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Automotive, Tooling, Metalworking and Associated Industries Sessions

SAFE HANDLING OF HAZARDOUS MATERIALS

By BYRON A. BERG
Manager, Industrial Hygiene,
Allis-Chalmers Corp., Milwaukee, WI

Like most companies, we rely on our first line supervisors to train our employees to work safely. The supervisor is responsible for teaching all of his employees the hazards of their jobs and what precautions must be followed to avoid the hazards. This training includes the new employee, the newly transferred employee, and the old employee who may not have performed a particular job for some time. The subject matter of the training includes both physical and chemical hazards; in the latter case, the safe handling of hazardous materials.

There are few companies where no chemical hazards exist. At one of our manufacturing plants, over 1600 different chemical compounds were purchased in one year. Even in a small manufacturing company, the number of chemicals can easily exceed 100 or more. If you have not checked with your purchasing department, you will be surprised to learn how many different chemicals they buy.

Even if we did not already feel the need for gathering information on the hazardous properties of chemicals used in our plant and getting this information to the users, OSHA health standards and union agreements would require us to do so.

For example, OSHA Standard, Section 1910.93 says, "All employees working in and around open-surface tank operations must be instructed as to the hazards of their jobs and the personal protection and first aid procedures applicable to these hazards." And Section 1910.1017 says, "Each employee engaged in vinyl chloride or polyvinyl chloride operations shall be provided training in a program relating to the hazards of vinyl chloride and precautions for its safe use." The vinyl chloride standard establishes a pattern that will undoubtedly be repeated many times as OSHA goes through the tables in Section 1910.1000 and develops individual standards for hundreds of chemicals listed there. It calls for formal training of employees using the chemical.

In addition, one of our union agreements contains the proviso that employees shall be given written information on harmful chemicals they work with, including precautions and first aid measures. Other unions will ask for similar provisos in time. From an accident prevention standpoint, who can say that such a request is unreasonable? We have a moral obligation as well as a legal obligation to provide this information.

Following the health and safety precept of first recognizing, then evaluating, and finally controlling the hazard, a chemical control program must start with a system for identifying materials with hazardous properties before they are introduced into the plant's operations. This identification process must begin at the planning stage. Whoever is responsible for selecting a

given chemical, whether he is a product design engineer, a materials processing engineer, a manufacturing engineer, a facilities and planning engineer, or a maintenance department supervisor, must be made responsible for consulting with the safety supervisor before the chemical can be ordered out through the purchasing department. (For safety supervisor substitute your title for the person responsible for the safety function in your company.) How you accomplish this depends on your company's size, its organizational structure, its reliance on written standards and on standard operating procedures. I recognize these differences—they exist among and within the 25 plants of my own company. However, your system for identifying hazardous materials must contain the rule that each new chemical must come under the scrutiny of the person responsible for the safety function before it is purchased for production or maintenance usage.

For example, one of our plants has an operating procedures manual containing a safety section, and one of the safety operating procedures is entitled "Chemical Control Program." It specifies that "before any new chemical product is ordered, the requistioner must consult with the safety department on the intended use of the product." In a small company, all that is required is an alert buyer who will talk with the safety supervisor and obtain his okay before placing an order for a chemical he has never ordered in the past.

One of the problems we have is the product engineer or the maintenance supervisor who gets chemicals into the plant on a trial basis. Then the safety supervisor receives a call from the plant nurse that an employee has been exposed and is adversely reacting to a chemical that he has no information about.

We had a number of dermatitis cases among experimental laboratory employees working with new epoxies and other resin systems when they were first introduced into industry on a large scale in the 50's. The same safeguards must be applied in the laboratory as are used in production situations. This is a hard lesson for laboratory supervisors and product design engineers to learn. Don't overlook such labs when you audit your chemical control program procedures.

Maintenance departments have been notorious as a repository for seldom-used chemicals that have sneaked in the back door. This happens when a well-meaning foreman runs across a new miracle cleaner at a trade show and decides to try a little out before ordering it in quantity through regular purchasing channels. An inspection of your maintenance department storage cabinets will almost always turn up something new to you.

The solution to this problem of product design engineers and maintenance supervisors working around you rather than with you. I think, is more than a written procedure. It lies in selling these people on the sense of the procedure and the advantages of following it. If the product design engineer and the maintenance supervisor know you can make a positive contribution in the selection of a chemical that will help manufacture your product and maintain your facilities in a safer and therefore less expensive manner, they will seek out your help—whether or not a written procedure says they must. You and I know we can't rule by edict. We must sell the worth of what we do. In the area of chemical selection and safe usage, we have a lot of positive selling points.

The other person in your organization who must be sold on the sense of these chemical control program procedures and the advantages of following them is your purchasing agent or buyer. He as much as any one is the focal point of the program. He will refer to you those in your company who may forget to consult with you in the planning stages of a new chemical process.

He will question the selection of a new supplier for a chemical that has already been approved and is in use in your manufacturing process. Such a change of suppliers will sometimes result in a change in the chemical formulation without anyone's knowledge or even suspicion. This has happened to us and it could happen to you. Purchasing or manufacturing specifications are often drawn up so that different chemicals can be used in a formulation without changing the specification at all. Paint forumlations are good examples of this. Viscosity, covering power, tests of durability and weatherability, and sometimes items of interest to the safety supervisor such as flash point, are specified, but the various solvents used are not covered by the specification. Therefore, the purchasing agent should question the change of suppliers and insist on a new material safety data sheet whenever such a change occurs.

He will also inform you of new chemicals on the market and new uses for existing chemicals. He will refer to you the salesmen for these chemicals even before they are considered for trial. Now you can have really tight control.

With my mention of the material safety data sheet, we should move on to the second essential in a chemical control program for identifying hazardous materials and evaluating their possible effects in your operations. When the safety department has been requested to evaluate a chemical that is under consideration for use, they must obtain sufficient information from the supplier to enable them to do the job. The logical tool is the material safety data sheet, and the most widely known and commonly used example of a material safety data sheet is OSHA Form 20. I'll proceed on the assumption that everyone here is familiar with it and with its intended purposes. I once thought that Form 20 would quickly be incorporated into the general industry standards, and some version undoubtedly will be included someday. Meanwhile, it serves as a model for most data sheets being used today.

Because of OSHA Form 20 and its increasing use, more and more suppliers are prepared to give you the information you need on chemical products. Through your use of a standard form such as Form 20, and through your purchasing agent's unyielding insistence that purchase of a particular chemical depends on obtaining satisfactory answers to all the questions on the form, you should get satisfactory answers and a completed form.

But what if you don't? Most suppliers will cooperate, but you must be ready to turn down the supplier who will not give you the information you need. This will put a lot of pressure on you at times, but you must stick by your guns. The alternative is introducing unevaluated hazards into your operations and making inadequate provisions for employee protection.

Although some companies send their material safety data sheets to suppliers via the safety department, I feel it is the responsibility of the purchasing department to make the contact. Usually, your buyer has a closer working relationship with the supplier and can explain the purpose of your chemical control program and the negative consequences to the supplier who refuses to cooperate. But it is perfectly reasonable for the supplier to consult with your safety supervisor if a question arises on how the form should be answered.

And how should the form be answered? The easy answer is as completely as possible. Sometimes we may be willing to settle for incomplete answers and we try to fill in the gaps with some educated guesses. Don't do that. The supplier normally will give you only what you ask for. If you get in the habit of asking for less, you will get less. Using Form 20 as an example, under the section on listing of ingredients, don't settle for a term such as ketones—there are many kinds and they have different toxic properties. Another unacceptable term is chlorinated hydrocarbons—what does

that mean? Methyl chloroform or carbon tetrachloride? Heavy metals—what could that include: lead, mercury, iron?

All of the sections in Form 20 should be completed where applicable. From the information the supplier gives you in all the sections, you are going to develop your own safe operating procedures. If you don't get a completed form, your material safety data sheet form should have a place for the name and phone number of the person who completed the form. Then, if you have any questions or need more information, you can deal directly with the man who can provide the answers. This person will usually be the technical director. Don't be afraid to call him. If by some mistake you are referred to the sales manager, just keep in mind that he is conditioned to think that his product is perfect. When I see a product described in a material safety data sheet as being non-toxic, physiologically inert, completely safe, and so forth, I can safely guess it was a sales person who had a hand in making out the sheet.

There is another side to the coin. When you get back your completed data sheet and if you find a potentially hazardous material listed, don't reject the product out of hand. Our philosopny has always been that any and every chemical can be handled safely if the proper safeguards are employed. This does not mean that we are not always on the lookout for safer substitutes. We certainly are. We continually work with our engineers, and with the supplier too, to find safer chemicals that are also satisfactory from a production standpoint. But if you reject the product of the supplier who has been completely honest with you and has told you everything, both good and bad, about his product, and then turn around and accept the product of the supplier who gives you incomplete information and tells you his product is completely safe, you aren't being fair—to the supplier or to yourself. Normally, the information you get from the supplier is not in a form that can be sent out into the shop. It will contain technical information difficult to interpret by the average shop foreman and worker. So you have to translate the supplier's information to answer these two basic questions: What are the potential hazards of this chemical as it is used in our operation? How can we handle it in a safe manner?

Where can you get help in making this translation? Well, someday the OSHA health standards will help answer such questions on many chemicals. The present asbestos standard, for example, lists ventilation controls, work practices, protective equipment needed, and so forth. Other health standards will follow the same pattern of including work practices and other control measures in their provisions. But for now, you must rely on such sources as your corporate industrial hygiene department (if your company is large enough to afford that luxury); your insurance carrier, if it has a trained industrial hygiene consultant group at your disposal; or your state, if they offer industrial hygiene consultant services.

Other sources for the do-it-yourselfer are the National Safety Council Data Sheets, The Manufacturing Chemists Association Data Sheets, National Fire Protection Association Bulletins, such as #49 on hazardous chemicals data, the American Industrial Hygiene Association Hygienic Guides. All of these sources give practical information on specific chemicals' toxic and other hazardous properties, on safe handling and storage procedures, on recommended protective equipment, and on other control measures.

As a last minute addition to this list of reference sources, I refer you to the September issue of OSHA's magazine *Job Safety and Health*. They list a number of government publications that will also be helpful to you. For those of you who do not subscribe to this magazine, a reprint of the article to which I refer is available free of charge from Office of Publications, Occupational Safety and Health Administration, Room N-3644, 3rd and Constitution Avenue, N.W., Washington, D.C. 20210. The article's title is "Guidelines to Chemical Hazard Evaluation."

Using these sources of information and using your own knowledge of how the chemical is to be used in your own plant operations, you can draw up, not a data sheet, but a written safe procedure for a specific shop operation. This procedure should include such information as: approved uses for the material, how it can cause harm, general safety precautions, recommended personal protective equipment, safe handling and storage, disposal procedures, fire fighting methods, as well as its chemical composition, physical properties, and the supplier's name, address, and phone number.

At our Independence, Missouri plant this information is published and distributed to all departments in the plant, as well as the first aid station and all Independence area physicians who normally treat Independence plant employees. It is also posted at the site of usage of the chemical in their operations.

Depending on your organization's procedures and standards, this written safe operating procedure can also be incorporated into your safety manual and then referenced into your engineering standards, your materials specifications, your quality assurance procedures, and so forth. If possible, get these safety procedures adopted into the mainstream of whatever written procedural system your company has. Then they will be living documents and not part of a dead file.

Written safe operating procedures based on your material safety data sheets, if posted at the sites of the chemical's usage in the plant, meet OSHA requirements for training employees in the safe handling of the chemicals. Site posting is important for other reasons too. Now the shop foreman has the information he needs to instruct his people and to re-instruct as necessary. He has a document to which he can refer in the event of an OSHA inspection. He has proof of employee instruction if discipline is needed to enforce the wearing of personal protective equipment. The employee also has a document to which he can refer if the foreman is not available.

Summary

Training employees in the safe handling of hazardous materials is increasingly important in any accident prevention program, large or small.

OSHA Form 20 or its equivalent must first be used to obtain background information from the supplier on every new chemical introduced in the plant before it can be released for production or maintenance use. The purchasing department is the most likely control point through which this information is obtained. Various reference sources such as NSC, MCA, NFPA, and AIHA will assist in translating information obtained on Form 20 into individualized safe operating procedures covering use of the material in your specific operations. Finally, wide distribution of these procedures and incorporation into your present procedural manuals, and especially site posting wherever the chemical is used in your operations, will put the information into the hands of those who need and will use it.

77 2823

CONTROL OF INERT GAS WELDING FUMES AT THE SOURCE

By LEO E. WILDENTHALER
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In 1969, Hobart Brothers Company entered into a major investigation of the smoke produced by the arc welding processes. In the course of this investigation studies were made to determine: (1) what elements are found in the weld smoke; (2) how much weld smoke is generated by the different welding processes; (3) what is the effect on the operator; (4) what is the effect on the general environment.

The elements contained in welding smoke are basically determined by the filler metal being used and the chemistry of the part being welded. The major element for mild steel welding is iron oxide, which comprises from 40 to 60 per cent of the total particular manner. Up to 40 different elements were identified.

Determination of the amount of smoke generated was limited to the continuous wire processes and the stick electrode process. The amount of smoke generated is given in terms of weight of smoke compared to weight of electrode used. General smoke levels for the most widely used processes are as follows: (1) For solid, copper-coated, small diameter steel wire on mild steel shot-blasted plate, one-half pound of smoke per hundred pounds of electrode used. (2) For flux cored wire with gas shielding on mild steel shot-blasted plate, one pound of smoke per hundred pounds of electrode consumed. (3) For stick electrode processes on mild steel shot-blasted plate, one and one-half pounds of smoke per hundred pounds of electrode consumed. This varied greatly with the type of electrode used. (4) For self-shielded flux cored wire on mild steel shot-blasted plate, two to four pounds of smoke per hundred pounds of wire consumed. These general levels can be used to determine the total amount of smoke generated in a given welding shop for a given period of time.

Various methods were investigated to control the smoke. Each of these was examined in terms of their advantages and disadvantages.

1. Use of processes that do not produce smoke—submerged arc process and the Tig welding process. The advantages of these are the fact that they do not produce smoke, but they have many disadvantages in that they are very limited in their process application, and they are generally slow for production welding.

2. The use of a general ventilation system for the entire welding area. *Advantages:* Can be used with all welding processes. There is no change in present production procedures or welding technique. The operator has nothing to do with the use or control of the ventilation system. *Disadvantages:* Systems require a large volume of air, which usually must be ventilated outside, and make-up air to take into the building and heat it. The general ventilation is not effective in closed containers, boxcars, or automobile bodies. The operator is not protected, as he is only an arm's length away from the smoke generation point, while the ventilation system is usually many feet above him in the building.

3. Use of table hoods and vents. *Advantages:* Usable with all welding processes. There is no change in present welding procedures. The operator has nothing to do with the operation of the system. *Disadvantages:* Large volumes of air are a requirement which must be ventilated to the outside. There is a very limited size and shape of part that can be used with these types of hoods and vents. Shop floor space is required for installation. Units are not effective for smoke removal in such things as tanks, etc. Operator has only limited or no protection.

4. Use of flexible hoods which are moved by the operator. *Advantages:* They can be used for all welding processes. They have very low initial installation cost. They are effective in closed containers. The operator is protected. They can be used on all sizes and shapes of the weldments. *Disadvantages:* Large volumes of air are required which must be ventilated outside. Welding procedures and time studies are drastically changed. The operator must move the flexible hood after approximately 12 inches of weld for the hood to have any effect. This requires a great deal of time. The location of the hood to the arc is critical to both effective smoke pick-up and weld quality. A high degree of supervision is required for effective use of these types of units.

5. Use of the smoke exhaust gun. *Advantages:* Requires very small volumes of air to be efficient. The operator is protected, as the smoke is picked up at the point of origin. Very effective in closed containers such as tanks, auto bodies, etc. System is part of the operator tool and, therefore, automatically goes to the source of smoke. This requires minimum supervision. This system is used on all sizes and shapes of weldments. *Disadvantages:* Usable for the continuous wire processes only. The tool is heavier and requires more maintenance.

The effectiveness of the smoke exhaust gun was obtained by measuring the amount of smoke under the operator's hood and the breathing zone. This was accomplished through a series of tests with various types of processes used in measuring procedures as specified by the National Bureau of Mines. The results of these tests are shown in a paper entitled "Application of a Smoke Extracting System," published by Hobart Brothers Company, Troy, Ohio. Generally, the test showed that the smoke levels in the breathing zone under the hood are reduced to under the minimum levels now required.

Considering the advantages of the smoke exhaust gun and the general results shown by testing prompts the question: Why isn't this such a common system that it is used by all welding concerns? The answer can be found in two specific areas:

1. The welding gun—the tool that the man holds in his hand—is larger and heavier than he is presently using due to the addition of this smoke exhaust system. This piece of hardware has not been sufficiently developed to the point where it is readily acceptable by the operator.

2. The general reluctance by most managements—but not all—to do nothing about the problem until they are forced to through inspections by either state or federal agencies.

Within the last six years, only four of the welding supply manufacturers attempted to produce equipment to solve this problem. Now, there are at best only two still actively engaged in equipment development for welding smoke exhaust. This is caused by the lack of a true demand for this type equipment by welding fabricators. The demand is only generated when the welding fabricator feels that he has no other avenue of escape from the general problem. This lack of true demand discourages further development of equipment.

To truly implement a system to control welding smoke, a team approach must be taken. The team must be headed by a manager who reports to the general management of the company. On the team it is recommended there be representatives from the safety department, welding department, work standards departments, and plant engineer-

ing. Management must be made to realize that any system will require proper funding and management supervision. This system must be so designed that work load, shop floor space, shop volume in general, plant air motion and heating, safety requirements, and maintenance are all coordinated into one effort. General experience has shown that when only one of the departments noted attempts to implement such a system, failure is inevitable.

Welding smoke can be controlled. The method that can best be applied must be determined by the variables within the individual plant and the product being produced. New equipment must be and will be developed when the user demand reaches the required levels. The company which attacks the problem on its own initiative generally solves the problem in a more efficient and more economical manner than the company which is forced into a solution by state or federal agencies.

77 2824

MEDICAL SURVEILLANCE PROGRAMS FOR SMALL PLANTS TO MEET GOVERNMENT STANDARDS

By B. L. WEISENBERGER, M.D.
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In 1970, faced with the OSHA revolution, plus rapid company growth, Cummins Engine Company was considering the development of new medical facilities to handle both problems. Until that time, Cummins was the only industry in the area with any existing occupational medical services. A few other companies in the area, motivated by OSHA also, inquired as to any way that they might avail themselves of these occupational medical services.

From this inception developed the Columbus Occupational Health Association, a voluntary, not-for-profit association of businesses and industries joined together to provide comprehensive occupational medical services to themselves. Hereafter, I will refer to the Columbus Occupational Health Association as COHA, its acronym.

The $2 million capital cost of the building, equipment, landscaping and land was absorbed by Cummins Engine Company (the services are on a fee-for-service basis). All charges are related to a numerical point value system. Each office procedure is assigned a point value, e.g., a simple office call being 1.0 point, AP & lateral chest x-ray 2.6 points, etc.

Each company receives an itemized bill monthly for the total number of points accumulated during the month for services rendered, multiplied by the dollar value of the point. The point value is arrived at annually and the charge remains firm throughout the year.

There is no charge for membership in COHA, only for services rendered. At the present time, the value of one point is seven dollars.

The cost of the center construction was absorbed by Cummins and is not amortized through the operation costs. Since it is a not-for-profit organization, the point value is aimed toward a break-even factor each year. Cummins has agreed to absorb any deficit occurring during the year. At the present time approximately 70 per cent of the services are rendered for Cummins Engine Company.

From the seven original founding companies in October, 1970, membership in COHA has grown to 100 businesses and industries. At the present time this involves a workforce of approximately 25,000 people. These businesses and industries are located in 15 states.

The staff of the medical center consists of four full-time M.D.'s, a medical administrator, three physician assistants, five nurses, five technicians, and seven clerk-secretaries. I might mention here that I am an enthusiastic supporter of physician assistants and feel they can be utilized very well in industry, expanding a physician's capacity by 75 per cent or more. Dr. Henry Seidel of Johns Hopkins has advised me recently that they have plans to graduate soon a class of physician assistants specializing in occupational medicine.

We operate the medical center on a regular 40-hour week, Monday through Friday, from 8:00 A.M. to 5:00 P.M. However, we provide a 24-hours a day, seven-days a week emergency service for occupational injuries from member companies.

Our largest service in terms of volume, and the primary reason for our existence, is our program of definitive

diagnosis, treatment, and rehabilitation of occupational injuries or diseases. In 1975, 150,000 visits were made to the center for this service. These represent some of the many varieties of our evaluations or treatments: surgery, industrial ophthalmology, back injuries, dermatitis, and fracture care.

Our physiotherapy department consists of whirlpools, hot and cold hydrocolators packs, steam cabinets, microwave diathermy, and ultra-sound modules. We are great believers in the "laying on of hands." Our patients are seen daily and treated while working their regular job or one of limited work requirement, if indicated. We feel that this increased attention to the patient, combined with intensive treatment, speeds his or her recovery both psychologically and physiologically.

In Indiana, choice of physician is reserved to the company. Selection of outside consultants, when necessary, is the sole responsibility of the COHA medical staff. I might mention one of our continuing problems is that of patients wanting to see us, and not their own physician, for personal problems.

Our second service is to provide consultation to industry in environmental health. The environmental health lab, under the direction of the industrial hygienist, is capable of any type of environmental sampling or analysis necessary, whether it be personal air sampling of dust or vapor, sound levels, or radiation exposure, to name a few.

At the present time, requests for polyvinylchloride levels seem to be our most popular item. Both the industrial hygienist and the medical staff are available for in-plant consultations with any of the member companies regarding environmental problems.

Our third service is a major one—our preventive medicine program. It consists primarily of a comprehensive annual physical examination. Recipients of the physical are at the discretion of each company. At Cummins they consist of all the salaried employees age 40 and above and the hourly employees age 50 and above. This year approximately 1800 men and women will participate in this voluntary program. Approximately 1250 of these are from Cummins and the remainder from other client companies. Cummins' salaried personnel are continued in this program after retirement as long as they live.

Some of the major components of this exam include graded exercise testing for early detection of coronary heart disease, AP & lateral chest x-rays, pulmonary spirometry, tonometry, proctosigmoidoscopy, etc. Additional, non-invasive cardiac evaluation is possible, if indicated, through the use of a multi-channel recorder which permits us to obtain vectorcardiograms as well as simultaneous recordings of apex, carotid, and jugular pulse waves.

For evaluation of known heart disease is the fascinating Holter monitoring system. This device allows us to record an individual's electrocardiogram for a ten-hour period. All patients returning to work following a heart attack are so evaluated. In this manner, we can observe the patient's response to his job or any other activity that we may wish to investigate. This ten-hour recording can then be examined on a composite scanner, which allows us to review it at a rate of an hour per minute or ten minutes for the entire recording. Executives who wish a less conspicuous device are recorded by telemetry, a device resembling an ordinary briefcase. By the use of this system we can better evaluate the stresses, either physical or psychological, of an individual's job upon his or her heart condition.

As you are well aware, there are many hazardous jobs which require not only environmental monitoring, but biological monitoring as well. In other words, the employee must be examined from time to time, depending upon his work or exposure. The most common situation at the present time is probably audiometry. We are at present performing 750 audiometric examinations a year, and anticipate that this will increase to over 2000 in 1977. Our specialized exams are cataloged for convenience to the office employees who must schedule the examinations. The nature of the exam is geared toward the particular hazard of the job or substance.

Of course, the most frequent special exam service is the pre-placement exam. Other specialized exams include: a cold room physical developed for a job where the employees are exposed to -65°F temperature; a physical for operators of laser beams; Interstate Commerce Commission driver exams, FAA pilot physicals, and many others.

At the present time there are approximately 50 or so criteria documents regulating hazardous substances in the Department of Labor. These will begin to be promulgated into law within the next few months. As this occurs, the number of specialized exams will necessarily increase.

There will be a continuing problem for industry to handle this data. Hazardous areas must be identified and recorded, employee exposure, last periodic physical, etc. In other words, the records of who is being exposed to what, for how long, and how often, can be a very cumbersome job. We feel that this can only be controlled by the computer. We are making our first steps to implement this now for Cummins, and hope to accomplish it during the coming year. If feasible, we will offer the service to member companies, assuming that this method proves successful.

As you can see, Cummins played a major role in the development of COHA. However, it operates as a cooperative venture. Cooperatively, the same measures could be developed from inception in other areas of the country. I believe they must and will occur.

77 2825

TOTAL ACCIDENT CONTROL PROGRAM

By EDWARD E. WILKINSON
Safety Director, Lukens Steel Co., Coatesville, PA

Industrial safety programs throughout the world are geared primarily to include only those accidents that result in injury in their organized accident reporting systems. Most people don't appreciate that what goes on under the name of accident prevention is actually injury prevention. So-called accident reports are reports on a few accidents resulting in injury to employees.

At Lukens Steel Company we have found through our Total Accident Control Program that investigating and analyzing all accidents further reduces the total number of injuries. Through the years Lukens' management has had a progressive attitude toward accident prevention. In fact, in the January 1974 issue of *Safety and Security for Supervisors,* Lukens Steel Company was recognized for originating the slogan "Safety First" in 1898. In 1915 the first director of safety and welfare was appointed. Since that time, of course, we have all recognized that safety is not first, second, or third, but must be considered an integral part of every facet of the company's all important production quality and delivery programs.

The disabling injury rate was reduced from approximately 90 per million manhours to less than two during the years between 1915 and 1950. During the early 1950's the trend was to initiate a program of investigating all accidents resulting in injury regardless of severity, which was an important step in the right direction.

The first steps were taken to integrate the accident damage element into an all-accident control program at Lukens in 1954 when Frank E. Bird, Jr. began developing the Damage Control Program. Safety personnel were provoking questions by making management aware of the number of damaged machine guards, doorways, stairways, hand rails, etc., that repeatedly appeared on routine plant inspection reports. By 1956 management fully recognized the benefits of employees reporting accidental damage. The property damage element gained importance very soon. In 1959 reporting and recording controls for property damage accidents were considered effective enough to consider the year's experience as a base year for future comparisons. The year-end costs of property damage for 1959 were $750,000.

The frequency and costs of property damage accidents are of related interest at this time. Analysis of 90,000 total accidents included in our Total Accident Control Program revealed that 15,000 involved injuries while 75,000 were exclusively property damage accidents—the ratio of one disabling injury for every 100 minor injuries for every 500 property damage accidents. Most safety people are familiar with the ratio published in 1931 by H. W. Heinrich in his book *Industrial Accident Prevention.* His formula was 1-29-300. He had the right idea, but no one paid attention.

Once it is decided property damage accidents are to be included in the safety program, the proper climate must be established to encourage everyone to report these incidents. Here are examples of broadening accident reporting rules:

1. "Report immediately to your foreman or supervisor any condition or practice you think might cause injury to employees or damage to equipment."

2. "Whenever you or the equipment you operate are involved in any accident that results in personal injury or damage to property, regardless of how minor, you must immediately report it to your foreman. Get first aid promptly in the company dispensary."

Adding "or damage to" makes little change in the sentence structure of the rules, but it can make a significant change in the meaning of the rule.

A program of strict enforcement of damage reporting will eventually strengthen the reporting of all accidents. To accomplish this, it is vitally important to have strong management support. As an example of how this management support can work, during a ten-year study, at least 90 warnings and 30 work supervisions were given crane operators for not reporting property damage. At the same time, 16,425 property damage accidents were voluntarily reported to crane supervision. Most accidents were of a minor nature, but in many cases immediate investigation showed that prompt remedial action was necessary to avert some serious consequences. These benefits would not have been realized if the men had not reported damage. And they reported the damage because they knew management wanted them to. A check of the three-year period prior to the study indicated an average of fewer than 25 reported accidents per year. The significant fact is that no program of enforced reporting existed at that time.

Accidental injury record keeping in modern safety programs depends upon the injury reporting center—dispensary or first aid station. These centers have made accident injury information readily available to safety people. But there has been no similar availability of accidental damage information. This has been one of the roadblocks preventing faster development of all accident control programs. The value of the "property damage repair center" parallels that of the "people repair center" (dispensary).

The method of reporting accidental property damage will vary with the type of damage control the plant desires. If attention is to be focused only on major accidents, little effort is required.

Three basic steps have been used successfully to introduce property damage in the safety program: spot checking; reporting by repair control centers; and auditing.

The emphasis and timing of these steps depends on the receptiveness of key managers and their willingness to follow up on the program. Step one is a simple matter of spot-checking repair centers, making observations, and taking notes. This permits estimates of damage by comparing cost of repair with sample observations. Management attention can be solicited by periodic reference to damage accident frequency and the cost of the item or items checked. Of course great emphasis should be placed on the potential of personal injury. This spot-checking system, without complete cost accounting accuracy, can be a warm-up period for repair center personnel. This period is a valuable time to cultivate necessary relationships. Fault-finding should be avoided during this time. The important value of this first step is that it can prove that a problem exists.

The second step is to set up a system in which the repair control center and key supervisors report property damage. The system should include a minimum of paper work. No one system will work in all plants because repair cost accounting methods vary from plant to plant. Here are methods used to gather damage data:

1. A "Defective—Do Not Use" tag is attached to equipment sent to a shop for repair. This tag tells the repairman what happened and who can provide additional information. The tags serve as a check for the program auditor and can be kept on file for future reference. The foreman on duty where the equipment is damaged or becomes inoperative fills out the tag.

2. Whenever repair work resulting from property damage is requested, the word "accidental" appears as the reason for repair on the service request form. The work order number issued is followed by an identifying "A." This number also appears on all time sheets and stores requisitions.

3. Once each week the safety depart-

ment receives a tabulated cost sheet and repairs for the week. This comes from the company's accounting department.

To keep a reporting system at least 85 per cent effective, it will be necessary to continue daily examinations of each individual work order. Experience enables the safety department auditor to clarify many questions by means of a phone call. Other questionable orders require an investigation by one of the safety advisors.

The human aspects of the safety program must be continually stressed as the prime objective. To minimize the human and humane to the economic factors could hurt the entire effort. But with no personal injury, the costs involved can and should be used to fullest advantage.

The supervisor whose department must pay for the repairs or replacement should be most interested in the investigation and corrective action that follows. Usually one or two word changes are all that are necessary to broaden the present injury-oriented investigation form to include all accident types. In fact, a completely new form may present the typical roadblock that comes with major changes. The success of the program hinges to a great extent on its acceptability to front line supervision. In addition to a standard investigation report form, several companies have designed investigation forms for particular accidents where specific details are useful.

There are numerous ways to obtain cooperation with the investigation phase of the program. One of the most successful is to send the department superintendent a simple "property damage accident notice" that requests proper investigation. The repair center or work order request system serves as the control agency for this notification. A copy of the notice should be retained for compliance and continued follow-up. The investigation of all property damage accidents serves several purposes: (1) makes supervisors more aware of the cost involved in all accidents and their responsibility in controlling them. (2) eliminates the common causes of personal injury and associated accidents. (3) eliminates the judgment determination and speeds up the investigation process. (4) provides a source of valuable data for detailed analysis. (5) assures management of specific remedial action to prevent recurrence of damage.

The manufacturing manager has a great interest in everything that affects his operating costs. He is acutely aware of his responsibility to operate his department at a minimum cost to the company. If the costs are not charged directly against his department, if they do not affect his operating budget, he will let someone else worry about them. The accident cost concept utilized for this study is designated as the ledger cost concept. It involves only those costs that presently appear on the operating manager's ledger. These costs are established and real to operating people.

This concept is concerned with damaged machinery, equipment, material, lost production time, and may or may not be associated with personal injury. It includes only those costs that are acceptable to management because of their importance, easy recognition, and accuracy. Averages, estimates and ratios are not included. When properly used, this method of accident cost accounting includes the long range, repeated costs that are missed completely by other cost concepts. It not only opens new doors to management motivation, but also provides a new source of accident statistics for safety performance comparisons.

When the system for reporting and investigating damage accidents is established, analysis of these accidents is quite simple. The general analysis of costs involved could include a breakdown by: department paying bill, ownership of agency most related, items damaged, agency or act, and comparison of rates. To capitalize fully on economic motivation, the basic analysis should be

expressed in dollars rather than incidents. The cost severity rate technique has proved the most significant and can be expressed as follows:

$$\frac{\text{Total cost of accidents} \times 1{,}000{,}000{,}000}{\text{Total man-hrs of mfg and maintenance}} =$$

Damage costs per million man hours

This method of analysis has the following advantages:

1. Uses the dollar sign to motivate management interest in the damage accident situation.
2. Shows the relationship between the cost severity and the frequency of repetitive accidents which have proved to account for the bulk of damage costs.
3. Facilitates use of the company's established cost accounting system for related maintenance without involved translation.
4. Establishes an experience rate that can be validated directly from the company ledgers which always serve as an existing control.
5. Focuses proper attention on smaller incidents which contribute to a major share of cost.
6. Minimizes the tendency to discourage accident reporting that sometimes prevails when a raw frequency rate is used.

Effective action can result from continuous follow-up by the area safety man with the operating foreman directly responsible. Sometimes the department superintendent, with the safety man as an advisor, may assign specific projects to specialized staff departments. For instance, he may ask the engineering department for a design solution, or solicit the help of Industrial Engineering when the methods or practices are complex.

This is an example that demonstrated these channels of cooperation in the area of remedial engineering. It's another example from the very important materials handling function. In our plant, 30-40 accidents each week, involving overhead cranes, were costing an average of $3,000 weekly. The yellow tag system for identifying the equipment damaged by the cranes indicated that 71 per cent were occurring in one area of the plant. Industrial engineering, operating management, crane supervision, and safety personnel cooperated in planning this study. Observers were obtained and properly trained to observe and analyze the situation on a 24-hour basis for 30 days. Following are some of the facts obtained from an analysis of the 4,886 crane lifts made during the 30-day study:

1. There were 150 accidents with the potential of personal injury and/or property damage.
2. Seven accidents resulted in property damage with no personal injury, for total damage costs of $560.
3. Three operators were involved in 50 per cent of all the accidents, and 11 operators shared involvement in the remaining accidents.
4. Groundmen were following safe job procedures for directing loads less than 33 per cent of the time.
5. Certain handling devices were obviously safer to use than others.
6. Though the observers considered the practices to be generally bad, an actual damage cost comparison of the study period with a previous 30-day experience indicated a 75 per cent reduction of accidents involving damage. This shows a definite relationship between the accident rate and the attention given to operators.

Top management involvement is basic and the most important aspect of any safety program. The success of Luken's program has been highlighted by the fact that executive management's door has been open at all times for direction and assistance on important safety problems and their continual involvement day by day. This fact alone emphasizes Lukens' concern that "all accidents are important."

The study of "near miss" accidents is a valuable source of information for analysis. Every accident provides the safety specialist with the opportunity to

identify situations which could, if not changed or altered, result in future injury or damage. This is based upon the widely accepted theory that the severity of an accident is largely a matter of luck.

Since the injury or damage-producing accident is a rare event compared to the number referred to as "near misses" or "close calls," it makes good sense to be interested in any technique that would clearly identify the relatively high-frequency non-injury or non-damage accidents or situations (near misses). The information obtained can be used as the basis for safety programming designed to remove or control these problems before injury or damage-producing accidents actually occur.

For practical purposes the accident may be defined as "an undesired occurrence that results in personal injury or property damage," and the near miss defined as "an undesired occurrence that, under slightly different circumstances, could have resulted in personal injury or property damage."

There are several excellent reasons why a near miss accident program should become a valuable part of a modern accident control effort: it is a before-the-fact measurement; it has been tested and proven successful; it is a more efficient accident reporting technique; it develops individual pride in performance; it improves supervision and employee morale.

Most of our measures of safety performance have in the past involved the recording of injury or damage accidents rather than a before-the-fact measurement of the problems that create them.

While there is no doubt that the after-the-fact approach produced results in the first half of the century, the fact remains that the existing national plateau of accident injury and damage losses points to the need for a change in technique. The value of before-the-fact safety was recently highlighted to the world as Americans landed on the moon in a space craft whose operation was assured by the efficient application of systems safety. This relatively new aerospace safety discipline was developed within the past decade to predict the possibility of system failures at the design stage of development.

The trend line for our property damage severity rate shows steady improvement. And most important, our all injury frequency rate continues to show steady improvement.

77 2326

Power Press and Forging Sessions

CONTROL RELIABILITY AND BRAKE MONITORING FOR PART REVOLUTION CLUTCH PRESSES

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press brakes

The Occupational Safety and Health Act as revised in the December 3, 1974 *Federal Register* allows "hands in the die" operation with presence-sensing devices, two-hand control device, or type "B" gate device when the press control system includes 1910.217 (b) 13 control reliability and (b) 14 brake system monitoring.

Control Reliability

Control reliability is defined by OSHA as follows: "The control system shall be constructed so that a failure within the system does not prevent the normal stopping action from being applied to the press when required, but does prevent initiation of a successive stroke until failure is corrected. The failure shall be detectable by a simple test or indicated by the control system. This requirement does not apply to those elements of the control system which have no effect on the protection against point of operation injuries."

Press Control System. A typical press control system includes a control panel with its various input and output elements. The control panel includes the starters for the different motors on the press and several control relays for controlling clutch and brake action. The motor control buttons, the mode selection switch, and control buttons for inch and continuous operation of the press can be mounted in the master pushbutton station.

Single stroke operation is usually controlled by the operation of two palm buttons at the operator's station.

The synchronizing of the mechanical motion of the press with its electrical control system depends upon the press driven limit switch.

Pressure switches monitoring clutch and brake air pressure, counter balance air pressure, and sometimes air cushion pressure or lube system pressure prevent operation of controls unless all the various pressure settings are satisfied.

Limit Switch Drive. One of the most vulnerable parts of the system is the limit switch drive. Care must be taken to insure the reliability of this drive. Several methods of accomplishing this are:

1. The double chain drive, a redundant method based upon the principle that two chains will not fail at the same time. A broken chain must be replaced immediately to continue operation of the press with the same degree of reliability.

2. A direct connected drive, usually considered more reliable than a chain drive; however, it does raise mechanical design problems when applied to certain presses.

3. Two separate rotary cam limit switches with separate drives is another method for improving the reliability of the drive. The second switch is wired into the control in such a manner to monitor or check the motion of the first switch. A failure of either drive will stop the press.

4. There are two methods for detecting

chain breakage that I am familiar with. One method consists of a spring loaded idler sprocket that actuates a limit switch when a chain breaks and stops the press. The other method incorporates a limit switch built into a hinged bracket that supports the rotary cam limit switch, and when the chain breaks a spring under the hinged bracket moves the bracket, operating the limit switch, and stops the press.

5. In the past few years another means of protecting the limit switch drive has been the motion detector. A pulse generator is usually built into the rotary cam limit switch or connected to the shaft extension of the limit switch. This pulse generator delivers pulses to an electronic component as long as motion continues. When the pulses stop, indicating a drive failure, a signal from the motion detector unit stops the press.

The common methods of obtaining control reliability are by redundancy and by check circuitry.

Redundancy. Redundancy is one method used to improve control reliability. By doubling up of relay contact, limit switch contacts, relays, or other components, the odds against circuit failure are vastly improved. One simple illustration of redundancy is two contacts of the same relay. The failure of either contact to open will not cause the solenoid to hold in. The odds of two contacts welding closed at the same instance is very remote. Another arrangement consists of doubling up of two relays. If one relay fails to drop out, the circuit still opens and drops out the solenoid. The chance of both relays failing to release at the same time is also very remote. Redundancy does contribute to better control reliability and has been used quite extensively on automotive press control circuits for years.

Check Circuitry. Another method of obtaining control reliability is by the use of checking circuitry. A simple example is incorporated in the double solenoid valves used for clutch and brake controls. The two valves are redundant; however, without a checking arrangement the failure of one valve is not easily detected. If one valve hangs up, the failure of the second valve could cause a malfunction of the press.

When a parallel flow double valve is used, a balanced spool in the valve body monitors the valve operation, and when one valve fails the spool shifts and exhausts the air in the valve and stops the press. The valve must be reset before it can be in operation again.

When a series flow double valve is used, extensions are made on the valve stems which operate limit switch contacts. These contacts are wired into the clutch control circuit in a manner that causes the control to check on the proper functioning of the valves and shut the press down upon failure of either valve. In the clutch control circuitry, one relay contact can be used to check the operation of another relay, or a rotary cam limit switch contact can be used to check the operation of a relay. By a careful selection of relays, relay contacts, and limit switch contacts, a circuit designer can build reliability into the clutch and brake controls.

Presses in many instances, depending on the type of job being performed, are subject to shock and vibration. Those elements of the press control that are mounted directly on the press can be affected by this shock and vibration. It is therefore necessary that components used in a press control system be carefully selected to minimize shutdown time and insure better control relialbility. For this reason it is advisable to use telephone type relays, 300-volt relays, plug-in relays, 120-volt pushbuttons using stab connectors, or stab connectors of any sort. It is also good practice to use MENA 12 construction for control panels, junction boxes, and oil-tight pushbutton elements in the master station and in the operator's station.

Brake Monitoring

OSHA defines a brake monitor as "a sensor designed, constructed, and arranged to monitor the effectiveness of the press braking system."

The stopping time of a press will vary depending upon the following factors: air pressure on the clutch, brake system; counterbalance air pressure; weight of that portion of the die attached to the slide; speed of the press; accumulation of dirt in the exhaust muffler; and condition of the brake lining.

The stopping time will vary from press to press, and it is therefore necessary to measure the stopping time with an instrument that is designed for that purpose. There are several of these instruments on the market which read stopping time in milliseconds on a digital indicator. Taking this stopping time, adding a commonly accepted brake deterioration factor of 20 per cent, and multiplying this by 63 inches per minute will give you a minimum distance for separating the operator's hands from the point of operation.

This separation distance applies to the distance the sensing zone or barrier is located from the point of operation with a presence-sensing device, or the distance the operator's palm buttons are located from the point of operation with a two-hand control, or the distance the gate is located from the point of operation for a type "B" gate device.

A brake monitoring system is required by OSHA to monitor the stopping action and stop the slide motion before the operator's hands can reach the point of operation. There are basically two different methods used to monitor the braking system of a press. The simpler system, which meets the OSHA requirement, is a positioning system. When a crankshaft drifts more than a predetermined distance beyond top dead center (say 20°) the press will stop and cannot be single-stroked again. This indicates the braking system needs maintenance.

Another system is the time measurement system. When a stop signal is given, an electronic counting system starts counting pulses. If the counted pulses exceed a preset number in an electronic timer, the press stops and cannot be single-stroked until the braking system has been repaired. The OSHA regulations call for measurement of the stopping time at the 90° position of the crankshaft on the down stroke.

It is easy to understand that a press control system that meets all the OSHA requirements is getting very sophisticated when compared to many existing press control systems, and is going to cost more. The trouble shooting of control failures of this equipment will require better trained electricians. Just how much control reliability and brake monitoring will contribute to safety is impossible to predict at this time. Possibly, accident statistics in the future will tell the story.

77 2827

SELECTION OF POINT OF OPERATION GUARDS, DEVICES AND FEEDING METHODS FOR PRESSES

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The extent of press pressed parts manufacturing, volume wise, will affect your decisions. Generally, the larger the volume of parts, the more simplified the decisions. For instance, when one press can be set up to run a particular operation over a long period. Choosing the guarding and feeding method for a specific application would appear to be simpler than for a press used for multiple operations. Generally, the smaller the manufacturing operations, the more complicated these selections are because of the greater variety of jobs the same machines are required to do.

Operational Concept

HOOD — hands out of dies.
HID — hands in dies.

Your decision here is which of the e is appropo to your operation, or must you use both. Regulations allow either or both.

In theory, if hands out of dies were possible, press operator accidents would cease. It would .eem, wherever possible, HOOD type operations would be desirable from a humanitarian standpoint even if uneconomical to do so. Statistically, from current OSHA reports, HOOD type operations are accountable for more accidents than HID type operations. There's no doubt in my mind that the reason for this is the undependability of the human element. It appears that telling people to keep out of the danger area is not as safe as utilizing safety devices to keep people safe.

Which of these feeding operations will the machine be required to do?

1. Primary feeding.
2. Secondary feeding.
3. Both — mixed operations.

Primary feeding is generally done by feeding stock, in strip form, into a machine. The machine can be run either in single stroke or continuous.

Secondary feeding may be required after the piece part from the primary operation is made, usually to further shape or size the part, and is generally a part piece that has to be individually handled and fed somehow into the work area.

Manufacturers with many presses generally have presses set aside for primary operations and others for secondary operations. There are many presses that have to be used for both operations. Each operation, primary and secondary, must be guarded. A guarding system for primary operations usually cannot be used for secondary operations, and vice-versa, with the exception of type "A" guarding.

The type of clutch engagement means a machine has affects guarding considerations: (1) full revolution machines; (2) part revolution machines. A full revolution machine, once engaged, will cycle a complete stroke before stopping. The press cannot be stopped or disengaged during the cycle. A part revolution machine has the ability to be disengaged and stopped usually anywhere in the first half of its stroke.

Guarding that may be O.K. for part revolution presses may not work on full revolution machines. When you consider differences in each machine and primary and/or secondary feeding on each, a variety of guarding systems may be necessary.

Single Stroke Capability

Modern full revolution machines usually have single stroking and continuous stroking modes of selection built into their clutch mechanisms. OSHA regulations requires each punch press machine be equipped with single stroke capability. This doesn't say the machine can't be run in the continuous mode, however. For those older machines without the single-stroking feature, it is recommended that the press manufacturer be contacted to update the clutch before attachments are considered that provide single stroking ability to these machines.

Modern part revolution machines usually have this feature built in electrically or pneumatically. There are older machines that were at one time lever operated; however, they do not have this feature. These machines, if sound, should be modernized with new clutch mechanisms; again it is suggested that the manufacturer of the press be consulted first as there are clutch conversion attachment manufacturers.

Stroke Initiation

The type of stroke initiation means will affect safeguarding selection. When using a foot pedal, the operator must be protected against being in the work area during the press cycle. Typical guarding would be pullouts, die enclosures, type "B" or "A" guarding.

The difference between a two-hand trip and a two-hand control device is that a two-hand trip is used on full revolution machines; once started, the press cycles a 360° of rotation without stopping. The two-hand control device is simply a two-hand starting device which has the ability to disengage the machine during the stroke cycle if released, since the part revolution machine can be disengaged during its stroke cycle.

Controls

Switching controls foot to hand and vice versa affects safeguarding requirements. There are many controls suited for primary systems that are not suitable for secondary systems, and the reverse is true also. If the press is set up for primary work, usually a foot trip system with enclosure guarding, and is then switched to a secondary operation where the operator will have access to the work area, he must have guarding that will account for his freedom of access. Usually, a press that is set for secondary work and guarded accordingly cannot be used for primary work. However, a press that is set up for primary work can be used for secondary work unsafely, i.e., a press can be set up with a pullout device and foot or hand trip to do secondary work in a fairly safe manner. However, when a primary operation is put into the machine, pullouts cannot be used nor can two-hand trips. So if the machine is to produce safely, other guarding must be utilized.

Guards, Devices, Guarding

The definitions used in ANSI B11.1 and the *Federal Register* (OSHA) for this purpose are as follows:

"Guarding" refers to all types and kinds of guarding such as stationary guards, movable guards, devices, and controls.

The term "guard" specifically refers to those barriers that enclose a work space physically with or without movable sections. They may use adjustable segments or the like fastened to either the press or die so that they are not easily removable. That is, one must use tools to remove or adjust them.

The term "devices" refers to barriers that can be adjustable, that may move to enclose the work area, that are attached to the press or can control the operator by means such as hand occupying or restricting.

1. *Single Purpose Guarding* is guarding that may be used for primary only or secondary only operations. It is guarding that is not readily interchanged nor,

in most cases, can it be used for both kinds of operations. Examples of primary operations are fixed, movable, or adjustable die enclosures. The operator normally controls the press with a foot pedal operation. For secondary operation, single purpose guarding may be a variety of individual die guards, controls, and devices. For hands out, tools, chutes, shuttle feeds, dial feeds may be used, while for hands in, tools or hand placement may take place.

2. *Combination Guarding* is usually single purpose guarding used for secondary operations. It can take the form of many combinations using foot or hand controls to initiate the press action and, for instance, sweeps (outlawed as of December 1976) pullouts, presence-sensing, or type "B" guarding.

The difference between type "A" and type "B" guarding is as follows: Type "B" guards must close and lock down before the stroke can be initiated. Once the ram goes through its first half cycle, the type "B" barrier opens as the ram raises. Type "B" guards do not protect against a press repeat stroke. Type "A" guarding does not open until the ram is stopped at the top stroke, and offers protection in the event of a repeat cycle.

3. *Multiple Operation Guarding* is guarding that has the ability to be used for both primary and secondary operations. Type "A" devices, foot or hand controlled, is this type of guarding. When using type "A" guarding for secondary operations, small piece parts must be nested or held in position by some means; strippers should be used. Large parts can be held outside the barrier area. For primary operations, the barrier can be held or locked closed; the side barriers are adjusted for primary feeding.

77 2823

POWER PRESS CONSTRUCTION REQUIREMENTS

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Standards

OSHA general industry safety and health standards have specific construction requirements for mechanical power presses, as well as general mechanical and electrical requirements that apply to presses and other industrial equipment. The construction requirements applying specifically to mechanical power presses are listed in part (b) of OSHA Section 1910.217 and are based mainly on the provisions of American National Standard B11.1-1971, Section 3.

Hazards caused by the rotation or movement of flywheels, gears, belts, chains, and other mechanical power transmission apparatus are common to many power driven machines. Section 1910.219 of the OSHA standards, based on ANSI standard B15.1-1953, calls for those hazards to be shielded from employees by protective covers and specifies permissible openings, minimum thicknesses of material, and other pertinent details for the covers. Generally, apparatus located so that any part is seven feet or less above the floor level must be guarded, and flywheel guards and their mounting brackets must have sufficient strength to hold the weight of the flywheel in case of shaft breakage.

Paragraph (b) of OSHA Section 1910.212, entitled "General Requirements for All Machines," states that machines designed for a fixed location shall be securely anchored to prevent walking or moving. Most presses are designed for a fixed location, although some, particularly in automotive stamping plants, are intended to be portable. This section of the OSHA standards is a carryover from the Walsh-Healey regulations of 1969.

In addition to the electrical requirements of OSHA Section 1910.217 (b) pertaining to presses, all electrical installations and repairs made after March 15, 1972 must comply with OSHA Sections 1910.308 and 1910.309. Section 1910.308 adopted the National Electrical Code of 1971, known as NFPA 70-1971 and ANSI C1-1971, by reference, but with a different definition of the word "approved." The National Electrical Code defines "approved" as "acceptable to the authority enforcing this code." This is generally a state or local electrical inspector. OSHA defines "approved" as "acceptable to OSHA" and goes on to generally require all equipment to be listed, labeled, accepted, or certified by a nationally recognized testing laboratory such as UL in order to be acceptable to OSHA.

On the March 15, 1972 effective date, however, practically no press control assemblies or other electrical equipment for presses, except for a few standard items such as motor starters and relays, had UL approval. It is now possible to obtain controls with UL approval, but this condition has existed for only about two years.

There is no OSHA or ANSI requirement that electrical or pneumatic equipment comply with JIC standards. This is up to individual purchasers, press builders, and control manufacturers, the same as compliance with various corporate standards.

The construction standards in OSHA Section 1910.217 and ANSI B11.1 apply to all types and sizes of mechanical power presses, whether floor mounted or bench mounted, but do not apply to similar machines such as hydraulic and pneumatic presses, press brakes, shears,

iron workers, cold headers, forging machinery, bulldozers, welding presses, high energy rate presses, riveting machines, fastener applicators, eyeletting machines, nibblers, and platen presses. Most of the machines just listed have their own ANSI standard or have an ANSI standard in the process of being completed. Forging machinery, including hot trim presses, is covered by ANSI Standard B24.1 and by Section 1910.218 of the OSHA standards. Cold trim presses come under the mechanical power press Section 1910.217, and since the same press can be used for either hot or cold trimming, it is recommended that all trim presses by brought into compliance with 1910.217.

Types of Presses

Mechanical power presses are usually classified by their type of frame construction, the basic types being straight side, with rectangular uprights on each side of the slide and bolster, and gap frame, with a C-shaped body that provides an open space on each side of the slide and bolster. The most common type of gap frame press is the open back inclinable, or OBI, with the frame mounted on a cradle-like base with legs that permit the frame to be inclined backward to permit the loading and removal of workpieces by gravity.

Construction standards do not vary according to frame type, however; requirements are determined by the type of clutch and by the modes of operation for which the press is intended. Two types of clutches are used on mechanical power presses. They are referred to as "full revolution" and "part revolution" because of their characteristics, which are quite dissimilar and which produce different press operating characteristics. Because of this, point of operation safeguarding methods as well as construction requirements are different for the two types of clutches.

Full Revolution Clutches. A full revolution clutch, when tripped, cannot be disengaged until the crankshaft or other drive mechanism has completed a full revolution and the slide has made a full stroke. The foot pedal or other tripping arrangement generally releases spring pressure to bring together clutch engaging members which by design must complete a full revolution before they can be disengaged, normally by a throwout cam arrangement, which is part of the clutch mechanism. Pins, blocks, keys, or multiple jaws are commonly used as engaging members. These clutches are sometimes referred to as positive clutches because there is positive engagement. Not all positive clutches are full revolution, however, as a few multiple jaw clutches can be disengaged during a stroke.

Part Revolution Clutches. A part revolution clutch can be disengaged at any point during the revolution of the crankshaft or other driving mechanism and at any time before or after the slide has completed a full stroke. Most part revolution clutches have friction discs that are engaged by air pressure acting against springs that disengage the discs when air is shut off and exhausted. An electrically operated, normally closed, three-way magnetic air valve is used to control the flow of air into and out of the air cylinder or diaphragm that actuates the clutch. Some part revolution clutches have hydraulically actuated friction surfaces. Others have no friction surfaces and use electrical eddy currents for coupling the driving and driven members. Some early designs of friction clutches were actuated by manual levers or by direct current magnets.

Direct Drive. A small percentage of large straight side presses have direct drive instead of a flywheel and clutch. Slide motion is obtained by energizing a special design of motor, and operational characteristics in production match those of part revolution clutches because the driving power can be disengaged at any point during the stroke. Construction and safeguarding requirements for direct drive presses are the same as for presses with part revolution clutches.

Construction Responsibility

New installations of presses, and this includes old presses moved to new locations, have been required by OSHA to comply with the construction standards in section 1910.217 (b) since August 31, 1971, except for the control reliability and brake monitoring paragraphs (b) (13) and (14), which have a compliance date of November 1, 1975, and are necessary only if operators place hands in dies when inserting or removing work. It is the responsibility of any reconstructor or modifier of power presses to do so in accordance with OSHA section 1910.217(b). Overall responsibility for all installations in a plant rests upon the employer.

When checking for compliance with regulations it is helpful to use the ANSI B11.1-1971 booklet, because it has helpful explanatory paragraphs not found in the corresponding OSHA standards. Some of the construction provisions that are not always completely understood are as follows:

Brakes. Every mechanical press must have a brake capable of stopping slide motion quickly when the clutch is disengaged. The brake must also be able to hold the slide and upper die in place at any point in the stroke and be inherently self engaging, requiring power or force from an external source, such as an air cylinder, to cause disengagement. Most presses with full revolution clutches have constant drag band or shoe type brakes, while most presses with part revolution clutches have disc or shoe brakes that are air-released when the clutch is engaged. Compression springs are used for applying proper braking torque. On many presses with full revolution clutches, this spring pressure is adjustable by means by a knurled knob. Supervision should make sure that all brakes are kept in proper adjustment to assure quick stopping.

Under certain circumstances, OSHA now requires monitoring of the brake system after each stroke of presses with part revolution clutches, to detect any deterioration.

Inherent hazards. In addition to mechanical power transmission hazards covered by OSHA Section 1910.219, there are possible hazards from broken or falling parts. Breakage of shafts may cause motor pulleys, flywheels, gears, etc., to fall, and the loosening or breaking of mounting bolts may result in the falling of motors, protective covers, or other stationary parts. Paragraph (b) (1) of OSHA Section 1910.217 and paragraph 3.2.3 of B11.1-1971 require that such parts or assemblies be designed, secured, or covered to minimize these hazards, as well as the release of mechanical energy from such things as broken springs. Possible pinch points between the slide and components such as feeding mechanisms and point of operation guards should be avoided or covered.

Point of operation hazards are an entirely different problem and do not come under construction requirements. Safeguarding the point of operation is covered by part (c) of OSHA Section 1910.217 and Section 5 of B11.1-1971. When two-hand control or two-hand trip is used for safeguarding, the control system must comply with both the construction requirements and the safeguarding requirements of the standard.

Full Revolution Clutch Presses

Single Stroke Capability. Present standards require that all presses with a full revolution clutch incorporate a single-stroke mechanism to prevent an unintended second stroke if the foot pedal or other stroking control means is not released before the completion of a stroke. Many older presses did not have a single stroke mechanism because early versions of the B11.1 code required it only when certain devices not directly connected to the slide, such as two-hand trip or some types of gates, were used for safeguarding.

The most effective type of single stroke mechanism is built into the clutch, but single stroke capability can also be

provided by separate mechanical attachments or by the antirepeat feature of an electrical or pneumatic tripping system.

Full revolution clutch presses can be operated in the continuous mode by disabling the single stroke mechanism in various ways. It is expected that the next revision of B11.1 will not require a single stroke mechanism on presses designed specifically for and used only in the continuous mode. Any machine used in a single stroke operation, however, must have single stroke capability and be operated in the single stroke mode for that operation.

If the single stroke mechanism is dependent upon spring action, the spring(s) must be of the compression type, operating on a rod or guided within a hole or tube, and designed to prevent interleaving in case of breakage.

Foot Pedals. When a mechanical foot pedal is used on a full revolution clutch press, the pedal must have a firmly attached pad with a non-slip contact area. At least eight square inches is recommended for the pad. The pedal return spring must be of the compression type with the same type of design and mounting features as springs in single stroke mechanisms.

The pedal must be covered or otherwise protected to prevent unintended operation by falling or moving objects such as tools, trucks, and crane hooks, or by accidental stepping onto the pedal. Since many older presses did not have a pedal cover, it may be necessary to add one to shroud the top and sides of each pedal. If an electrical or pneumatic foot control is used, it should also have the top and sides of the pedal covered.

Two-Hand Trip. If two-hand trip of any type is installed, the system must: (1) have each button protected by guard rings or other means against unintentional operation; (2) have the buttons mounted so that use of both hands is required; (3) require concurrent actuation of both buttons; and (4) incorporate an antirepeat feature to limit the slide to a single stroke if either or both buttons are held in the actuated position. To initiate another stroke, both buttons must first be released.

If two-hand trip is used on a multiple operator press, each operator must have a separate set of controls.

If a two-hand trip is used for safeguarding the point of operation, each button must be located at a safe distance from the dies so that the operator cannot reach into the point of operation prior to die closure. A formula for this safety distance is given in OSHA 1910.217 (c) (3) (viii) (c) and is based on press speed and the number of clutch engaging points. Two-hand trip is usually not practical if speed is less than 120 SPM or if the clutch has only one or two engaging points, because the required safety distance could result in the buttons being several feet away from the press.

Part Revolution Clutch Presses

Stroking Selector. The control for part revolution clutch presses must have a means for selecting Off, Inch, and Single Stroke modes of operation, as well as Continuous if the press is intended to operate in the continuous mode. Fixing of selection must be by a means capable of supervision by the employer. A key lock is generally used for this.

Since 1971 all press builders have been using a stroking selector switch arrangement of Off, Inch, Single Stroke, and Continuous (when supplied) as the switch is turned clockwise. While not mandatory, this arrangement is recommended in B11.1-1971 for standardization purposes.

There have been accidents caused by inadvertent turning of the stroking selector to the Continuous position when Single Stroke operation was wanted, or because an operator on a new shift did not know that the controls were set for Continuous operation. When this happens, there is no "holding time" during die closure and the press does not

stop at the end of the stroke. To prevent such accidents in the future, controls on presses with both single stroke and continuous functions must now be arranged so that (1) completion of the continuous circuit may be supervised, and (2) the initiation of continuous run must require a different prior action or decision by the operator in addition to turning the stroking selector before actuation of the operating means will result in continuous stroking. Three of the possible arrangements are outlined in explanatory paragraphs of the B11.1 Standard.

Single Stroke Two-Hand Control. When a part revolution clutch press has two hand control for single stroke, the system must:

1. Have all the features, including antirepeat and two protected buttons requiring use of both hands, called for in a two-hand trip system.

2. Have holding time requiring the concurrent pressure from both hands during the die closing portion of the stroke. This is obtained by proper adjustment of the rotary cam limit switch so that any release of a run button prior to die closing will stop slide motion.

3. In addition, any control installed after August 30, 1971 must have interrupted stroke protection, requiring release of all buttons before an interrupted stroke can be resumed. Regardless of installation date, however, the control must have interrupted stroke protection if a hand is placed in the dies for loading or removing parts.

Because electrical controls utilizing a pair of run buttons for each operator is the most common type of clutch control on presses with part revolution clutches, the term "run buttons" is used to describe the operating controls, although it is possible for such controls to be pneumatic, fluidic, or mechanical. If so, equivalent features are required.

If two-hand control is used on a multiple operator press, each operator or helper exposed to point of operation hazards must have a separate set of run buttons. The clutch control systems for such presses must provide for activating and deactivating the run buttons in each operating station in complete sets. Locking out individual buttons is not permitted. The bypassing of stations not needed for particular operations must be done by a means capable of supervision. Operating station plug and receptacle arrangements with "dummy plugs" for by-passing, or lockable selector switches are used to meet this requirement. The control system for such presses must also be designed with so-called "dummy plug protection" to prevent actuation of the clutch if all operating stations are bypassed.

If two-hand control is used for safeguarding the point of operation, each button must be located at a safe distance from the dies so an operator cannot release a button and reach into the die area before the slide motion stops. A formula for this safety distance (different than for two-hand trip) is given in OSHA Section 1910.217 (c)(3)(vii)(c) and is based on stopping time of the slide at approximately the 90 degree position of crankshaft rotation. This is normally at the mid-point of the downstroke where slide speed is greatest.

The safety distance must be greater than the slide stopping time in seconds multiplied by a possible hand speed of 63" per second. For example, if the stopping time is 250 milliseconds, or one-fourth of a second, the minimum distance would be ¼ x 63, or 15¾ inches. To allow for increased stopping time due to wear and heating of brake linings, differences in upper die weights, variations in air pressure, and dirt accumulation in the air valve muffler, I recommend increasing the calculated distance by 50 per cent, and would use a minimum safety distance of 24 inches for the above example.

After the safety distance has been determined, the buttons must be fixed in position so that only a supervisor or safety engineer is capable of relocating them. This means the operating stations

must be bolted in place or arranged in some manner so the distance cannot be decreased by an operator.

Where an operator places one or both hands in the point of operation when inserting or removing work, and two-hand control, presence-sensing, or a type B gate is used for safeguarding, there are additional control reliability requirements called for in paragraph (b) (13) of OSHA Section 1910.217.

Clutch/Brake Air Valve

Because a single air valve can fail to properly shut off incoming air and quickly exhaust clutch and brake air for stopping slide motion, OSHA requires that all clutch/brake valves installed on new or old air-clutch presses after August 30, 1971 be designed to prevent a significant increase in the normal stopping time in case of a failure, and to inhibit further operation if such failure does occur. A self-checking double valve is commonly used to provide this protection. The requirement does not apply to machines intended only for continuous, automatic feeding applications.

If one or both hands are placed in the point of operation for inserting or removing work, however, the exception for valves installed prior to August 31, 1971 does not apply and all valves on single stroked air clutch presses must be of the double, self-checking type regardless of when the press or the valve was installed.

If a press has a separate clutch and brake system requiring individual valves connected to a common manifold, both valves should be of the self-checking, double type. Failure of a brake valve is just as dangerous as a faulty clutch valve, and sometimes is even more apt to cause an accident.

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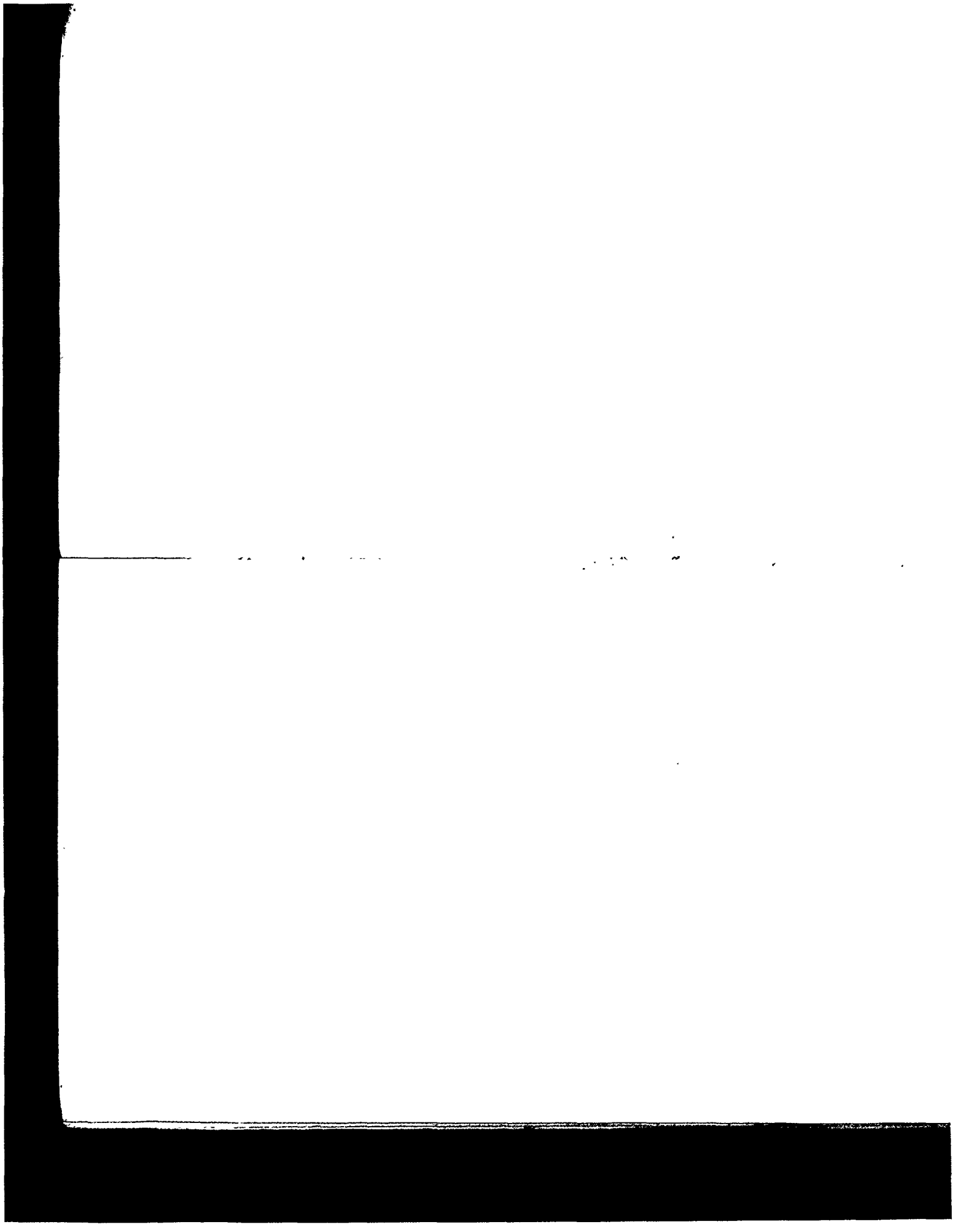

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