it will reap a tangible reward at the end of the year, hopefully in the form of higher profits. The fact that the public manager has no such direct system of rewards makes the implementation of safety programs generally more difficult.

There are, however, a number of approaches to reducing injury losses that can be adapted by the public sector. One of the most attractive involves getting the right type of equipment into the hands of collection personnel. All other things being equal, better equipment will increase the productivity of the work force and tend to reduce the very high injury rates just discussed. A part of this has to do with a worker's pride in his job and tools. Certainly a part has to do with the way in which the value and condition of a person's tools relate to the esteem in which he is held by his employer and by the public.

Newness or cost of equipment will not, of course, translate itself automatically into enhanced worker safety. There has to be some form of guideline or standard that will specify exactly how this newer, more productive equipment can be made inherently safer. Fortunately, such guidelines for refuse collection equipment exist and are available for use by the public, as well as the private, solid waste industry. The guidelines are the American National Standards Institute Safety Rquirements for Refuse Collection and Compaction Equipment (ANSI Z245.1-1975.

Before discussing the ANSI standard itself in more detail, it may be useful to comment briefly on the way equipment is procured by most government agencies. A key element in the recent past has been a fairly strict system of competitive bidding whereby the agency must buy the lowest priced equipment that meets a particular set of design specifications. Rarely have those specifications given more than cursory attention to safety matters and, because of the lowest price concept, manufacturers did not have a strong incentive to introduce features that were not specifically required. For this reason it has been very difficult in the past for safety-conscious government collection agencies to involve safety considerations in the purchase of new mobile refuse compaction equipment. Now, however, such agencies can and should avail themselves of the ANSO Z245.1 Standard.

Properly used, the standard makes it practicable for local governments of any size to get a measure of safety in their mobile equipment which was denied them in the past, not by anyone's conscious design but by the very nature of the procurement process. A natural trend in this direction will be aided by state action in some cases. California, for example, is in the process of making the ANSI Standard mandatory in that state.

This is a new standard and a new trend to encourage its use. While everyone involved looks forward to reduced injury rates as a result of its implementation, the

fact remains that the standard does require a measure of understanding and interpretation if it is to be used most effectively.

The standard is a voluntary guide to the manufacturer and the user, who are encouraged to comply with its recommendations. Except in a limited number of situations, compliance is not required by law. The American National Standards Institute (ANSI) is a nonprofit organization based in New York. Procedures for approving standards are, however, quite rigorous, and wide participation and consensus is required before a standard is approved. The Z245.1 Standard was approved in October, 1975. For new mobile compactors it becomes effective on March 16, 1978. In general, it is not intended to apply retroactively, and equipment manufactured before the effective date may not be able to meet all the requirements specified by the standard.

The scope of the standard is remarkably broad. Covered are most classes of mobile refuse compaction equipment, including front, rear, and side loaders, hoist-type vehicles, tilt-frame equipment, and satellite vehicles. A separate section deals with stationary compactors. Also, the standard applies to not only the manufacturer, but the owner-operator and worker as well. As such it is helpful not only in buying safer equipment but in establishing a comprehensive safety program.

It has already been noted that the parts of the standard that relate directly to the manufacturer of the equipment can and should be used to write procurement bidding specification for this class of equipment. The specific areas discussed in the rear loader standard include, for example, identification, operating instructions, lockout procedures, controls, hoisting devices, lights, packer blade protection, riding steps and grab handles, and safety markings. In general the standard presents a performance specification and allows the manufacturer to meet that specification with a number of alternative design solutions.

As managers or safety officers of refuse collection operations, your responsibilities for safer equipment do not end with getting ANSI specifications written into your procurement documents. While a big step, it is only part of the safety program and, for that matter, only part of the ANSI requirements. There is, of course, the need to check equipment at the time of delivery to see that all the stipulated requirements have been met. The Waste Equipment Manufacturers' Institute (WEMI) of the National Solid Wastes Management Association (NSWMA) is developing a certification program that will simplify this task, but the program will probably not be operational by March 1978. Until this type of certification is available, managers or safety officers should check each vehicle with care for ANSI-required features.

There are important sections of the ANSI standard that are addressed, not to the manufacturer, but to the owner and user of the equipment. For example, an owner should be sure that any subsequent modification of the equipment to meet local conditions is done in accordance with the standard. As a general consideration, owners of equipment should be aware that deliberate removal, modification, or disabling of ANSI-specified safety devices will not only weaken the overall safety program in which such devices play a role, but will also tend to relieve manufacturers and employees from their full responsibility for providing the best available equipment and using it properly. The effective—that is, injury reducing—potential of the ANSI standard depends most heavily on responsible leadership from line managers in the refuse collection field. Such actions will speak louder than words to convey a serious commitment to a safer working environment.

Having placed a heavy burden on the manufacturer to provide refuse collection equipment that meets a set of safety criteria, the ANSI standard goes on to

place the responsibility for proper maintenance of that equipment with the employer.

The standard states that the employer shall keep the mobile equipment properly adjusted and maintained in conformance with the manufacturer's recommended instructions. This is sound economics as well as sound safety policy. Supervisory personnel, mechanics, and operators should all be familiar with the vehicle's operating instructions and put those instructions into practice. Again, a major factor in this regard is that management's attitude toward the collection equipment is shown by the thoroughness of its maintenance and cleaning programs. Employees cannot be expected to respect equipment that is neglected by management.

So important is the concept of proper maintenance to the implementation of the ANSI standard that a separate requirement even provides for a program of inspections, complete with written records, As few refuse collection agencies currently keep such records, there will be a new burden imposed by the Z245.1 requirements.

The standard is very explicit is stating that the employer is responsible for providing instruction and training in the proper use of the mobile equipment before assigning the employee to that vehicle. Instruction in this sense should be taken to mean a formal, structured orientation conducted by supervisory personnel in the safe operation of the equipment. Specific safety procedures and mechanisms explained in the manufacturer's instructions should always be a part of the training. Also, this is an ideal opportunity to review safe working practices in general, pointing out that safer equipment alone will not eliminate injuries in the refuse collection field.

There is no safety device yet invented which cannot be circumvented by man's often perverse ingenuity. Emphasize to your employees that, while you respect their ability to outmaneuver the machine, the reward will be disciplinary action, if not injury.

The standard also addresses another, sometimes overlooked, aspect of employee training. It is not only the operator who needs to know about the safety features of equipment, but the mechanical and maintenance staffs as well. If any employer maintains his own equipment, he has the responsibility to train competent personnel for this purpose. Again, the manufacturer's instructions will provide a starting point, but good management may dictate that the staff be given more extensive training.

The fact that the ANSI standard goes beyond specifying equipment improvements may surprise some people. It should not. The standard recognizes that properly built, maintained, and used equipment will lead to fewer accidents and injuries. Equipment manufacturers have, in general, reacted positively to the standard. By March of 1978 most of the major producers of compactor bodies should have ANSI-type equipment in production. You must be prepared to ask for it, check it, and use it properly. Make it the function for a new safety program for the next few years.

It is necessary to tell you that the accident rate for refuse collection is far too high. It is necessary because, over the years, you may develop a certain tolerance and acceptance for that information. It simply is not tolerable or acceptable to injure as many people as are injured each day in refuse collection activities.

Use the ANSI standard as a guide to equipment purchasing, and the new equipment you will be getting beginning next year should help you to cut those outrageous statistics.

But do not expect more than the machinery can deliver. If real progress is to be made, the new equipment must be maintained and used properly, as the standard itself requires.

78 1589

ACCIDENT PREVENTION IN THE SOLID WASTE INDUSTRY

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The items I want to share with you are not intended as a cure-all for solid waste accident/injury problems, but simply as the outline of one safety program that has worked well in one municipality and under one specific set of circumstances. I do, however, intend to show you that it has worked, and worked well. I then intend to share the components of that program with you and point you in the direction of other successful programs or additional information that may have escaped you.

Injury Frequency

Year	Collection (National)	Disposal (National)	Combined (National)	City of St. Petersburg
1971	90.90	127.66	109.28	93.29
1972	96.21	91.48	93.85	112.80
1973	101.63	89.70	95.67	48.72
1974	104.36	80.24	92.30	36.21
1975	99.78	71.61	85.70	19.04

Injury Severity

Year	Collection (National)	Disposal (National)	Combined (National)	City of St. Petersburg
1971	2890	1409	2150	1863
1972	2862	1773	2318	2041
1973	3069	3020	3045	597
1974	3284	3238	3261	463
1975	3264	4670	3967	211

In addressing our topic I would naturally like to begin by referring to those factors that I believe have accounted for the very great improvement in the statistics for one city while others have skyrocketed.

Gerald Van Beek's list of benefits to be derived from a well-organized and aggressive Safety program are as current today as when published in 1969[1]: reduced personal injuries; reduced vehicle accidents; reduced absenteeism; lower maintenance costs; improved customer relations; improved employee morale; a better image for the department or company (and the entire industry;) lessening of exposure to negligent entrustment suits (and/or third party torts). Rather than being outdated, these come very close to being a good set of goals for any sanitation safety program.

With regard to program costs, you must have an administration that is concerned primarily with the savings in human suffering rather than program costs. If management is not sufficiently concerned with employee welfare and morale, you simply will not have an ongoing, aggressive accident-prevention program. The worker's personal suffering, loss of family income, and the possibility of permanent physical disability or death should be your prime motivation. Then we can concern ourselves with program costs.

However, for most of you who are already involved with statistics, it will come as no surprise that the cost for one accidental injury incurred in St. Petersburg last year will far surpass the total costs for the entire safety activity plus, the workmen's compensation costs for the entire workforce of 3,600 employees! Additionally, one sanitation vehicle accident three years ago has already cost more than the entire sanitation safety program for the succeeding three years! Need we say more regarding the advisability of pursuing an aggressive, results-oriented program?

For purely statistical purposes, the foregoing data could have been reduced even further by drawing a finer line between first-aid cases and medical cases. However, each case is checked individually by the sanitation worker's supervisor, and where even the slightest doubt exists regarding the need for medical attention we prefer that employees be sent or taken to the clinic. Quite naturally, employee welfare and morale are critically important, and possible human suffering cannot be weighed against statistical gains.

Our approach to accident prevention in the solid waste industry does not criticize or cast aside the traditional management techniques and approaches. The only thing that might be considered unique in our approach is an almost compulsive willingness to try anything that will reduce accident-injury frequency and severity. We reject nothing that comes recommended to serve that purpose, be it a traditional approach or something totally innovative.

Accident statistics can often be modified (and sometimes very much so) by a change in operational procedure. These changes do not always result in reduced injury or severity statistics, and I would even suggest to you that the national increase in injury frequency and severity for municipal collection personnel during the years 1972, 1973, and 1974 most probably correlates with new equipment, new procedures, and sometimes innovative changes. However, if coupled with a good orientation and/or safety training program, there is no reason why new techniques should spell new troubles.

In terms of building or supplementing such a safety training program, if you are the innovative type—more power to you. I heartily agree with Dan Peterson's article[2] and his suggestions for change and innovation with a strongly behavioral approach and the tremendous need for change in safety management attitudes, but I would also want to assure you that many old, standby safety programs still form a fine framework and make a good beginning point for a new program or a renewed program effort. The primary elements of a basic accident prevention program remain the same:

1. Management commitment plus leadership. Neither tokenism nor short-term commitment will suffice. Quite the contrary, short-term, fluctuating, incomplete support results in either losses of profit or reduction of productivity and services.

2. Sufficient authority to carry out your activities. Never mind that it never matches your responsibilities. Here's where initiative and imagination can compensate.

3. Accident information system. Analyzing frequency, severity, causes, total costs, category costs, and total breakdown for your particular operation. It is the writer's opinion that there is currently no more accurate or sophisticated analysis available for the solid waste industry than the September, 1977, issue of *IRIS News*.[3] The City of St. Petersburg has participated in the Injury Reporting Information System (IRIS) since its inception as an EPA/OSWMP-sponsored project of Safety Sciences and currently plans to continue beyond that stage as a participant/user.

4. Providing safe and healthful working conditions. This is such a broad and important area that neither time nor space will permit an adequate summary. It is even tempting, at this point, to say

that workplace standards in the solid waste industry are so untested and inadequate—whether state or federal—that we might better begin by developing new and specific ones. Our approach in this one area has been (now, brace yourselves) to largely ignore state and federal regulations while concentrating on the very useful OSHA General clause. Loosely translated, it says: "Every employer shall provide safe and healthful working conditions." What better guidelines to work with? I think every safety official will agree that such a statement is all-encompassing and certainly legitimate.

While we are on the topic of working conditions I am going to assume that each of us was virtually nursed to loss control maturity on the "unsafe act" theory. Basically, the theory says that concentrating on elimination of unsafe conditions does not merit such attention because "most accidents result from improper human behavior." A University of Wisconsin study[4] has shown that "most" equates to approximately 26 to 35 per cent of accident causes (in their study) but that unsafe conditions accounted for between 54 and 58 per cent of the causes. So, let's get busy on those "safe and healthful working conditions."

If you are new at the profession or even if you are not, make an effort to familiarize yourselves with the references I have given and also refer to Mitchel deRossett's "Program Planning and Its Application to Safety."[5]

5. Instituting a safety training program. If you have successfully reached stage five, we can almost assume that a safety training activity is well on its way. It is vitally important that this be a responsive, ongoing part of your program. Our experience has shown that any let-down in this area is reflected quite rapidly in both vehicle accidents and industrial injuries.

6. Medical procedures is another category that seems to be handled in a slightly different manner by each agency, company, or industry. We have tried almost every arrangement, and though we are currently using a combination of an "in-house" first-aid program (with training provided by the American National Red Cross) and a contract agreement with one centrally located medical clinic, we emphasize that in any bona-fide emergency employees may utilize any medical facility in the city. Follow-up visits in those situations are scheduled through our clinic, and in this way we are able to regain control. It remains my strong impression that a "company" doctor is still the best choice for every aspect of work-related injury treatment, and that self-insurance is not only less costly but more effective in terms of program goals. This would apply to all but the smallest agencies or industries.

7. The last basic element of an effective accident program goes by many names but is usually covered by the organization's Handbook of Rules and Regulations. It deals with the organizational arrangement for the employee's recognition of his responsibility for working safely, preventing accidents and injuries, and keeping unnecessary costs at a minimum by caring for the equipment assigned to him, protecting his fellow-worker, and using any necessary or required personal protective gear to protect himself. And it deals in the final analysis with raises and promotions or with the loss of promotions and with discipline.

I most certainly agree with Dan Peterson that "punishment as a (prime) approach to safety is inefficient, ineffective, and counter-productive." In the first place, it presupposes that the unsafe act theory is correct and almost suggests that the employee does not care about his own safety.

However, our approach has been to follow a mid-line. We certainly do not conceive of discipline as punishment, but in those cases where discipline is necessary, we feel that the certainty of discipline is more important than the degree of discipline decided upon. One

strong suggestion here is that discipline most certainly becomes counter-productive when your men begin to feel their life is almost totally controlled or regulated. I feel that our success in this area is that safe driving awards, "Injury-Free Years" certificates, and award presentation dinners (wives invited!) far-and-away outnumber the Notice of Disciplinary Action forms issued and the men, consequently, do not resent the fairly-administered discipline.

Now, for a few specific notes on the St. Petersburg program. As I indicated earlier, the one consistent element of our program is change, and perhaps the most important aspect is a willingness to change. Are you, as a safety director, willing to suggest major changes when you clearly see a need for such changes? Is the sanitation director or company president ready and willing? In this day and age of continual change in collection and disposal practices, are you really keeping informed on new waste management practices and their implications as well as keeping abreast of those developments which will affect your area? Have you studied the recent accident/injury statistics for Task versus Hourly? Two-man crews versus one- and three-man crews? Curbside versus tubout? Two-times weekly versus three-times weekly? Transfer systems versus standard transport? How about total automation?

We long ago modified Operation Responsible into a strictly Florida production and used it successfully, but times are changing. We have a sanitation safety van designed specifically for tailgate meetings but adaptable, with its generator, projector, and screen, for other safety functions. On cold days, hot coffee can be dispensed, and in the hot summer months we go through more colas than some local stores. In addition to regular safety meetings and driver training sessions, we have effective new-employee orientation programs and driver training for the specific vehicle, plus extra training sessions for drivers involved in preventable accidents. The certificates of award and notices of disciplinary action are supplemented by accident/injury review boards, dinners, an up-coming picnic, and by you-name-it. We are also currently participating in the IRIS study on the national level and several smaller ones within the department. We use 8 mm, super-8, and 16 mm films, as well as cassettes, and have recently purchased the audio-visual programmer training unit on refuse collection safety.

In terms of accident prevention I consider our sanitation director our greatest single asset, but I should emphasize that we try to utilize any individual and try to maintain contact with any industry, agency, company, or organization that might even remotely help us meet our goals. We may be a governmental agency, but we utilize everything available from industry. A recent Columbia University study shows industry more efficient than government at collecting and disposing of wastes, and even though this is not true in St. Petersburg, it behooves us to seek-out anything they have to offer. We watch for developments, trends, or innovations not only in solid waste but also in training, safety, and in equipment. Simply put, we see that accident prevention is a major input to all facets of solid waste management.

We have no intention of equipping any more Alley Cats with 16-inch grab rails to supplement the horizontal bar now that full-length vertical bars have proven so effective. We have no intention of placing a man with L-5 S-1 disc problems in a lifting job. We do not plan to put one-eyed drivers behind the wheels of 50,000 lb. trucks, or as Ramsey DeLibero (president, Waste Resources) recently put it, "If we can't find a driver who can count up to 13, why buy a 13-speed transmission?" His point, I believe, was simply that solid waste management is changing, and the industry is rapidly becoming quite sophisticated. My question today is: Has your program changed, and are you keeping up with the new levels of sophistication?

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78 1990

FIRES IN REFUSE TRUCKS

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Refuse truck fires are just as common today as they were years ago. Most often they started from hot ashes or materials people used for cooking and heating.

Today, the fires have all these ingredients plus plastics, chemicals, and toxic materials. Trucks also are bigger and come in all sizes and shapes and cost much more. For this reason we can't afford to burn them up.

If your driver saw smoke trailing behind the truck as he drove down the road, what would his reaction be? Would he panic and drop the load in a vacant lot, or have your drivers been trained to look for the signs?

Let's follow one driver of a front loader through his sequence of events. The first thing he noticed, driving down the road, is an abnormal amount of smoke. He went completely around the truck to determine the extent or intensity of the fire. The fire seemed small and near the front of the load. He knew what he had picked up and nothing seemed that flammable. Getting back in the cab he called on his radio and told the dispatcher that his load was on fire and to notify the fire department. The driver also said he was going to try to go to the dump. He gave his present location and the landfill he was going to. This way the fire department might be able to meet him enroute and follow him in. The next thing was to compress the load as tight as possible.

Upon arrival at the landfill, the driver should go through the checkgate without stopping and head straight to the dumping area. This is no time for check-in or weigh-ins. Approaching the dumping area, other truck drivers should be trained to give a truck on fire the right-of-way.

Landfill personnel or other drivers should check the wind direction and dump the load downwind. We don't want fire spreading into unburned refuse. Also, pick a spot where the fire department can have access to the truck that's on fire. All other operations should cease until this problem is taken care of.

Once the truck is spotted, open the back door, but be careful of persons behind the truck. Don't open the top lid unless the fire officer in charge tells you to do so.

The driver should stay in his truck at all times because he can operate it better than anyone else. At this point the load is pushed out and the driver watches in his mirrors for the burning material. As the truck is pulled ahead, do it slowly because people get excited when they see heavy black smoke.

Don't assume anything, just because the load is on the ground and the blade back. You can still have a problem. In this fire there were solvents on the floor of the truck body. When the load was pushed out and on the ground, either the fumes or liquid caught fire and went under the blade. In seconds, the whole inside of the body looked like a furnace. Even though the trash might be burning on the back of the truck, the most important consideration is the hydraulic system.

If the fire department hasn't noticed the fire inside the truck, re-direct their efforts. And if the driver is by himself, he should direct his fire extinguisher into the fire area to stop the fire spread. Also, if there is fire in the area between the body and the truck, raise the arms clear so the cab can be tilted forward for access.

The fire department may direct the driver to move his truck at any time. If this is done, it must be slowly and check the mirrors to make sure no one gets run over.

Some other areas dealing with fires in

refuse trucks pertain to all trucks. Have a plan ahead of time, train your drivers, and have drills.

When changes are made, make sure everybody is aware of them. Solicit help from your drivers in making up the plans.

Remember: In case of fire think first, and then react. And watch out for other excited people.

78 1931

PROCESSING AND MONITORING WORKMEN'S COMPENSATION CLAIMS

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It may come as a surprise to those outside the safety profession that safety personnel are directly involved in the administration of workmen's compensation claims and benefits. Some of you belong to organizations which are self-insured for workmen's compensation. If you have the responsibility for such a program, then you are aware of the direct dollar impact on your employer's budget and have probably instituted many of the measures for the processing and handling of workmen's compensation claims I will suggest here. I therefore will direct my remarks to those who represent employers covered by a state fund or private insurance carrier.

Workmen's compensation insurance is a unique form of insurance which provides benefits to the employee and protects the employer for job-related injuries without the requirements of liability or negligence. While it is realized that workmen's compensation laws vary state-by-state as to the scope of coverage, the underlying intent of each state workmen's compensation law is basically the same.

What has happened to workmen's compensation coverage in recent years which should cause us to take a closer look at the premium costs associated therewith?

All of us know that inflation has taken its toll in many areas of our roadway operations. Construction costs have risen to the point where some highway departments cannot match the Federal dollars available for highway construction. At the same time, voters are not very receptive to increases in gasoline taxes. This has resulted in a cost squeeze within our roadway agencies.

Workmen's compensation costs have not been immune to the realities of inflation. In fact, workmen's compensation rates have, in some states, risen beyond the cost of living index and, indeed, skyrocketed as a result of liberalized benefits and court interpretations, increased medical tests, and an actuarial awakening on the part of the carriers to the costs of these benefits.

I am sure that many of you represent employers who are large enough to be experienced-rated for workmen's compensation coverage. The premium difference between an employer with an experience rating credit as opposed to an employer with an experience rating debit can amount to several hundred thousand dollars each year, money which could be used for other purposes in our agencies such as increased construction or better maintenance of our roadway systems. What can we as representatives of employers responsible for the administration of workmen's compensation do to reduce the costs?

All of us realize that a good safety program is one answer. However, in spite of an effective safety program, accidents to workers will and do occur, so we must look beyond our safety program to reduce workmen's compensation costs.

One thing we can no longer afford to do is sit back and assume that our insurance carrier can handle all phases of workmen's compensation without any assistance from the employer except the completion of the accident report. Here are some steps we can take to help our insurance carrier, the injured employee, and our employer:

1. Investigation of personal injury accidents can have the two-fold benefit of

preventing a recurrence of the same type of accident and obtaining information pertinent to the case which will benefit the insurance carrier. Investigation of minor injuries can many times be done by the immediate supervisor via a supervisor's report of personal injury. In more serious cases, investigation by a member of your safety staff may be in order. Sometimes these investigations reveal that the injury or illness is not job related or that it does not fall within the scope of your state's workmen's compensation laws. Such information should be relayed to your insurance carrier in the form of a supplemental informational letter or letter of protest. Cooperate to the fullest extent with the insurance investigation of such cases.

2. If the accident results in loss of time from work, furnish such information to the insurance carrier along with the date the employee returned to work, thus providing faster claim service and alleviating the complexities of overpayments.

3. If the time away from work involves extended time periods, visits to the employee by the employee's supervisor or by safety personnel will do much for the morale of the employee.

4. Statistics show that once an employee is off work for a period of six months or more (for example, with a back injury), the likelihood of that worker ever returning to the job is rather remote. Therefore, efforts should be made to return the employee to part-time work, light duty work, or even create a job the employee can handle commensurate with his or her physical condition. The job so created may be on a lower pay scale. However, some workmen's compensation laws provide for supplemental payments in order to bring the employee back at his or her normal wage scale.

5. Some insurance carriers and/or state governments have rehabilitation centers and retraining programs for employees injured on the job. Maintain close liaison with your insurance carrier and recommend specific employees for entry into such programs.

6. A certain percentage of employees will not return to work if their incomes on disability are higher than was their take-home pay. Examples of this are disability payments under workmen's compensation plus Social Security benefits. Some workmen's compensation laws allow for a Social Security offset which allows the carrier to subtract Social Security disability payments from workmen's compensation disability payments if the employee is under the age of 62.

7. Periodically request copies of correspondence and medical reports from the insurance carrier. Analyze this information and periodically express your opinions to the insurance carrier in writing. It may be that the employee has not been seen by a specialist, or that physical therapy may be in order. Remember that your insurance carrier's operation is conducted by personnel who may not have the same insight into the case as you have.

8. Make your thoughts known to the insurance carrier if you feel benefits paid are insufficient or excessive, based on your analysis of all the facts.

9. In the event that disagreements between your insurance carrier and the employee result in litigation, be sure that your employer is represented at such hearings by your employer's legal counsel or by a lay representative. Interest shown by the employer will have an influence on the decision of the hearing examiner or board.

The processing and monitoring of workmen's compensation is a specialty in itself. But a specialty that is closely related to any employee safety program. If you have the assigned responsibility for the administration of workmen's compensation claims, give that assignment the attention it deserves. The dividends will be returned many times over in the form of better employee relations, lower premium costs to your employer, and an improved, overall safety program.

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