The computer printout shows the name, department number, average cost, and type of accident of each individual involved in an accident. It also shows whether or not corrective action was taken to prevent recurrence. If not, an area is presented for management to become involved.

The "report on time" column shows the date the accident was investigated and the report submitted. If the date of investigation is different from the date of the injury, the printout will show "No." The justification for this approach is that, if you have a production problem any time during a shift, immediate action will be taken to correct it because production is important. If safety is important and we have an accident during a shift, it will be investigated. We must show the same concern for safety as we do any other function that has been deemed important.

The last column shows the name of the supervisor in charge when the accident occurred. This provides a measure of the supervisor's performance in safety, a criterion that should be used in measuring his total performance. When management evaluates a supervisor, they take into account all the points they believe are important—his production record, the number of grievances, quality, etc. Let's include safety as an item for evaluation.

An analysis of performance by department, shift, and age is made. The department is shown, the number of accidents that department contributed to the total, and the per cent. The best departments will not be shown, because they will not have had an accident. The number of employees is shown under the "labor" heading, and the per cent each department has of the total work force.

It is not enough to say that one department has twice the number of accidents as another. It may have twice the number of people. This is why the accident-to-labor ratio is very significant. Mathematically, if a department is having accidents on a random basis, this ratio should be 1.00. Whenever these ratios increase above one, and the farther they increase, the more serious are the problems in those departments, an indicator of where action needs to be taken.

The cost column is the average medical and compensation cost of the accidents incurred by each department. The same analogy is applied to shift and age groups. Again, another guide for management action.

A summary of the type of injuries incurred during the period measured is a guide to developing relevant programs of corrective action. Still another tool that can be developed in conjunction with the systems approach to provide another benchmark is an annual cost chart. As you can see, we have tried to identify any existing relationships that may exist between medical and compensation costs, employment, and frequency.

I can testify that when we initiated these charts at Goodyear, we gained a great deal of attention from management. This is because, prior to our work, these cost figures were not readily apparent. They weren't hidden, but were spread throughout the year so that management never had an opportunity to see the total picture.

At the beginning, I said we cannot begin to solve problems in safety until we have gained management's attention—the same attention they devote to production, marketing, or finance. I implied that cost was one factor that can be used to gain the needed attention. As you have seen in the previous figures, there are systems capable of analyzing the data most of us have available with a little digging. This data can include cost factors that—if you do your groundwork accurately—should stimulate a great deal of attention.

There is one last point I would like to propose. The function of safety should not be the negative one we see so often—the prevention of accidents. Instead, it should be positive—maximizing productivity by assuring the availability of the total work force.

Maximum productivity cannot be obtained if a per cent of the labor force is incapacitated because of accidents. Thus, the function of safety is to maximize the availability of the labor force for production, and thereby minimize accident costs that reduce profits.

PROPER LABELING OF HAZARDOUS MATERIALS IN INDUSTRY

By GEORGE L. WILSON
Industrial Hygienist and Toxicologist, Firestone Tire & Rubber Co., Akron, Ohio

For many years the Manufacturing Chemists Association (MCA) has periodically published a revised edition of Manual L-1[1], *Guide to Precautionary Labeling Of Hazardous Chemicals*. The latest edition, the Seventh, was published in 1970. The first edition was published in 1945.

Manual L-1 has become the "Bible" for proper labeling of hazardous chemicals. Indeed, the labeling required by regulations promulgated under the authority of the Federal Hazardous Substances Act, which applies to hazardous household products, are largely patterned along the lines suggested by the MCA *Guide*. The American Petroleum Institute, in its *API Bulletin on Precautionary Labels*[2] also suggests a labeling system very similar to that recommended by MCA.

In recent years, there has been a proliferation of statutes and regulations at the state level. At this time, insofar as can be determined, at least twelve states have statutes on labeling industrial chemicals. Those of California, Oregon, New York, New Jersey, Illinois, Massachusetts, Kentucky, Minnesota, Nevada, and Colorado were discussed recently in an article by McCarl.[3] Since the publication of McCarl's article, Wisconsin and Tennessee have passed labeling laws.

One of the most comprehensive regulations is that published in California's *General Industry Safety Orders*.[4] California and the other states mentioned by McCarl follow the MCA Manual L-1 in general, and several refer to it as the guide which is to be used. We have no details as yet on the Tennessee and Wisconsin statutes.

Contrary to the opinion of many people, there is no Federal statute governing labeling of hazardous industrial chemicals. The Federal Hazardous Substances Act and regulations promulgated thereunder specifically cover hazardous substances intended or packaged in a form suitable for use in the household;[5] the Act does not apply to industrial situations or to industrial supplies taken into the home.

Sooner or later there may be a Federal statute on labeling industrial chemicals. It might supersede those of other governmental jurisdictions, thus attaining uniformity country-wide.

Importance of Proper Labels

In general, there are at least three broad reasons for labeling hazardous substances.

1. *Informs User.* A proper label informs safety engineers, supervisors, and other employees; safe handling procedures and preparation for emergencies can be devised.

2. *Lessens the Likelihood of Third Party Liability.* We are living in an age of consumerism. It is not at all uncommon for an individual to claim he has been injured by a product he uses. This extends beyond household products, and includes those used in industry. After all, an employee can collect compensation from his own employer only as awards are established by schedule in the various states. On the other hand, he can make the distributor or manufacturer (or both) party to a lawsuit. The amount of damages awarded depends on the court. Monetarily, awards often far exceed what can be recovered under workmen's compensation regulations.

3. *Prevent Overlabeling.* Overlabeling is probably worse than no labeling. It is like crying, "Wolf." Soon no one pays any attention to labels at all.

Overlabeling may cause problems in the factory. We know of an instance where workmen refused to use a chemical because of some statements on the label. Investigation of the toxic properties of the substance revealed a clear-cut case of overlabeling. The workmen would *not* accept reassurances that the hazards were not as severe as stated on the label; they did accept the manufacturer's label as authoritative, which it should have been.

It is the first reason—informing the user—which will comprise the balance of this discussion, and on which emphasis is placed.

The provisions of Manual L-1, if followed, result in labels which are proper and which are very informative to anyone who understands the principles involved. If you do not have a copy of the latest edition, it is strongly suggested that you acquire one and study it in detail. Having done so, you will be able to interpret to your employees what labels really mean. In recent years more and more manufacturers are labeling hazardous substances according to this manual, and it appears quite likely, in view of several state regulations already in effect and labeling presently required under the Federal Hazardous Substances Act, that should a Federal law be passed, regulations promulgated thereunder would closely follow the MCA recommendations.

Label Content

As stated previously, if you understand the principles involved, the degree of hazard and precautions which should be taken become clear. Good labels contain the following essential elements:

1. *Name of Product.* The name of the product is important information for the safety of handlers and users. It is preferable that the chemical name be used. If the product is a mixture, those components which contribute substantially to the hazard should be identified. A non-descriptive code designation or trade name should not be used as the only identification of a hazardous chemical. If the complete chemical name is not shown, the label should at least clearly state the type of chemical, e.g., "corrosive acid," "lead compound." In any case, identification should be adequate to permit selection of proper treatment in case of exposure.

2. *Signal Word.* The signal word is one of the most important elements of the label. It is intended to draw attention to the presence of hazard and to indicate the degree of severity. In the order of diminishing severity of hazard, the signal words recommended are: DANGER! WARNING! CAUTION! Degree of severity can be expressed only in relative terms. DANGER! is the strongest of the three words and indicates a severe hazard or hazards. CAUTION! is used for those compounds presenting the least serious hazards. WARNING! is intermediate between the others. The signal word is in capital letters of appropriate type size. A label contains only one of the three signal words. The one to be used is determined by the most severe hazard.

3. *Statement of Hazards.* This statement gives notice of the hazards that are present in connection with the customary or reasonably foreseeable handling or use of the product. Many chemical products will present more than one type of hazard. Appropriate statements for each significant one should be included on the label. In general, the most serious hazard should be stated first. For example: EXTREMELY FLAMMABLE. MAY BE FATAL IF SWALLOWED OR ABSORBED THROUGH THE SKIN. Note that the statement of hazards is also in capital letters of an appropriate size.

4. *Precautionary Measures.* These instructions are intended to supplement the statement of hazards by setting forth briefly the measures to be taken to avoid injury or damage from stated hazards, for example: "Keep away from heat, sparks, and open flame," and, "Avoid breathing dust." In some cases, the total hazard of a product, while justifying one or more precautionary measures, may be of such order as to require no statement of hazard on the label. For example, no statement of hazard is required because of the toxicity of butyl alcohol, but the precautionary measure, "Avoid prolonged or repeated breathing of vapor," is suggested.

5. *Instructions in Case of Contact or Exposure.* The primary purpose of precautionary labeling is to prevent injury or damage. However, instructions in case of contact or exposure may be included in those instances where the results of contact or exposure are severe and immediate treatment is highly desirable, and where simple remedial measures may be taken safely before medical assistance is available.

First aid instructions are limited to recognized procedures based on simple methods and commonly available materials. Instructions for strictly medical treatment should be included when specifically required by law or indicated by special circumstances.

Because of the serious and lasting effects that may result from eye injuries, a recommendation to get medical attention should accompany any specific instructions directed to treatment of the eyes. For example: "FIRST AID: In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Wash clothing before reuse. Discard contaminated shoes."

6. *Antidotes and Notes to Physicians.* Specific therapeutic measures which can be taken before the physician arrives may be presented under the heading "Antidote." Example for Cyanides— "Antidote: Always have on hand a cyanide first aid kit. Break an amyl nitrite pearl in a cloth and hold lightly under nose for 15 seconds. Repeat five times at 15-second intervals. Call a physician."

It may, in certain cases, be desirable to acquaint the physician with an antidote or with a specific form of medical management through a note to physicians on the label. Obviously, such information must be written by a physician for physicians. Example for Soluble Arsenic Compounds—"Note to Physicians: If swallowed, give gastric lavage followed by saline cathartic. Force fluids. In all cases, give dimercaprol (BAL) in recommended dosages."

7. *Instructions in Case of Fire, Spill, or Leak.* Accident instructions should be as simple and brief as possible and should advise the use of suitable materials for control. They should provide persons who handle containers during shipment and storage with appropriate instructions for confining and extinguishing fires and for cleaning up spills or leaks. This information on labels affixed to containers will insure reference and provide opportunity to plan for emergencies that might occur during storage and use of the product.

Such instructions may be used as separate labels or may be a part of the precautionary label text. Examples: "In case of fire, use water, dry chemical, or CO_2." "In case of fire, soak with water." "Flush spill area with water spray."

8. *Instructions for Container Handling and Storage.* Care should always be exercised in handling and storing containers of hazardous chemicals in metal drums, glass carboys, cylinders, fiber drums, aerosol containers, etc., and in removing the contents. Applicable phrases should be used. These may also be used either as separate labels or as a part of the precautionary label text. Examples: "Keep closure up to prevent leakage." "Replace closure after each withdrawal." "Do not drop onto, or slide across sharp objects." "Do not puncture or incinerate container."

Use of "Poison" and Skull & Crossbones

The use of the word "Poison" and the skull & crossbones on a label should be limited to those cases where the product is highly toxic as defined in Manual L-1, or where such use is prescribed by law. When used, this legend should *not* take the place of the signal word.

Summary

In conclusion, let's look at the label for an imaginary chemical synthesized for the purpose of this discussion. The chemical is benzoacetaminocarbonamide. You will see that it is a very hazardous chemical. The following are the eight elements of the label:

1. *Name*—Benzoacetaminocarbonamide.

2. *Signal Word*—DANGER!

3. *Statement of Hazards*—MAY BE FATAL IF INHALED, SWALLOWED, OR ABSORBED THROUGH THE SKIN. CAUSES EYE IRRITATION. COMBUSTIBLE.

4. *Precautionary Measures*—Do not breathe vapor. Keep container closed. Use only with adequate ventilation. Do not get in eyes, on skin, on clothing. Wash thoroughly after handling. Keep away from heat and open flame.

5. *Instructions in Case of Contact or Exposure*—POISON—Call a physician—FIRST AID: If inhaled, remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Discard contaminated shoes. If swallowed, induce vomiting by sticking finger down throat or by giving soapy or strong salt water to drink. Repeat until vomit is clear. Never give anything by mouth to an unconscious person.

6. *Note to Physicians*—Warning symptoms are blurred vision, nausea, and abdominal cramps. There is no specific antidote. Never give tranquilizers. Treat symptomatically.

7. *Instructions in Case of Fire, Spill, or Leak*—In case of fire, use water, dry chemi-

cal or CO_2. In case of spill or leak, flush spill area with water spray.

8. *Instructions for Container Handling and Storage*—Keep closure up to prevent leakage. Do not drop or slide across sharp projection. Drum must not be washed out or used for other purposes.

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3. McCarl, G. Warren; "Present Status of Labeling of Materials in Industry," *Amer. Ind. Hyg. Assoc. J. 30:510* (1960)
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THE FEDERAL GOVERNMENT—PARTNER IN SAFETY

By F. A. VAN ATTA, PH.D.
Asst. Dir., Research & Technical Office of Occupational Safety
U. S. Dept. of Labor, Washington, D. C.

The Federal government is currently more involved in safety activities in this country than you probably realize and, apparently, in the near future is going to be even more involved. We have had, for some time, some considerable interest in safety. We have had the Walsh-Healey Act since 1936. That is not very new. Safety requirements under that Act affect, at any given time, something like 75,000 plants. About 250,000 contracts are awarded annually. The contracts cover, at any given time about 27,000 employees in those 75,000 plants. We have also the McNamara-O'Hara Service Contract Act which applies to contracts for personal services to the government in excess of $2,500. That affects about 25,000 work locations and about 6,000,000 employees. We have the safety and health aspects of the Longshoremen's and Harbor Workers' Compensation Act which covers about 200,000 employees on the waterfront loading and unloading ships; building, repairing, and tearing down ships; and doing various types of construction work on the navigable waters. Since August 1969 we have had the Construction Safety Act, Public Law 91-54, which we estimate will apply at about 200,000 construction sites and protect about 2,300,000 employees. It applies to construction which is financed or assisted by the Federal government. We have the Vocational Rehabilitation Act which [illegible] people in sheltered workshops who, for one reason or another, are [illegible] any work or occupation in a [illegible]

ment, and the Arts and Humanities Act which is to protect the casts and other people who work on performances financed or assisted by the Federal government. That one is unusual because we are trying to do something about the safety of the performers and stagehands and such. Prior to the Arts and Humanities Act we have had quite a lot of laws and rules and regulations all designed for the safety of the audience. As far as the backstage people were concerned, you dropped that asbestos curtain and let them take care of themselves as best they could.

We have an idea that if we make a regulation under any one of these Acts it should apply equally to the same subject matter when it is regulated by any of the others. In other words, we are going to try to make the regulations uniform and, at the present, the regulations under the Walsh-Healey, McNamara-O'Hara, and Arts and Humanities Acts are identical. The Longshoremen's and Harbor Workers' Act [illegible] is different. [illegible]

reasonable question is, "What will those regulations look like?" While it cannot be answered in detail until the Act is actually in effect, some general ideas can be inferred from the philosophy of the Department of Labor about the proper nature of regulations and about who should be the "Partners in Safety." Under a considerable amount of urging, particularly at the 1964 hearings on the regulations under the Walsh-Healey Act, we have decided that, so far as possible, our regulations will embody the voluntary consensus standards, which will make the whole safety community our partners in safety. What that has meant in practice is that we have adopted by reference the safety and health standards of the American National Standards Institute, the National Fire Protection Association, and the American Society for Testing and Materials. As a natural extension of this philosophy, we do and intend to continue to support these institutions as strongly as we can. We participate in the development of many of their safety and health standards as members of technical committees and review boards. We have not made an effort to participate in the management of those organizations. We think that that should be voluntary and not government initiated.

To get standards which will have the maximum possible acceptance where we do not find consensus standards, we have looked at the proprietary standards of technical and professional associations. Under the four Contracts Acts we have adopted the threshold limit values of the American Conference of Governmental Industrial Hygienists. In spite of the fact that it says governmental, it is a private, professional organization and the members are not all employees of governmental units, so the standards are proprietary. We have also adopted some of the standards of the Compressed Gas Association and some of the standards of the Association of Building Commissioners of the United States. When we are about to adopt that sort of material we advertise the fact as widely as we can. We have quite a large mailing list to which we distribute the material directly, and we ask those people to again distribute it widely. We ask for comments and criticisms and usually, and always we hold a public hearing to provide opportunity for oral argument. Sometimes we hold several hearings, both formal and informal, in various parts of the country to provide the maximum ease of participation which we can. We have not the slightest compunction about changing a proprietary standard in the course of adoption if the consensus appears to be that it should be changed.

Everyone who has an interest is perfectly welcome and is encouraged to take part in that process. It is not the quickest way of arriving at a set of regulations and I am not sure that it is the most efficient way, but it is the most democratic way which we have been able to devise. We do feel that we must have regulations and I think that almost everyone agrees with that. You can do quite a lot by voluntary action but I don't think that you can do quite as much as the National Safety Council thinks that you can. As Jimmy Durante said about the bee among the flies on his nose, "There has to be one in every crowd who spoils it for everybody." That bee in every crowd who won't behave voluntarily and has to be squelched is the precise reason that we eventually have to come to regulations which can be vigorously and effectively enforced.

We thoroughly agree with both the desirability and the necessity of education as to the necessity for the type of practices we advocate and their social and economic desirability and only add that if they are socially desirable then they must be and can be enforced against the antisocial types. We do not need that enforcement be almost as you might expect. With our [illegible] we manage to make about 5,000 plant inspections annually. In about 90 per cent of those inspections, we find [illegible] the regulations [illegible] for those violations. About 2 per cent of those violations are not corrected [illegible] and legal actions are taken [illegible] all of those [illegible] corrected [illegible] of those [illegible] and [illegible] of those [illegible] of those [illegible] the only [illegible] are the [illegible]

Under the Longshoremen's and Harbor Workers' Compensation Act, where we have had regulations for about ten years, we have

doesn't work for two main reasons. One is that the regulations have to be written in detail for each operation, so that the inspector with the book can enforce them. As time passes the technology changes, the operation changes in detail, and the regulation does not fit anymore, but it still must be enforced and is enforced because there it is on the book. The more fundamental reason, and perhaps it is another way of saying the same thing, is that in writing that sort of a technical specification it is almost inevitable that you will get so involved with the technicalities that you will lose track of the main objective, which is to protect living, breathing people, not to provide an exercise in technical virtuosity for the writer. We have seen numbers of such regulations—in this country building codes are notorious for this fault—and we have taken the lesson to heart.

We believe that a regulation should not tell you what you must do. It should tell you what you may not do. It should also plainly state what you are supposed to accomplish and provide a quantitative measure of minimum satisfactory performance. Beyond that people should be permitted to go each his own way and accomplish the stated objective, or anything beyond it, each in his own way. We try very hard to write our regulations that way and to influence the voluntary organizations to write their standards that way.

It is not too easy. It requires a pretty clear and detailed visualization of the problem. But when you have accomplished it you have something which will protect the human values with which you are concerned and will, at the same time, not impede technological change. One of our major concerns is to accomplish that protection of people with no unnecessary interference with production processes.

HYDRO BLASTING—WATER AT WORK

By DAVID J. MARIANI
Staff & Safety Engineer, The Goodyear Tire & Rubber Co., Akron, Ohio

And God said, "Let the waters under the heavens be gathered to one place." From the beginning of time, man has been dependent on water to sustain life. He is also aware of its devastating deluge, power potential, recreational resources, and cleansing capabilities. Now man is harnessing water again and putting it to work in another fashion. He is combining, literally, the words of Genesis and the laws of hydraulics to arrive at hydro blasting. We gather a quantity of water, force it through a lance into one controlled place where it can unleash its productivity. Obtaining this safely and efficiently is our goal.

The problem of accumulations and unwanted residues that adhere to surfaces of equipment and structures is a source of concern within industry. In recent years, hydro blasting (or high pressure water cleaning) has been used as a mechanical means of removing adhered particles from surfaces. Under tremendous pressure, water is emitted through a jet nozzling device capable of blasting operations similar to sandblasting, but without the uncontrollable mass of sand and dust to contaminate the cleaning area and without the abrasive, cutting away action of sand, shot, and other blast media, rodding, drilling, and air or steam blasting. Since it is common for pressures of 10,000 psig to be used, and range upward to 45,000 psig for some cleaning jobs, safety must be built into these machines when they are manufactured, and a safe operating procedure be developed in writing for each job. The man assigned the job of using this unit, commonly referred to as the operator, must be thoroughly trained in all functions of the operation. Most important, he must be regularly reminded of safety procedures. Any infraction of safety regulations should be severely dealt with. All the safety devices conceivable will not protect the careless worker or one who will purposely take unsafe short cuts. Your best safety device is training a competent man who is in good physical and mental condition.

a statute which directs the Secretary to make rules and regulations and enforce them and also to engage in educational, training, and promotional activities with the employers and employees. Under that Act we have for the past ten years done about 20,000 inspections per year. We have also conducted training classes for ten to twelve or fifteen thousand individuals per year, classes which vary from a single two-hour session to a week of eight hours per day. We have had a minimal number of legal actions which, under this Act, result in Cease and Desist Orders. The results have been that in the shipbuilding, ship repairing, and shipbreaking industry we have seen a 40 per cent in frequency rate over the ten years, and in the longshoring industry a reduction of about 75 per cent. We have spent about $8.5 million in that ten year period and we have seen a direct cash return to the industry of about $65 million in reduced compensation insurance premiums. Perhaps it is a little brash to say that we are responsible for those reductions but it is observable that, in the ten years before our involvement with the industry, there was no such reduction in rates, and in the years over which the reductions have been achieved occupational rates in general have been uniformly rising. We are convinced that if you have a properly balanced program, if you do the training which is necessary to get people going along with you voluntarily (and we are convinced that if you can't get the vast majority of your constituency to go along with you voluntarily you might as well forget it—pack it in and go home), if you do the necessary minimal amount of enforcement, in short, if you do exactly the things which every safety professional has known for twenty or twenty-five years that you should do, and if you work hard at them and really mean it, they will work. We see the results statistically, and we see the results in human terms. I expect that under the new law, when it comes to pass, the philosophy will not change very much and the performance will not change very much.

All of the bills which have been introduced contain some provision under which the states can become "Partners in Safety" and permit each state to maintain control of governmental safety and health activities within its own borders. There are minor variations but no substantial differences. They all say that if the states will enforce standards which are the equivalent of the Federal standards and if they will produce a plan of action which will make those standards effective, then the Federal government will not only not take over occupational safety and health within the boundaries of that state but that it will provide some financial assistance to sweeten the program. We have had some voluntary cooperative plans with some of the states under the Walsh-Healey Act, but we do not have very many of them for a variety of reasons, not the least of which is that many of the states do not want them. Under the Walsh-Healey Act the Department is permitted to enter into such agreements but all that we can really offer the state people is more work with no more remuneration. Many people do not care for a job on those terms.

There has been some complaint in the press that the standards which we have adopted from the voluntary agencies are minimal. Ralph Nader has insisted strongly on that point, and we do not disagree with him. We think that it is not only inevitable in the long run but also desirable that the consensus standards and Federal regulations and state regulations should represent minimum satisfactory performance. We think that those things should represent a floor below which no one should be permitted to go. We do not think that it should ever be conceived or represented to be optimum performance. We both hope and believe that a lot of people will do better in their own self-interest than it would be proper to require by regulation. This is the fundamental difference between the system which is in use in many European countries and the system we have here. The European pattern is that the law says that the employer will comply with the rules and regulations of the Central Labor Authority. The Authority then sets up regulations which state in detail exactly what he must do.

It is a simple system to administer; once the rules are written all you need do is read the book. The result has been exactly what you would predict. Everyone does comply with the regulations and does not one iota more, partly because doing more would be a violation, in a technical sense at least, but it doesn't work very well. It

Let us call the units that gather this water into one place a pump. And for practical purposes, we shall not delve into the lower pressure washers that are on the market in abundance. These use a mixture of lower pressure water, detergents, steam, or abrasives. We shall primarily stay with the larger units in the ranges of several thousand pounds and up. The units themselves are normally portable, mounted on wheels. A few are on skids or even the back end of a truck. These units can quickly be moved from one location to another. The power source can be gasoline, or diesel. The specially built cart has hooks included for hose storage.

A stationary electric unit of 6,000 pound capacity is piped solidly. The feed water passes through a strainer and, in the event of water loss, the pump automatically shuts off. Another control sprays the pistons with water for lubrication only when the pump is energized. The discharge piping is of the hydraulic type, with an electric receptacle and the water connections close together.

After the water is gathered, it must be confined or directed to one spot. This is done with a lance. The lance can include a fail safe water control valve. Additional safety was applied by the user: A flat guard over the handle reduces the possibility of the gun accidentally discharging should the unit be dropped onto its handle. Another form of lance holder uses a tripod arrangement that holds the lance with three chains and clips for quick connection. The main thing for cleaning purposes, as in all cases, is to keep your lance tip close to your work. The proper nozzle, along with water pressure and quantity, should be analyzed for optimum cleaning.

In a plant of our size, encompassing some 25 acres, there are many areas in which hydro blasting can be put to work: cleaning grounds; maintenance of vessels, pipe lines, and cleaning equipment, inside and outside; primarily cleaning vessels such as reactors, one area in which hydro blasting has proven most beneficial. It is much faster to clean with a hydro blaster than the previous muscle power and hand tools. It is safer than a solvent and a less expensive cleaning material.

In order to clean reactors more safely, more effectively, and more efficiently, we have designed a ring that fits on the manhole of the reactor or any other vessel that must be cleaned. Another unit of similar purpose—safety in the use of the hydro blaster—is constructed of chain instead of the solid metal ring. This makes it adaptable to any size manhole. As long as the safety ring is used, the dump valve can be eliminated.

The operator, even though working from outside the vessel, wears his rubber suit to prevent an accidental, rather chilly, bath. The nozzle or business end of the lance is inserted through the manhole. The agitator is then locked out to prevent a confrontation between lance and agitator blades. The safety ring is locked to the manhole opening. Two clips, 120 degrees apart, are slipped under the flange. A tee-handled stud is then tightened to lock the unit securely. No tools are required.

The operator dons his face shield, takes a firm grip on the lance to direct the force of the hydro blast, and has his fingers on the electric switch. With a squeeze of the trigger type switch, he will start to remove the buildup on the interior of the reactor.

Looking over the operator's shoulder, we can see the coagulum buildup that is to be removed safely and rapidly. The use of hydro blasting has reduced the down time. The use of the retaining ring has increased the safety factor and reduced the effort the operator must use to control the lance. The effectiveness of the ring is dramatic. Only one of three chains holds this unattended lance, which is under 3,500 pounds of pressure.

The theory behind the retaining ring substantiates the use of a chain for cleaning floors, pumps, or exterior of equipment. Any reasonable length of chain can be used, with a snap lock connection on both ends. One end is hooked to the lance, the other is wrapped around a solid object. By directing the blast toward the solid object or vicinity, the chain reduces the back thrust of the lance. In this type of application, the dump valve must be included as part of the lance. The properly trained operator will always be found dressed for the occasion.

Tests were conducted by a Houston, Texas, based company, using soft white pine. White pine was chosen because of its softness being in proximity to human flesh. A 10,000 pound unit at 17 gpm was used. With the lance up close, one-half inch to 6 inches, penetration is to the bone, a complete cutting action. From six inches to two feet, one will receive deep cuts and flesh removal. From two to five feet, one would receive surface skin damage. From five to eight feet, you can damage soft tissue; beyond this point, there is no normal surface damage. One merely becomes saturated.

Another hazard on direct contact, would be water infusion. Should a small jet come into close contact with one's flesh, the water could be injected, causing painful swelling. Indirect contact hazards could come from burst hose or pipeline failures, couplings being generally the weakest point. Safety practice should also be adhered to under refueling techniques. Safety training of the lance operators should include these techniques. It is beneficial if he understands the normal operating procedures and also emergency shutdown procedures.

Occasionally in the area of hydro blasting, there may be lights or other electrical cords that could be severed by the cutting action. A circuit interupter is a ground fault interupter designed to protect branch circuits against lethal electrical shocks, fire hazards, and damage to equipment caused by line to ground fault circuits. Water and an electric charge can also be devastating.

Personal protective equipment can be rubber suit, gloves, boots, and a face mask. The most important single personal protection device is a pair of safety glasses as minimum coverage for the eyes. A full face shield keeps flying particles away from one's mouth and protects the face. Should the need arise where conditions are such (there may be chemical contamination or other hazardous ingredients and you want full head protection), you could go to a complete head coverage.

Bridges seem an unlikely prospect for hydro blasting. One in Cincinnati, Ohio was given a rejuvenation after the power of the hydro was put to work. The cleaning and blasting revealed spalled concrete while it prepared the areas for the needed repairs. The steel tie rods were more corroded than anticipated once the dirt and rust were removed from in between the two steel rods.

Expansion joints on highways are similar to in-plant roads that occasionally require maintenance. The expansion joint can be easily cut out with high pressure water. The joint is cleaned without damage to the concrete. Chances are you have guard rails in your parking lot and your in-plant roads. They, too, can be hydro blasted ready for painting by use of high pressure water.

Preventive maintenance is most important in keeping our plant up, and also in keeping the hydro blasters in top working condition. You should inspect your system, your pumps, for vibrations, any leaks, make certain the guards are on and the release systems are properly set to protect your people and investment. For most, it just requires a handful of small parts to keep the equipment in top condition.

In conclusion, hydro blasting is another modern way to safely maintain one's plant and equipment, reduce downtime, and even become part of one's production techniques. This can be accomplished by purchasing well designed equipment engineered to your needs. The foregoing can be calculated and proven. In order to obtain desired results, the human factor is brought into play. Herein lies the problem area. Most accidents are caused by unsafe acts. We must train and retrain the operators that the tools they are using must be treated with respect. As with any tool, it should be used as designed. A well written specification, thorough training, constant reminding, and insisting they become cognizant of their tools will keep the accidents caused by unsafe acts from occurring. Hydro blasting can be as safe as a hammer or as deadly. A thorough physical to determine the man's mental and physical competence should be a prerequisite for any operator.

"And on the third day He created the waters . . ." now, let us put the water to work—safely.

Following the presentation, there was a question and answer period.

Q: When working from a scaffold, what protection is necessary from keeping the scaffold from tipping over because of back pressure from the nozzle?

A: Back pressure is more of a function of gallons per minute than pressure. The greater the gallonage at a fixed pressure, the greater the back pressure. Water blasters are normally low volume, operating between 10 and 20 gallons of water per minute, and the back pressure does not present a problem. However, any time one is working on a scaffold