FILE NAME: Lone Star Industries (LS)

DATE: 1970

DOC#: LS006

DOCUMENT DESCRIPTION: Transactions of the National Safety Council - Cement, Quarry and Mineral Aggregates

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1970

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AUDIOMETRIC TESTING

By MARVIN ENGELBERG
Chief, Audiology and Speech Pathology, Veterans Administration Hospital, Cleveland, Ohio

Proof of the effectiveness of a hearing conservation program resides solely in the results of employee hearing tests. In spite of this importance and that these results must be proven valid in a court of law, hearing testing remains one of the least controlled parts of a conservation program. Let's take a look at how we measure hearing, the necessary equipment, some of the pitfalls, and the effects of excessive noise on hearing.

There are six criteria, all of which must be satisfied and coordinated as a unit to have an effective hearing evaluation program:

Environment

Quietness. There must be sufficient quietness for external noises to not interfere with the employee's perception of the test sounds. This requires a special sound-treated enclosure situated in an area away from noise. Standards for maximum allowable noise levels have been established by the American National Standards Institute. Noise levels are assessed by sound level meter with octave band filter.

Controlled atmospheric conditions. The hearing testing area must have controlled heat, ventilation, and cleanliness of air so as to keep the employee alert and comfortable during the testing.

Equipment

Sound-treated room. We have already mentioned the importance of this. Seldom is a factory room quiet enough. A commercially constructed enclosure is almost invariably a necessity.

Audiometer. An audiometer is an electronic instrument which allows the determination of the least amount of sound pressure needed to just hear sounds of specific frequencies. In industry, the frequencies used are 500, 1,000, 2,000, 3,000, 4,000 and 6,000 cps or Hz. There are two types of audiometers: self-recording and manual.

With the self-recording audiometer, the employee presses and holds a button for as long as he hears the test sound. He releases the button when he no longer hears the sound. Pressing the button attenuates the sound pressure, while releasing it causes the sound pressure to increase. By a separate circuit, the audiometer automatically changes from one test frequency to another. The advantages of an automatic audiometer are: it permanently records the actual responses of the employee; it is quick in that it takes only six minutes to test both ears; it does not require as skilled a technician to administer the test as for a manual audiometer. The disadvantages are: it is sometimes difficult to determine the actual threshold of a test sound because the audiogram consists of a series of peaks and valleys as responses and not a straight line; approximately 10 per cent of the employees are unable to follow instructions sufficiently for the proper administration of the test.

With the manual audiometer, a technician sets the controls to present a sound of specific sound pressure level and frequency characteristics. The employee raises his hand when he hears the sound and lowers it when he does not hear the sound. The technician varies the sound pressure until the threshold is obtained. The advantages are: it is easier for the employee to understand the instructions; it gives precise threshold levels. The disadvantages are: it takes longer to administer, frequently 15 or more minutes; it requires a more skilled technician; the actual responses of the patient are not recorded.

Calibration Equipment. The audiometer and sound-treated room must be checked for satisfactory operation. Sound-pressure measuring and frequency counter instrumentation are required.

Calibration Procedures

The equipment must receive both gross and fine calibration checks to insure its proper operation. A defective audiometer or sound-treated room is worse than none at all because each can give you a false sense of security.

A gross check of the audiometer and sound-treated room must be made daily by the technician. She checks the audiometer by obtaining her thresholds and comparing them

with her known thresholds. If they agree, she then concludes that the audiometer is operating effectively. For the sound-treated room, she checks the seals on the door and the joints for sound leaks.

The fine calibration checks are performed electronically approximately every three months. These are performed by a more skilled person. Records must be kept of both the gross and fine checks and filed for possible future use.

Audiometric Technician

This is the person who administers the test and makes gross calibration checks. This person must be trained to give specific instructions to the employees, to obtain case histories in an unbiased manner, to place earphones correctly on the head, to understand the audiometer sufficiently not only to operate it but to recognize breakdowns, and to spot possible unreliable behavior of the employee.

The technician must be compulsive so as to not deviate from instructions to the employees, to check and record daily the performance of the audiometer and the sound-treated room, and to record the employees' hearing results correctly. In order to keep her interested, and thereby effective, she must be made an integral part of the conservation team.

Audiologist

The audiologist is a specialist in hearing. He trains the technician and checks on her performance. He reads the audiograms for hearing levels, reliability of responses, and possible recommendations.

Audiometric hearing levels must be read very carefully, especially on the self-recording audiometer. There are many variables associated with audiogram reading, and they can be very costly if overlooked.

There are many reasons why an employee's responses may be unreliable: (a) on the pre-employment hearing test, the applicant may be trying to hide a pre-existing hearing loss; (b) on the monitoring tests, the employee may attempt to exaggerate an existing loss or give indication of a loss where none exists; (c) the employee may not have understood the instructions, so is not responding correctly; and (d) the employee may not be alert enough to give reliable responses for such reasons as lack of rest, emotional problems, drugs, alcohol, and so forth. Unreliable hearing responses are indicated by the pattern of the audiogram, test-retest variability, extent and patterns of peaks and valleys on the self-recording audiometer, and the employee's overall behavior.

The recommendations may consist of a request for a more comprehensive audiological evaluation, referral to the plant physician for medical study, or for more frequent testing. In a hearing conservation program with adequate staffing, the problem cases are discussed with the staff otologist. A hearing loss is indicative of an injury to the ear, which is a medical responsibility.

The audiologist electronically checks the calibration of the audiometer and the adequacy of the sound-treated room. He is a troubleshooter for any part of the testing program.

Forms—Their Usage and Disposal

The audiogram on each employee must be in sufficient copies to satisfy all interested parties. Thus, special forms must be developed so as to obtain copies at the time of the hearing test with a minimum expenditure of additional time and possible copying errors.

An effective and concise case history form must be developed. It should stress past noise exposure, ear disease and hearing change prior to the first test, and all such changes since the last hearing test.

There must be a system of filing whereby the employer can quickly and accurately evaluate present and past hearing results for changes in hearing on each employee.

There are primarily two effects of noise on hearing: communication interference and hearing loss.

Communication Interference

Noise can interfere with the employee's perception of important communication during work, thereby increasing his chances of performing his work unsatisfactorily and/or of being injured on the job. The employee thus becomes a liability instead of an asset.

Hearing Loss

Hearing test results in industry are shown by an audiogram, a graph which plots sound pressure versus frequency. The graph depicts thresholds of specific test frequencies.

The first effects of an over-exposure to noise are tinnitus (ringing in the ears) and/

or a temporary threshold shift (TTS), i.e., a temporary hearing loss. Both are in the high frequencies, from 3,000 to 6,000 Hz. The hearing will usually recover and the tinnitus will subside, but the hearing should not be tested for at least 16 to 18 hours after the last noise exposure. As the noise exposure increases and the ear becomes permanently impaired, the temporary threshold shift (TTS) becomes a permanent threshold shift (PTS), i.e., a permanent hearing loss. What actually happens is that there is only partial recovery from the TTS. The tinnitus usually also becomes permanent. This PTS, if allowed to increase, spreads to include adjacent frequencies.

TTS is closely related to PTS. Some current knowledge of these two phenomenon are as follows:

a. If a noise produces no TTS, it will not produce a PTS.

b. Noise whose maximum energy is in the low frequencies will produce less TTS than those in the higher frequencies. In other words, a rumble is less hazardous than a screech. The *A* rating scale on the sound level meter was selected for assessing the hazard of noise because it attenuates the influence of the low frequencies.

c. For equal noises, intermittent exposure is less hazardous than continuous exposure.

d. When ears are exposed to noises of less than 80 db *A*, there is no hazard regardless of length of exposure. Levels of 80 db *A* and above are hazardous. Thus, the Walsh-Healey regulation of 90 db *A* assumes some employees will have TTS and, most likely, PTS.

e. The growth of TTS is on a logarithmic scale, meaning that a major portion of the shift is within the first part of the exposure period. Recovery is rapid during the first part of the post-exposure period. This is the reason that test results are reliable after only 16 to 18 hours post-exposure.

f. PTS and TTS are not so closely related that we can reliably predict PTS from TTS.

g. The extent of TTS and PTS is contaminated by the aging process, individual differences, and exposure to noise and ear injury away from the job.

h. PTS has not been shown to be of a progressive nature.

i. Evidence is not conclusive as to whether a PTS ear is more susceptible to further PTS than is a normal ear.

j. PTS is an indication of inner ear damage which produces a loss in the understanding of speech. This loss in understanding is relatively independent of the loudness of the speech. The person with this type of loss says, "Don't yell at me, just talk plainer." The more unwanted sounds present in the listening environment of this deafened person, the more difficulty he or she has in understanding speech. A hearing aid is usually of little or no benefit because it amplifies only. Unfortunately, we do not know how to make speech more understandable with this type of hearing loss.

In conclusion, those people who are both deaf and blind state that, if they had the choice, they would prefer their hearing to their sight. Let's preserve the hearing we have!

'71 '750

NAME OF THE GAME

By M. THOMAS SUMMAR, M.D.
Dir., Otology, Hearing Conservation, Inc., Virginia, Minn.

There is a need for preventing noise induced hearing loss for humanitarian as well as legal reasons. Industry is aware of these factors but several areas of concern still exist. The largest question, "Can noise induced hearing loss be prevented over the years?" had not been answered until recently.

Industry has had some concerns in attempting to work with the noise situation. Two of the most common questions have been: first, if a program is started, will this result in a flood of compensation claims? In the past, this has not occurred, provided the program is complete, valid, open, and above board.

The second often repeated concern is that the company has had no claims so "let's not rock the boat" by admitting that we do have a noise problem. Unfortunately, when

claims are filed, it is usually several years too late to have prevented the hearing change.

When a company is deciding to establish a hearing conservation program, two areas are of interest relating to risk. First, what is the risk on hiring an employee? Second, what is the risk if nothing is done to protect the worker?

In order to provide some information on the risk of hiring a new worker, Hearing Conservation, Inc. (HCI) completed a study in which approximately 800 consecutive pre-placement examinations were evaluated. All tests were done in an environment which meets present standards; audiometers were in proper calibration; technicians properly trained; and the tests evaluated carefully.

If the study is taken as a whole without regard for age or previous exposure, 3.1 per cent of this population had hearing impairment when they walked through the door of 15 dB or more, ASA, average at the three speech frequencies. (The American Medical Association method to compute impairment uses the average of 15 dB ASA for beginning impairment at the three speech frequencies of 500, 1,000, and 2,000 Hz.) In the 32-38 year age group, 25 per cent (or one in four) had an average of 15 dB or more. Almost all had had previous military and/or industrial noise exposure.

Due to the difficulty in obtaining skilled experienced workers, this becomes extremely important. So as not to be misunderstood, there is no medical reason why these men cannot work in noise at their regular job in which they have experience. Certainly industry would like to have their services. The pre-placement examination of the worker should not be used as hiring criteria. Added emphasis must be placed on the educational phase for these workers and shorter interval monitoring hearing tests instituted. These workers can be protected.

What is the possibility of noise induced hearing loss occurring if nothing is done to protect the worker during his work life? What are the risk?probabilities? Communication with Dr. Aram Glorig indicates data are available revealing significant probabilities.

Frequencies of 500, 1,000, 2,000 Hz, ASA 1951, with an average of 15 dB hearing threshold level as the low fence for impairment, eight hours daily exposure, and years of exposure beginning at 18 years of age are again used as the basis. The permitted level of 90 dB*A* in the Walsh-Healey act, eight hours daily, reveals that after twenty years (age 38) the risk is that 15.5 per cent will have hearing impairment. Exposure of the group to the level of 110 dB*A* reveal the risk probability is that 77.5 per cent will have hearing impairment after twenty years. It should be pointed out that these data do not indicate the extent of hearing threshold change in the individuals.

What, then, is "The Name of the Game?" Is it how many ear protective devices are passed out and/or worn under mandatory provision? What good are they to the worker and company if the man loses his hearing ability?

Is it how many hearing tests are done? What good are they if the tests are of little value because the validity of results is poor?

The Walsh-Healey Act now provides some interesting rules of the game. First, noise will be controlled by engineering methods where possible. By the very nature and complexities of the problem of acoustics, it will take years and much money to accomplish this due to the necessary changes in production techniques, equipment, and buildings. Marked acceleration in this area is needed now if this is ever to be accomplished.

Second, control will be by administrative means. This is a financial impossibility in most industries when it is remembered that exposure to 100 dB*A* requires working time of two hours or less only, and higher noise levels allow even less exposure time.

The real name of the game is succinctly stated in paragraph (d): "In all cases where the sound levels exceed the values shown herein, a continuing effective hearing conservation program shall be administered." Before you, as management, say, "We are not covered by the Walsh-Healey Act," I remind you that discussions of impending new Federal and state regulations will embody some or all of these criteria.

What is an effective hearing conservation program? It is one which provides proof of the prevention of noise induced hearing loss in a significant number of workers in known noise environment over the years. This implies that every part of the program meets present prescribed standards and is valid in all respects. If we can show that the program is effective, the legal aspects will take

care of themselves because there is a decrease in potential liability to the company.

The what, why, when, and how of a controlled valid hearing conservation program have been discussed and the literature is filled with the word on the subject. However, there is a lack of evidence of whether hearing conservation related to noise exposure can be accomplished. Can the criteria for effectiveness be met? They must be, can be, and are being met.

Our fire program began in 1956. Since then over 10,000 workers have been added in programs in various types of industry using the same methodology. We have followed the requirements for control, coordination, and validity noted previously in this series.

Our experience indicates that several points be emphasized. These are:

1. A team of experienced individuals is necessary due to the numerous complexities of the problem.

2. The human nature of the worker's attitude about the production of noise induced hearing loss require the expenditure of much time and energy over the years to accomplish the end result.

3. The "proof of the pudding" of effectiveness lies in valid monitoring audiometric tests with the background data controlled and accessary information known.

The need for and the lecture material which is included in a worker education program has been discussed. But how it is done is a different matter. Many conditions, often not realized by those providing the education, are present and must be given attention both prior to and during educational sessions. The problems one finds are:

1. Sessions are usually the hour before or after a work shift, and the worker doesn't want to spend any more than eight hours at the plant whether he is paid or not.

2. After the workshift the employee is tired, and the majority have temporary threshold shift which makes discussion difficult.

3. Antagonistic attitudes lead to questions as, "What is the company making us do now?" or, "Will I be fired from my job over this?"

4. The workers may think, "We've told the company for years that it is noisy and they have done nothing about it."

To combat these and many other undercurrents, a lead time prior to start of sessions is necessary. During this time, discussions should be held between management, union, and workers on what will be coming. Foremen and other supervisors must emphasize the program.

To stand before a group of fifty men who are tired after working eight hours and often dirty because time did not allow cleaning up, and who want to get home, is a remarkable experience. A real potpourri exists when you add varying ages, education, ethnic backgrounds, jobs, and degrees of hearing loss. After four to eight sessions per day, one realizes the evangelism required to accomplish the task.

To gain the desired result, one must identify with the worker and they with him. Yet the educator must have stature of authority and experience. "Tell it like it is," and many areas in the future will not become problems. The workers must understand the whole problem of noise induced hearing loss, be m de a part of the solution, to make wearing ear protective devices effective.

In our programs, these educational sessions have been led by the author, aided by plant physicians and other personnel. After twelve years of working with the system approach and repeated education, approximately 70 per cent of the workers continuously exposed to hazardous noise are voluntarily wearing ear protective devices.

Are the entire programs meeting the criteria for effectiveness? Are those workers who have been convinced to wear ear protective devices using them effectively so that hearing loss is prevented? Adequate hearing acuity at 500, 1,000, and 2,000 Hz is considered necessary for hearing the spoken voice. Noise induced hearing loss usually shows the first permanent change at 4,000 Hz. A recent study of a large group of workers in our hearing conservation programs was completed. Workers selected had hearing threshold levels within normal limits when hired and had yearly hearing tests which met criteria for validity. They worked in noise levels of 10-100 dB*A* (generally flat octave band levels) with exposure to 105 dB*A* occasionally. Two age groups, 20-29 and 40-49, were studied.

A good method of evaluating hearing change is to compare a man with himself over a period of time. Thus, the net change

at each frequency is obtained. In our study, the tenth year hearing threshold level was compared with the pre-placement level and the net threshold change determined.

In the exposed group wearing ear protection only, two per cent or less had significant change at either 2,000 or 4,000 Hz. However, the exposed group without ear protection revealed that 55 per cent had significant shift at 4,000 Hz, and 46 per cent at 2,000 Hz.

Of equal importance is the fact that the group not exposed to hazardous noise levels compared with the continuously exposed group with protection revealed no statistical difference.

These data reveal that these programs meet the criteria of effectiveness. The prevention of noise induced hearing loss can be accomplished by these methods. The employee has the opportunity to preserve his heritage—the ability to hear and communicate—not damaged by industrial noise exposure. The employer benefits by knowing he has helped his employees and, coincidentally, his long range liability position.

SAFETY SPECIFICATIONS FOR NEW MOBILE EQUIPMENT

71 751

By DAVID E. VISNAW
Loss Control Systems, Inc., Madison, Wis.

Each year it becomes more important that particular emphasis be given to the safety equipment and devices which are installed on the various types of mobile equipment found in industry today. This importance is due not only to humanitarian considerations but is to a large degree caused by the increased emphasis on various forms of liability. Here we will discuss briefly the various types of devices available for mobile equipment as well as the liability implications of their absence.

First, I should point out that I corresponded with twelve manufacturers of mobile equipment in an effort to solicit their ideas on the subject. I received a reply from only one manufacturer, and that reply was to the effect that they did not feel they could be of assistance. This is a most regrettable attitude on the part of an otherwise responsible major industry.

There can be no firm outline of the responsibility of the purchasing agent in regard to the specifications for safety devices on an individual piece of mobile equipment. A major determining factor must be the size of the company in question and the makeup of the staff. It can be stated, however, that the purchasing agent should coordinate most closely with the engineering department and the safety director.

The safety director should be the best judge of the types of protective equipment which must be provided and the potential hazards which must be guarded against, but the engineer should be the best authority on necessary specifications for that equipment. It is therefore important that both these agencies be drawn very closely into the purchasing procedures. In the final analysis, however, the purchasing agent must be considered the "project director" for the purchase, and the responsibility for a complete and comprehensive purchase order must rest on his shoulders. I realize this may be considered somewhat arbitrary in nature, but it represents my thinking.

Because of the breadth of scope of the subject of safety equipment and devices for mobile equipment, it will be difficult to do much more than generalize on the topic but it should be possible to highlight the most common and important considerations:

All mobile equipment, both in-plant and over-the-road, should be equipped with heavy-duty seat belts. This applies to such vehicles as front loaders, forklifts, and the Bobcat type of equipment.

Broad-area rear view mirrors will prevent many accidents. Ideally, a band of vision as broad as 160 degrees should be available from a combination of mirrors. This is particularly important for in-plant vehicles where they frequently operate in close quarters.

Every vehicle must be equipped with a foam or dry powder BC extinguisher. In most cases, a 2½ pound extinguisher is suffi-

cient but the industrial code of your state should be checked, particularly for over-the-road vehicles. The type of material to be carried by the vehicle can affect the size and number of extinguishers; for example, a truck to be used for the transport of explosive material.

There is another consideration when selecting the capacity of the extinguisher. There is an advantage to the installation of a ten-pound extinguisher on all in-plant vehicles. This allows every forklift, front loader, etc. to be, in effect, a piece of mobile fire-fighting equipment, and this could be very important at some time.

A roof-top flasher is frequently an important and valuable piece of equipment. It should be especially considered for slow moving vehicles such as road sweepers and snow removal equipment which have occasion to use public roads during periods of restricted vision. It may also be considered for fast moving equipment in built-up areas as a protection for pedestrians. For example, I was with a company that employed a flasher on its Euclid earth mover which was used to move clinker in the immediate plant area. A note of caution: it has been reported that drivers have sometimes been temporarily blinded when following too closely a vehicle using the strobe type flasher.

All open-cab vehicles should have a canopy or roll bars. Continually increasing emphasis is being placed on this feature. Again, you should check the industrial code of your individual state, since several states have extremely stringent requirements regarding the construction and strength of the canopy. A rule of thumb is that the canopy should be able to withstand a weight equal to 2½ times the weight of the vehicle on which it is mounted. As an aside, I would strongly urge that, regardless of whether you have a company policy regarding hard hats, all equipment operators wear head protection. There have been serious injuries when an operator's head has forcibly struck the canopy.

A deflector shield, in conjunction with the canopy, should be used on all forms of lifting equipment to protect the operator from material falling back on to him. This is particularly important with front-end loading equipment. I once observed the operator of a front loader cleaning a spill from the raw end of a wet-process cement plant. His bucket was filled to its utmost capacity when he raised the bucket sharply all the way to the top. The force of the sudden stop caused a series of splashes down onto the furious operator, who could only sit and take it. We all laughed uproariously at the discomfiture of the operator, but what a different story it would have been if that bucket had been filled with rock!

All in-plant vehicles and over-the-road dump-type vehicles should be equipped with a warning device which operates automatically when the vehicle is moving in reverse. This alarm must be audible for a distance of at least two hundred feet. Alarms are required by law in certain states. Another word of caution: employees frequently become accustomed to the sound of the back-up alarm and tend to ignore it. There is no real substitute for the guide on the ground.

All trucks with a capacity of 2½ cubic yards or greater which are used for hauling gravel, stone, or comparable material should be equipped with a cab shield.

All equipment should have safety glass installed in at least the front windows. Wire mesh protection may be employed in other windows, but I would urge that safety glass be used throughout.

All boom-type mobile cranes must have a load capacity chart for both load and radius prominently displayed in at least one location in the cab. Also, if the equipment is of the cherry picker type and can be operated from the bucket, this same chart must be located in the bucket.

Finally, all vehicles equipped with air brakes must have an emergency air braking system or its equivalent.

There is yet another safeguard that my clients utilize and which I strongly urge you to consider. This is in the form of an overprinted statement on your purchase order form which should read: "All equipment supplied under the terms of this purchase order must conform in all respects to the provisions of the appropriate industrial safety code of the State of (Wisconsin)." The purpose of this statement will become clear as we continue with our discussion.

The areas of product, public, and third-party liability are fast becoming of increased importance to industry. Every city has a number of attorneys who engage almost exclusively in this type of litigation on a percentage basis. These suits are frequently

for a large amount and, in recent years, the courts have shown an increasing tendency to order large awards. In addition to this, most states have a penalty system which awards increased compensation to injured employees where it has been found that the employer was guilty of negligence in the matter of employee protection.

Much of my work at this time is in connection with employer negligence and various types of liability suits. I cannot say that I am in complete agreement with the present trend, but it is a condition of life which will become of even greater importance before it begins to level off. I frequently find myself saying that the 1970's will become known as "The decade of the liability suit."

This would be a good time to examine some of the situations encountered daily by industry and see what effect the failure to provide all necessary safety can have. I am working on a case in Wisconsin at this time which involves what the state calls inadequate or lack of guarding on a portable cement mixer. This mixer was provided with a partial guard over the top opening, and the company involved welded several additional steel rods into the opening. It so happened that an employee managed to get his foot into the opening while filling the mixer from the bed of a truck. The foot was rather badly cut. Under Wisconsin law, the employee was awarded an additional 15 per cent compensation due to the alleged negligence. Under state law, this penalty may not be paid by the insurance carrier but must be paid directly by the employer. I should mention also that, depending on the circumstances, the penalty can range as high as 300 per cent! As you can see, the penalty can amount to a rather significant amount of money. Of course, the amount is insignificant compared to what the cost would have been if the injured party had not been an employee. This event was completely within the realm of possibility, since the employer is a contractor and was working on the property of a farmer. The injured party could just as easily have been one of the farmer's children; in that case, the employer would have been subject to a liability suit for whatever the traffic would bear.

The ironic aspect of this case is found in the industrial code of the State of Wisconsin. To fully comply with the code, the mixer can have no opening greater than two inches square. The last time I saw my good friends in the Department of Industry, Labor, and Human Relations, they were still attempting to determine how aggregate could realistically be shoveled through two-inch openings.

The point I would like to stress in this example is the importance of a thorough knowledge of the provisions of the safety codes of your state. Earlier recognition of this provision would have allowed an opportunity for a change order or stop order to modify the code. Further, it illustrates the purpose of the statement I have already suggested for your use. Not only does it serve as a caution to the manufacturer that his equipment must comply with all safety rules, but more importantly it provides you, the employer, with the basis for recourse back to the manufacturer in the form of a product liability suit. It is perhaps unfortunate that we must put so much emphasis on suits, but loss potential today is so great that every effort must be made to protect one's self from what could result in a fatal loss.

I would now like to cite yet another example which will strike even closer to home. This will be a hypothetical incident but it is completely realistic and is typical of what can and will happen.

Let's assume that early one morning the shift foreman sends your front-end loader out to clear snow from the access roads into the plant. While engaged in the work, the loader is struck by an automobile and both the operator of the car and the loader operator are injured. Obviously, the employee is covered by Workmen's Compensation, but the loader was not equipped with a flasher as required by law. This means that the employee is entitled to increased compensation. Since compensation proceedings are quite informal, they normally progress much faster than courtroom proceedings, so the penalty has already been assessed before the suit of the driver of the car comes to court. As you may know, the state is not concerned with who was responsible for the negligence, but only as to whether negligence existed. The penalty, therefore, will be assessed against the employer. The unfortunate outcome is that you will go to court in the liability suit with the fact hanging over your head that the state has already found you negligent. Again,

your only recourse is a product liability suit against the manufacturer of the loader, and this suit can be successful only if you have proof positive that the manufacturer was negligent in regard to your instructions to him.

To further highlight the impact of such an incident, I would like to point out that I am presently involved in a product liability suit against a small manufacturer which will probably end up in the area of a quarter of a million dollars. An additional cause for concern is the fact that there has been a recent tendency in certain states to allow an injured employee to collect compensation and then go to court for an additional liability settlement. This, of course, greatly compounds the loss potential.

I have endeavored to apply a very broad brush to an area of paramount importance to industry today. I must admit that I feel vehicle safety is of far greater importance than several other areas of industrial safety, because of the aspect of high loss ratio in the liability field. This is a loss potential not normally found in plant-type operations where your greatest loss concern is limited to workmen's compensation. I have spent little time on the actual safety equipment itself; the equipment requirements do vary from state to state, and the appropriate state agency can advise you. I hope I have alerted you to the many hazards to be found in complying with state and federal law, and to the serious loss potential which is involved.

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RIGGING FOR MAINTENANCE OPERATIONS

By I. R. BRISLEY
Dir., Operation Services, Superior Stone Co., Raleigh, N. C.

The cost of maintenance and repairs to plant and mobile equipment will vary greatly from one quarry operation to another. Our experience, primarily in the field of crushing granite rock for construction aggregates, indicates that approximately one-third of our total manufacturing cost is involved in the maintenance and repair of our equipment. This figure would include 25 per cent of our labor cost.

Looking at our own experience, we find that approximately 60 per cent of our reported medical accidents requiring the attention of a physician are due to accidents involving maintenance and repair work, whereas only 40 per cent of these accidents would be chargeable to normal production work.

I believe the top management in our industry is taking a step in the right direction. They are beginning to give maintenance and repair the attention it will require, and they have also come to realize that a good safety program cannot function separately from a good maintenance program.

About a year ago the Maintenance and Repair Committee of the National Crushed Stone Association made a survey of the industry to see what planning, training, and facilities were provided for the heavy lifting work necessary to our maintenance and repair functions.

In most of the smaller quarry operations, rigging a lift of 10 tons or more would be planned and supervised by the superintendent. Some of the larger operations have maintenance superintendents or master mechanics who would supervise this work. Smaller lifts were generally planned and supervised with plant or maintenance foreman.

At Superior Stone Company's Castle Hayne Quarry we are using a three-ton manually operated hydraulic floor crane. It is wheel mounted and can be moved about the maintenance shop floor. At our Pomona Quarry we use a shop built A-frame operating on T-rails set in the floor. This carries a three-ton electric hoist with two part line and 18 fpm block speed.

A loader converted to crane service by Concrete Materials Company is used at their central repair shop in Cedar Rapids. The boom assembly replaces the loader bucket. A sling made from belting protects the screen housing. This type of sling is also very useful for handling large rubber tire and wheel assemblies.

A two-ton electric hoist mounted on an F600 maintenance truck operates on a 12-volt battery and has an extensible boom.

This truck works out of our central repair shop at Salisbury, N. C. It carries heavy rigging gear and jacking equipment used in setting up portable plants and making repairs to crushing equipment.

The quarrying industry appears to be self-sufficient to handle the problems of rigging and relies very little on outside professional help. Less than five per cent of the companies reporting indicated any formal training program for this class of work. People who are doing the rigging work in quarries are trained on the job by working with and observing more experienced personnel.

Very few operations have set up any guidelines or standards for the use of chain and cable slings for this work. All operations report that they have made manufacturers catalogs and data books available to personnel for the proper selection of slings. We have received a definite impression that the information is available but not in general use.

Approximately one-half of the companies report that they do purchase factory-made chain and cable slings for lifting work. Others use homemade slings.

Almost all operations indicated that they were building hoisting equipment into their crushing plants. These consist of bridge cranes and heavy monorail hoists over the crushing stations, and electric and air operated monorail hoists and hand operated chain hoists throughout the rest of the plant.

A 30-ton bridge crane serves a 42 inch gyratory crusher at Superior Stone Company's new Arrowood Quarry. It operates on a 26 ft. span over a 72 ft. long runway. The main hoist is rated at 30 tons with a hook speed of two to ten fpm. An auxiliary 10-ton hoist has a hook speed of two to 20 fpm. The bridge travel speed is two to 50 feet per minute. Controls are in the primary control house.

At the secondary crusher station in the Arrowood Quarry, we use a 20-ton bridge crane with a 38 ft. span on 40 ft. runway to service a 5½ STD and 7 foot SH crusher. The three crane motors operate from a single pendant control.

It is suggested that new plant designs incorporate such facilities or that tower steel be adequate for the future installation of stiff leg or monorail hoists. The alternative would be to design plant layouts to allow mobile cranes access to working areas.

We were asked to show some better method than an electric hoist to handle big rock at the primary crushers. A five-ton hydraulic claw serves a 42 x 48 jaw crusher at the Nello L. Teer Quarry in Raleigh. The three jaw grapple will open to 40 inches and is carried on an 18 ft. boom. These units are available with 60 inch grapples rated up to 12½ tons.

Less than 15 per cent of the operations reported they were still carrying screen cloth up into the towers with manpower. Others use monorail electric or air hoists. Some use a set of sheaves in their tower and pull the load up with a truck or loader.

A 1½ ton electric monorail hoist installed in a screen tower at our Augusta Quarry is used to handle screen wire and maintenance supplies. The block speed is 26 fpm, and we have drum capacity for 84 ft. of lift.

Many operations are using their dropball cranes to assist in the repair work in the pit when the crane is heavy enough for this service, but only one-third of the reporting operations indicated that they used dropball cranes in the plant area for maintenance and repair work.

Dropball service is rough on crane booms. The Weston and Brooker Company feel they get better service from a steel plate boom than from the conventional lattice boom.

My own company's experience with rubber tire mounted dropball cranes has been most gratifying. These machines have good mobility for working large pit areas in dropball service and can be moved quite easily from the pit to the plant area for general maintenance and repair work. For heavy lifts of this nature, we generally use out-riggers on the machine for increased stability. These machines do cost 50 per cent more than track mounted cranes, but often do the work of the two crawler cranes.

Several companies indicated that they were using hydraulic rubber mounted truck cranes which they had purchased for general use in maintenance and repair work in addition to construction work. Others indicated that on major repair lifts they were renting these units. It would appear that the big advantage of the hydraulic crane for maintenance and repair work is that only five minutes time is required for set-up once the machine is in location.

Appalachian Stone Company uses a 17-ton hydraulic crane for maintenance and construction. The operator can hoist, swing, and extend or retract the hydraulic boom all at the same time. This permits reaching into a tight place of a screen tower to handle chutes and other materials.

At this time I would like to pass along several suggestions we received relating to safety in rigging.

In a blind lifting operation the signal man can be as important as the crane operator. There should be only one signal man. He should be qualified and use standard signals understood by the crane operator.

When working in the vicinity of power lines, do we have spotters located to assist the crane operator in keeping his boom away from high voltage lines? Is the spotter in a safe vantage point?

One operation reported breaking a crane boom because the hoist line was too short to lower the load all the way to the ground.. This problem becomes more acute where a multisheave block is used to handle a heavy load at a safer and slower speed.

There is a growing preference for using cable slings rather than chain slings for most work. Chains can fail more suddenly than cable. Chain hooks can work loose on a shifting load. Our own company experience indicates that in very few cases are we using a factory made chain sling with a certified load rating. It is very difficult to determine the safe working load of an untagged chain which could be made of alloy steel, high carbon steel, or be a low carbon proof coil chain.

In 1969 there was a fatal accident in a midwest quarry when the lifting eyes pulled loose from a heavy feed chute over a crusher. The failure was due to the heavy stresses imposed on the sling legs working at a very flat angle.

In many operations it is difficult to provide a safe working platform for maintenance personnel. Spider staging, hydraulic powered work platforms, and cherry pickers were suggested for this work.

I noted before that our industry is using on the job training to develop rigging skills. Only two companies indicated that they hire people as apprentices and train them with shop maintenance and repair crews for two years before they are classified as riggers.

In some areas of the country, operators will have the added problem of jurisdictional disputes over this class of work. Usually, rigging is included within the ironworker's jurisdiction but it can also involve millwrights, operating engineers, and others.

In our own company we do not have as many trained and experienced riggers as some of the industry's older quarrying operations. We realize the need for more training for our people to work safely and efficiently.

Our *Supervisor's Safety Manual* has been expanded to include instructions on the care and use of rigging gear, the load ratings of various cable and chain slings, the inspection and use of cranes in lifting service. Training slides can be used to illustrate good and bad rigging.

For those of you interested in developing a training program on rigging, several fine publications are listed as references. I would invite your particular attention to the *Handbook of Rigging* by W. E. Rossnagel.

On the subject of training we might point out that the normal engineering graduate in civil or mechanical engineering would not have had courses relating specifically to the use of construction and hoisting equipment or the proper and safe way to hook up and handle a load. As has been indicated, this must be learned on the job. The most that we can hope for in training our people is that somewhere along the line they have had the equivalent of a good high school course in physics which covers the basic laws involved.

When working on such a training program, you may find that your present operating practices fall far short of recommended standards for safety. This begs the question as to whether on the job training is sufficient in itself. How long can your operation get by working with a rule of thumb?

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