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New Ideas...

If safety is to keep pace with today's rapidly advancing technology, we must continually have "new ideas."

Each year, at the National Safety Congress, the ideas and experiences of many of the nation's top safety men are presented in the various sessions. Many of these ideas, devices and methods, first presented at a Congress session, later become generally accepted within their fields.

In order to present this information conveniently and at small cost, the Congress Transactions are published in volumes, one for each Section or Division, along with a General Sessions and Detailed Index to all volumes. The 34 volumes of the 1951 Congress Transactions are listed on the last page of this volume.

Safety directors everywhere have found the Congress Transactions a useful aid in their accident prevention programs. In industry, for example, their judicious distribution to key personnel in management and supervision has proved to be of invaluable service.

In preparing these Transactions, the proceedings of the Congress have been condensed and edited for reference purposes. Complete original manuscripts, with any charts or illustrations which were used, are available in National Safety Council files. Views expressed at the Congress or in this record are those of the Congress participants and are not necessarily those of the National Safety Council.

THE METALS SECTION

The volume is a record of the sessions held at the 1951 National Safety Congress by the Metals Section. The conduct of these Congress sessions each year is only one of the many cooperative activities which the Metals Section carries on in behalf of its members, and for the benefit of accident prevention work in the metals industry generally. The Section gives guidance in the praparation of a great variety of technical and educational material useful in the day-to-day safety programs of metals plants. The activities of the Section are under the direction of its Executive Committee, the members of which are listed at the close of this volume.

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The American Package

By ROB ROY MACLEOD
Chairman, National Affairs Committee, Buffalo Chamber of Commerce, Buffalo, N. Y.

(Summary of a Speech)

Not long ago a refugee from the U.S.S.R. landed in New York. He looked about him at the wealth and lushness of American life and asked a question which we might all ask ourselves:

"Why should you have all this?"

If we give an honest answer we must say that most of us merely inherited this American package.

But what is this 'American package,' this way of life which we have inherited. While we are only 7 per cent of the earth's population, we enjoy most of its automobiles, more than half of its cars, almost half of its telephones and electric power.

But why is this? I do not think that we shall find the answer in things which we can see or touch, in our form of government or in our abundance of natural resources, but in an intangible idea. The greatest danger of our times is in straying away from this idea.

Any society may be divided into three general spheres; the religious or metaphysical, the socio-political, and the economic. The first of these generates ideas which permeate and color the schemes of the other two.

I feel that the basic concept upon which our way of life is built is that God is the master of men, and therefore the state never can be.

The American ideology springs from the Judaic-Christian religion with its principles of one God, the brotherhood of man, and of all men equal before the law. The communist ideology has its origins in the pagan religions where God became united with the state under one head.

Here we have the American package in its essentials, to contrast with the other package the people of the world are asked to buy.

But what are we doing to maintain and preserve this American package? How may we help in this time of crisis?

First, we must strengthen our religious foundations.

Second, we must realize that we must pay for our freedom.

Third, we must realize that to have good government we must have good citizens in the government.

Fourth, we must have courage and resolution to face the dangers to come.

And finally, since we are called upon to sacrifice, we must demand of our government complete prudence and honesty in making our sacrifices count.

Use of Directional Explosives for Tapping Open Hearth Furnaces

By R. H. FERGUSON
Assistant Director of Industrial Relations, Republic Steel Corp., Cleveland, Ohio

Probably no one job in the entire cycle of open hearth operations has received more attention from a safety standpoint than that of the second helper and his task of opening up the furnace. All of us are familiar with the hazard and the possibilities of an accident and that is one of the reasons the job has been surrounded with so many safety precautions. Accidents from this cause, while not entirely eliminated, have certainly been reduced, and any job change which would make it possible to spend less time at the tap hole should certainly receive serious study.

Undoubtedly most of us never anticipated that the day would come when we would openly advocate the use of explosives as such to promote the safety of men in the open hearth shop. Many present today remember the first use of oxygen to open a tap hole and some of the mistakes made down through the years. But that same production tool, the oxygen lance, the hose, the container and the regulator, if used as recommended, are exceedingly valuable and yet must be surrounded with every precaution.

To overcome some of the difficulties experienced in tapping a furnace, with particular emphasis from a safety angle as well as resulting hazards to personnel from a poor tap, the idea of using directional explosives was suggested. The development program has been in progress for nearly four years. For the past eighteen months, the explosive, better termed the "Jet Tapper," has been in use by the furnace crews at Republic's Warren Shop, and since the first of the year our Buffalo Open Hearth has adopted the jet tapping practice with considerable success.

It was with considerable misgiving that I entered the discussions for developing the practice of using explosives. With a number of serious hazards already in existence, it seemed that adding another was just a little too much. If such a job was to be handled by special crews it meant one thing, but to turn the job over to the regular operating men was a different story.

To follow the first practice meant increased man-hours, increased exposure, and increased cost. To follow the latter meant that our training and explanations must be thorough, and that each melter, first and second helper must be sold on the procedure. The latter practice was followed.

The procedures which have been established are the results of considerable testing, discussion, and evaluation. We did not seek the minimum level of precaution, but rather have sought the maximum to make this practice as nearly foolproof as can be devised. The procedures have been studied and evaluated and passed on by safety-conscious personnel of three companies, leaders in their respective fields. The Du Pont explosives people, with years of know-how and field experience, have expressed the opinion that this method of using explosives is completely safe if handled in accordance with the safety recommendations as set up.

These are two features with which we in safety are particularly pleased:

1. The Jet Tapper accomplishes the opening of the tap hole without any individual being near the runner. The control station is behind a building column at one end of the furnace. The placing of the Jet Tapper in the tap hole requires but a few seconds' time, and this takes the second helper away from a normally hazardous location.

2. The Jet Tapper reduces the skulling in the stopper well, with the result that pouring is accomplished with fewer running stoppers. This reduces the hazards at the pouring platform where serious accidents may occur as the result of poor stopper control.

It may be of interest to review briefly the surveillance testing that has been conducted concurringly with development.

The explosive used is cyclonite or RDX. I suppose it is only one of several fast burning explosives that might be used in a shaped charge. However, cyclonite, compared to most commercial explosives, is relatively insensitive to impact, friction or heat. It can be detonated consistently only by a No. 6 electric cap or its equivalent. In this particular charge, the cap must be located in the cap well provided, in order to cause proper functioning of the shaped charge.

If heated to a sufficiently high temperature cyclonite will burn, but will not detonate. For example, in testing, a case of 24 Jet Tappers was completely burned in a bonfire of kerosene-soaked wood without any sign of a violent reaction. In another test, six Tappers were laid side by side between steel plates, and a 150-pound steel weight was dropped nine feet onto the upper plate. Although the charges were completely crushed, there was no evidence of detonation.

To illustrate the insensitivity to propagation in terms of open hearth usage, a steel storage cabinet, similar to the one used on our charging floors, was built at Du Pont's testing laboratory. This cabinet was loaded with six Jet Tappers assembled and stored as is done in the plant. One of the assemblies was wired to a blasting machine and deliberately fired. Although the one explosion scattered the contents of the cabinets, sprung the door, and drilled a hole through the roof of the cabinet, it did not propagate to fire the neighboring charges.

We still wished to satisfy ourselves about two other factors: (1) what happens if, for some reason, a Jet Tapper after it is in place in the tap hole cannot be fired by the operator, and (2), what happens if the heat breaks out and the gush of molten metal washes the assembly down the runner into the ladle?

Depending on the rate of heating or the direction of heat in flux, the cap may be heated fast enough to shoot most of the unconsumed charge, but as soon as any part of this charge, particularly the copper cover, is destroyed by heat, the detonation will not result in proper functioning, and will seldom have the power to tap the furnace. In effect, the cap shoots some portion of two ounces of explosive without directional effect.

To determine this behavior, several standard complete assemblies were placed in the tap holes of furnaces and deliberately left to burn. In a period ranging from three to eight minutes, each of the charges tested in this manner was heard to detonate.

In the case of the three minute test, the report was quite audible; apparently the cap fired all or at least most of the charge, and this furnace was satisfactorily tapped. In the case of the eight minute test, the report was not much stronger than the report generally heard when firing a cap alone, and we could only surmise that the rest of the assembly had already been consumed by fire. The following conclusions were then drawn:

1. In the event of misfire, wait for explosion.

2. The insulation of the charge will protect it for at least three minutes in the temperature of the tap hole. This gives the operator time to reach the firing station. (He usually does it in 10 to 20 seconds from the time he starts to push the assembly into the hole.)

3. Once placed, the Jet Tapper is never to be removed. Wait for the explosion and then go ahead as usual.

To simulate the break-out condition, several assemblies were made up, standard in every respect except that a dummy charge was used. (No cyclonite in the case, but containing the usual blasting cap.) These units were tossed into the ladle during the tap, both before and after the additions, where they floated around on the steel, burning. In one to three minutes, the caps were heated to the detonating point, proving once again that the insulation was sufficient to protect the charge from heat under the severest conditions.

In setting up the use of the Jet Tapper, we were very careful to make sure that the work was thoroughly understood. We were in no hurry, and we were sure that there would be no mistakes. Some of the safety and operating rules deemed necessary to do this job are:

1. Jet Tapper head and caps are explosives. Let us not forget that at any time. And they should be treated as explosives.

2. The storage of explosives must conform to the requirements of the location—either state or municipality. Remember tapper heads and caps are stored separately.

3. Details for such storage buildings are available. We suggest that you follow them.

Note: Only responsible personnel shall have the keys to these storage magazines.

4. Only authorized persons shall be permitted to transfer charges and detonators from storage to the furnace floor.

5. Be sure that the person making up Jet Tappers is well trained and responsible. This job is done in the thermocouple room and in some instances the man handling that equipment also handles the tappers.

Only a sufficient number of heads and caps needed for twenty-four hours' use should ever be removed from the magazine and prepared for use. Develop the floor storage to hold only enough for this purpose. In this way excess materials on hand will be prevented, and it will be much easier to account for all Tappers.

6. When the furnace is ready to tap, the hole is dug and raked out as is standard practice. The melter then secures the assembly from the daily storage cabinet and gives it to the second helper. Prior to this, the blasting machine should be placed in the bracket on the furnace and connected with the electrical circuit. The handle of the blasting machine must be retained in possession of the second helper, or the man who is to place the Tapper assembly in the hole. This is to make sure for his safety and the safety of others that no other person can fire the Tapper. The Tapper is then placed in the hole.

The second helper carries the Tapper to

the runner with the connector cord still coiled and shunted, but detached from the loading pole.

He places the Tapper in the mouth of the tap hole with the flat side of the insulating body down, and with his right hand on the end of the loading pole, pushes it in until it contacts the facing.

He then drops the end of the loading pole into the runner, moves to plug in receptacle, removes the shunt from the connector cord, and plugs into the receptacle located on the back of the furnace.

Retiring to the firing station, he inserts the key into the blasting machine. Only 10-20 seconds have elapsed.

The operator is now in a safe position. He should make sure all persons on the pit side have been warned. Particular attention should be given to persons on the pouring platform and crane operators. When he is sure that all persons are in the clear, he should fire. We recommend a signal whistle warning.

When the shot has been fired, the connector cord can be recovered and returned to the daily supply cabinet for reuse.

The rules prepared and followed in this work are available.

1. Make responsible personnel available for this work and explain it carefully, you will experience no difficulty.

2. Remember you are dealing with explosives and molten metal. There should be no half way methods or jobs tolerated.

This is a safe method of tapping an open hearth and will be found very useful to the industry.

The Jet Tapper Practice at the Open Hearth

By HAROLD WALKER
Gen. Supt., Steel Plant, Republic Steel Corp., Warren, Ohio

and A. ROBERT ALMEIDA
Arthur D. Little, Inc.

Presented by Mr. Walker

It is rare indeed in open hearth experience to depart radically or suddenly from the conventional way of doing things. Changes in practice are gradual and take place almost without notice. Over a period of years we have introduced new tools and have become mechanized, as required by the demands of increased production. Great strides have been taken to make our mills and shops more productive and to make them better places in which to work. The improvements have been made slowly and constantly and without excitement.

Now, however, we at the Republic Open Hearths are excited about a radical change in our way of doing things. Thirty years ago, we dropped the bar and sledge in favor of the oxygen lance to open up the tap holes of our furnaces; this year we are dropping the oxygen lance and substituting a directional explosive charge, the jet tapper. We are making a significant change after thirty years of apparent satisfaction with the conventional practice.

At the beginning of the development program it was hoped that we could reduce the hazards connected with tapping a furnace. Since then we have enjoyed not only a safer practice, but a practice that benefits the operation of the open hearth in many ways. This is why we are excited.

First, the jet tapper provides a good, clean, fast tap without heavy labor. The tap hole is opened from a remote position, and seldom do the slaggers have to use a tapping bar to knock out the hole. The task of the second helper has been made easier and safer.

Secondly, the uniform full stream flow of steel, right from the start, has given the melter the opportunity to tap and make the additions under the best conditions. Skull production is cut in half, the manganese drop is reduced and tap hole maintenance is improved.

Thirdly, the pouring practice is cleaner and safer. The running and leaking stoppers which were caused by plate skulls around the stopper have been reduced to a minimum. With this improvement we are enjoying better surface, better quality, and better working conditions.

Description

The jet tapper is a small, shaped explosive charge, designed specifically for the purpose of tapping the open hearth furnace. Two ounces of a relatively insensitive explosive are enclosed in a bakelite case, which is fixed in proper position in a hollow insulating body with walls one-half inch thick. This insulation is sufficient to prevent the charge from being destroyed by the heat of the tap hole, and sufficient to prevent the blasting cap from being detonated by the heat for a minimum of three minutes when in the tap hole of the open hearth.

The special high temperature electric blasting cap fits snugly into the well provided in the rear of the charge.

The bomb shaped insulating body, 3 inches in diameter and 8 inches long, has a flat bottom to prevent rolling, and is easily fixed to a loading pole for proper positioning against the facing of the tap hole of the furnace. The loading pole is made of spiral wound cardboard tubing.

The hollowed shape of the explosive and the copper liner are responsible for the ability of the jet tapper to punch a hole through the frozen crust of the tap hole, with little sideward and rearward blast effect. This shaped charge will penetrate, under controlled test conditions, about seven inches of cold, mild steel. Yet in all our experience there has never been any evidence of damage to the tap hole structure; in fact, our tap hole maintenance has been reduced, and the tap holes are maintained straight as originally designed.

When the charge is detonated by the electric blasting cap, the high pressure developed by the explosion causes the copper liner to collapse progressively from its apex to the base, squeezing a jet of copper particles from the inner surface of the cone. These tiny particles, travelling at speeds up to 30,000 ft./sec. possess tremendous energy and will penetrate any type of target. As the energy of individual particles is dissipated in penetrating the facing of the tap hole, succeeding particles continue to penetrate until all material of the jet is exhausted. This action takes place in a matter of microseconds. As we hear the explosion, we happily observe a full stream of steel pouring into the ladle.

Development

It may be of interest to highlight the development of this new tool. During the period when the engineering teams of Arthur D. Little, Inc. were observing closely the operation of the first two pressure blast furnaces, it was evident to them that some of our every-day operations involved one or more men under conditions which exposed them unnecessarily to serious potential danger.

One such operation was the tapping of the furnace with the oxygen lance, which required the handling of cumbersome equipment near the tap hole and until such time as the iron or steel began to flow. The Arthur D. Little engineers concluded that a directional explosive of a type similar to the war-time bazooka projectile, could be fired statically from a remote position to tap the furnaces. Two additional factors had to be considered and resolved in this connection: (1) the depth of penetration required to open the tap hole and (2) means of protecting the explosive charge from the heat of the tap hole. It was realized that a charge of sufficient strength could be designed with due consideration given to the structure of the tap hole. On the other hand, various insulating media were available but the assembly had to be held to reasonable size.

At this stage, a patent application was filed covering this invention, and the subject was taken up with the duPont Explosives Division in view of their extensive experience in the development of the shaped or hollowed charge of war-time fame. The subject was presented to them with the following specifications:

1. A directional charge was desired to perforate the crust of the tap hole—the crust being an agglomerate of metallic and ceramic materials.

2. Such perforation to be accomplished without causing damage to the structure of the furnace.

3. It required stability toward heat and shock expected by rough handling at the furnace floor.

4. Above all, it must be safe to use, consistent with ease in handling, placing and firing the charge.

Temperature measurements were taken in the tap holes and various insulating materials tested to determine the rates of heating. Mock-ups of the tap hole structure were built in 55 gal. drums to simulate the furnace conditions, and in these assemblies the first units were tested. At this stage, one ounce charges, capable of perforating 4 inches of cold, mild steel, were fired in the steel drums. With these tests satisfactorily completed, similar charges were tested at the furnaces themselves.

Through a succession of furnace tests, a series of different models were fired, and evaluated under a variety of conditions. Surprisingly, it was found that the tap hole crust could be very tough indeed, and only when a two-ounce charge was finally used, did we successfully tap most of the heats.

This brief history deserves emphasis in one respect, it should be noted that the primary impetus to the development of this device came from the need for greater safety. As will be shown, the benefits to the operation have in addition been remarkable.

Results

The present design has been fixed for over a year, and nearly 2500 units have been fired to date. It is generally felt now that the occasional failures of the Jet Tapper to open the tap holes are attributed to irregularities in method of tap hole maintenance, or unusual conditions with respect to the particular heat, such as long charging delays which cause hard metal soaked holes.

This paper will omit discussion of the methods of handling and firing which have become standard, these subjects being covered by another paper by Mr. Ferguson of our Industrial Relations Department. As far as the operators are concerned, by that we refer to the second helpers, the opening of the tap hole with the jet tapper is an easier task than the corresponding use of the oxygen lance. It is a one-man operation, with full responsibility given to him. He handles the charge and has possession at all times of the mechanism by which the charge can be fired. There is no doubt that the jet tapper has promoted safety. Our operators respect this device and follow to the letter the standard operating procedures. Their cooperation and compliance has been gained by the fact that the jet tapper does a good job for them. From the point of view of the melters, it permits better control of the heat at tap time.

Let us take a look at the operating results from the Warren shop.

At Warren, our production consists by and large of low carbon rim grades, with a scattering of aluminum killed and low carbon silicon grades. With this schedule it is found necessary to plug the tap holes tightly, perhaps more so than at other shops. The following practice is followed to close the hole; after tap, the hole is first chilled off until clean and dry, then filled with double burnt dolomite by the second helper from the rear of the furnace, and finally faced off by the first helper, again with double burnt dolomite. Raw dolomite is never used.

With the jet tapper practice we generally gain a full stream flow of steel as soon as the hole is opened. Thus, a tapping bar is not required to clear the hole. The resultant tap, about one to two minutes faster than the oxygen lanced tap, is steady and uniform. The tap hole itself is generally free of ridges, and is maintained in alignment, in contrast to our former oxygen lanced holes which tended to drift to one side.

This uniform tapping of the heat permits our melters to tap when ready; they do not have to wait for a little more temperature to protect themselves against a poor tap. Where we have to watch surface quality so critically, this is an important factor.

It has also been observed that the manganese drop from first to last ingot during pouring has been reduced. Generally our manganese losses are fairly high, since we work with highly oxidizing slags to promote good rimming. The frequency of a four point or less manganese drop has been increased from 50 to 60 per cent. This again is of importance to quality and yield.

The most tangible results of the faster tap are given by our skull production. By eliminating the dribbling start of the tap, the jet tapper reduces both the number and weight of skulls.

With reference to the heavy skulls on the low carbon rim grades, it may be noted that the frequency of heavy skulls has been reduced from 13.6 per cent to 7.5 per cent. Note also that 85 per cent of the successfully jet tapped heats have not had any skull. Putting this on a weight basis by assuming 4000 lbs. as the weight of "bottom" skull and 5000 lbs. as the weight of "1 ft. or over" skulls, it is found that 203 jet tapped heats produced an average of 310 lbs. of skull per heat compared to 589 lbs. per heat for 323 oxygen lanced heats. This represents a reduction in skull of 47 per cent. Actually, the number of scrap skulls has been correspondingly reduced so that on a weight basis the total skull has been cut by at least 50 per cent. These results are certainly significant and represent important savings.

At Buffalo, the jet tapper was introduced late in December and was quickly adopted by the shop. At the time of the preparation of this paper, results were available on the firing of some 350 jet tappers. These results were considered premature, although they paralleled closely the Warren experience. In fact, the skull savings were even greater, and the benefits of more important significance in that shop whose production is made up of higher carbon killed grades.

An important advanage to jet tapping, noticed immediately at Buffalo, came from the pouring platform. The operation of the ladle stoppers became much more uniform, and the frequency of leaking and running stoppers was substantially reduced. This is attributed to the fact that skulls at the stopper well of the ladle have been minimized. On he basis of actual ingot count, the use of the jet tapper in January cut the number of leaking and running stops by more than 50 per cent.

Safe Use of Cables and Slings

By WILLIAM HOBBS JR.

Asst. Mgr. of Sales, Wire Rope Division, John A. Roebling's Sons Co., Trenton, N. J.

For many types of hoisting duty, a wire rope sling is a very important part of the equipment. The sling connects the crane hook and the load and is the vital link. Before a crane can hoist a load, provision must be made to connect the two together. Sometimes special pains are taken at the load for attaching, but, usually, the sling must be adapted to the natural contour of the load.

Slings which are inadequate or insecure endanger human life, as well as valuable loads. While slings are a specialty, experience and data have been correlated into types and tables so that most slings can be safely selected by the user.

Consideration of the angle of inclination, number of rope parts and factor of safety, may, at times, get things involved. Diagrams can show what happens when you try to save by making slings too short, which is to say a small angle of inclination.

For instance, at 30°, the tension in the sling will double, making it necessary to use a sling which is twice as strong as one that is used to handle the load vertically. Try to make use of head-room.

"How do you determine the number of rope parts handling the load?" is a question often asked. You simply count the ropes that are in the space between the load and the hook, irrespective of whether the slings attach to the load or pass around it.

A direct approach is used in the Roebling sling tables, wherein safety factors already have been included and in which safe loads are given. These are actual loads that can be lifted safely.

Roebling slings are of three general types. The first is round rope, which needs no explanation. The second is the grommet type. It is a hand-made endless wire rope, fabricated from a single piece of strand. The third is the woven six-part Flatweave sling.

In passing around short-radius curves and sharp corners, wire rope suffers a reduction in strength. This fact has brought about three general load classifications—Classes "A", "B", and "C". Class "A" represents the best conditions of operation; "B", conditions of medium severity and "C", the most rigorous types of duty.

Class "A" slings suffer no loss in strength in their application to the load. They are used in straight tension or pass around large circular bodies.

Where the sling is protected at the corners of the load by suitable protective saddles, it is considered a Class "B" sling.

No protection for the sling results in a Class "C" sling.

Slings with loop splices often are subjected to more abuse than special slings, so the safe loads for these are less than the safe loads for Class "C" slings.

For unusual hoisting conditions or severe types of duty, special protective features can be incorporated in the design stage of the load. Saddle surfaces for the rope, threaded holes for eye-bolts, or holes for hooks can be provided at little expense.

Another means of sling classification is descriptive of the manner of load attachment—a cradle sling encircles the load.

A bridle sling hitches directly to the load, usually by means of fittings.

Slings which have one end passed through the other compress the load. These are called choker slings, or simply chokers. To facilitate handling and to improve sling life, sliding choker hooks should be used.

Sling fittings may be necessary at the crane hook or at the load. Among the many types used at the crane hook are steel-casting equalizing thimbles.

"Flatweave" or round rope slings often are attached or spliced to rings. Rings should be forged without welds, assuring maximum safety. Sometimes these rings are put through an additional operation—and formed into a pear-shaped link.

Sockets or hooks are the most commonly-used fittings for load attachments. It is suggested that standard fittings be used wherever possible. This means low-cost slings and prompt deliveries.

Sometimes the legs of a sling must be kept in a vertical position to prevent damage to the load. This is accomplished by the use of a spreader beam.

In such a beam the rope extends from the ends of the beam to the crane hook, putting only compression in the beam.

Lack of head-room may not permit the use of a spreader beam. Then it becomes necessary to attach the crane hook directly to the beam. This is known as a lifting beam, and, generally speaking, it is much heavier than a spreader beam, because of the bending stress which is introduced.

However, lifting beams are used to advantage for loads with a shifting center of gravity, because the hook attachment can be placed at any position along the beam.

Round rope slings, up to 1⅛ inch diameter, are made of 6 x 19 classification "Blue Center" Steel Wire Rope with Independent Wire Rope Core. Larger slings are made of similar rope, except the 6 x 37 classification is used. Grommets are fabricated of the 19-wire strand classification up to 1⅛ inches and 37-wire strand classification for the larger sizes.

It is no secret that wire rope slings will kink when improperly used or handled. A severe kink can result in as much as a fifty per cent loss of rope strength. After years of study, Roebling recently developed a new-type sling, which is highly resistant to kink damage—the "Flatweave" sling. It is easy to handle and is recommended for use where the legs choke the load or where the sling comes in direct contact, in other ways, with the object being lifted.

The "Flatweave" sling body is flat, flexible and free of scissors action between the six separate ropes that terminate in the seven-part, reinforced loops. The flat body means minimum surface marking of the load in handling materials where this is important.

Designed to fulfill a definite need, namely, those applications where kinking is a factor, it was recognized at the outset that "Flatweave" slings would be used for the most severe types of duty. Designed for all types of loads and conditions, only one set of safe load values has been established for "Flatweave" slings—Classes "A", "B" and "C" do not apply.

Where it is necessary, standard or special fittings can be supplied for these slings. Usually, the loops are attached to the crane hook, although they can be attached through the use of other fittings. The loop is reinforced substantially with seven rope parts, making it unnecessary to resort to outside servings for protection.

Eye hooks, shackles or sockets are used as load connections. Thimbles can be furnished in the loops, although they are rarely necessary. Ordinarily, "Flatweave" slings are used with no fittings, other than the permanent swaged sleeves which form a part of the sling.

"Flatweave" and round rope slings can work together for minimum sling cost. The part which is clear of the load is not subject to wear or kinking, and, consequently, lasts for an extended period of time. This part should be made of round rope. The parts in contact with the load should be "Flatweave" and renewals are confined almost entirely to these sections of the sling.

Slings with loops on each end are by far the most common. For years these were spliced, but mechanical means of splicing with pressed on fittings are today making better and safer slings available than ever before.

The Number One and Number Two hole sleeves are two new types where the end of rope is brought around the thimble and held permanently under a pressed steel sleeve.

The Tapered Sleeve Sling is another new and similar type but one which embodies a very unique safety feature. The end of the wire rope is divided and formed into a Flemish eye before attaching the streamlined tapered sleeve.

Even the regular splice has been modernized into the Walles Splice, in which all wire ends are inside the splice. No serving is required on these splices as there are no objectionable wire ends to injure a workman's hands. This gives it an additional safety feature as well as aiding appearance.

Efficiency of the end attachments on slings must be considered. They play a part in safety as well as economy. Obviously, a sling is no stronger than its weakest part. A rope may have a strength of one hundred tons, but a sling made from that rope has a strength of only eighty tons if a splice at one end has an efficiency of only eighty per cent.

The selection of end attachments on slings is important. It's possible on large sizes, especially, to actually reduce the rope size, using sockets or tapered sleeves, which develop catalog rope strength, and obtain the same safety factor as spliced slings made of larger rope.

It is also just as important to consider how the sling is attached to the load. When a wire rope is passed around unprotected corners on the load, its efficiency may be reduced to an appreciable extent. Nothing has been gained by increasing the efficiency of the end attachments on the sling if the strength of the rope in the body of the sling has been reduced to a lower net strength than the attachments.

Wire rope slings are correlated into many types and combinations, many of which are more or less common to certain industries. Very often what appears to be a special sling requirement can be reduced to a standard type with the result that quicker deliveries can be obtained and at a lower price.

In the past, some users have made a practice of buying wire rope and having it spliced in their own plant. However, today management and safety men are finding it more economical and more efficient to buy their slings from those people whose business it is to recommend and manufacture slings.

Wire rope has proven to be the safest material for sling purposes. The greatest safety in the application and operation of wire rope slings is best realized when those responsible make an earnest effort to apply available knowledge to their specific problem and at the same time maintain a healthy respect for the law of gravity.

Warehouse Safety

By R. J. FOSTER

Secy., Republic Structural Iron Works, Cleveland, Ohio

A typical steel warehouse could be described as an average industrial steel structure with a monitor type roof, covering approximately 175,000 square feet, and representing floor space interrupted only by suporting columns and perhaps a small section set off by low partition. The supporting columns are arranged in such a manner as to define four or five wide aisles some 400 feet in length and serviced by electric over-head cranes.

The average distance from the floor to the monitors in the roof is around 50 feet; some, but not all of the floor area is paved, and various pieces of cutting equipment are located at appropriate spots in each aisle. These plate, sheet, bar and angle shears, burning equipment, hacksaws, and high and slow speed saws are generally situated adjacent to the driveway, which runs through one side of the warehouse structure.

On the opposite side there is located a railroad spur running inside the building where cars of incoming steel are spotted for unloading. The order flow is then from the incoming railroad cars to the stocking area, to the cutting machine, if necessary, to a zoning area, and therefore, onto outgoing motor trucks.

To accomplish the entire operation, we need a superintendent, a foreman or two, and around 50 wage earners. Some steel warehouses may be larger or smaller, and in many instances, there is a fabricating operation closely allied to and considered a part of the business; however, this can be considered typical for the purpose with which we are concerned today.

It is important to know that nearly one-fifth of all the finished steel mill products in this country flows through warehouse distributors to a half-million steel users. In 1950, 13,282,000 tons, or almost 19 per cent of a total record output of 72,232,000 tons, reached consumers through steel warehouse channels. Now these warehouses fall into three general classifications:

1. *Merchant products.* In this group are nails, fencing, roofing, water and gas pipe and similar items.

2. *Oil country goods.* These include the pipe, tubing, drill rods and other products used to get oil and gas out of the ground and to pipe them in bulk for refining and redistribution.

3. *Industrial steel products.* These products are made of carbon, alloy, high tensile and stainless steels. They include plates, shapes, bars, sheets and strip in the hot rolled and cold finished grades and many other steel products. Approximately 700 warehouse distributors specialize in these industrial steel products and several hundred others carry limited stocks in conjunction with other goods and services.

Industrial steel distributors serve an estimated half-million steel users in all parts of the United States. For example, 334 member warehouses reported handling in September 1950, a total of 770,255 separate orders—an average of 2,306 each. Representative warehouses in the larger industrial areas fill 25,000 to 50,000 and even more orders a month. Recent studies show that the average size of a warehouse order ranges from 800 to 1,500 pounds, depending upon the territory.

In the performance of the warehouse business, there are relatively few so-called highly skilled jobs. Aside from a maintenance man and a few machine operators possessing specialized training, the majority of employees perform unskilled jobs constituting for the most part the handling of finished steels inside the warehouse.

Furthermore, our work pattern is far from constant; for example, there are days when we may have sufficient plate orders to keep a plate shear gang busy for several full turns; however, we may then experience a period when there are no plate orders and the men who normally perform such work are assigned to other duties which may encompass other shearing activity, or perhaps hacksawing, stocking material, helping another employee fill orders, or even performing janitorial duties in and about the warehouse.

In normal times, practically all orders are received, filled and shipped within 48 hours, so the volume and type of steel desired by the customers govern the job assignments of our employees from day to day. Therefore, in order to assure an effective organization, we must maintain a high degree of flexibility in all job assignments.

I have gone into this detailed data so that you may understand and readily appreciate that although the safety hazards concerned with machine operation do involve a few employees, our greatest hazard is associated with the very general responsibility of handling material.

A review of injury records as recapitulated from accident reports by cause and responsibility indicates that more than 25 per cent of all our accidents each year are attributed to material handling. In some years when experienced help was not readily available, the percentage has risen as high as 40 per cent.

Industrial accident experience for iron and steel work as recorded by the State of Ohio Industrial Commission—we find that of the 1,143 accidents reported, 343 employees received eye injuries. 214 received finger injuries and 113 received injuries in the lower extremities of the legs. During this same period, nine developed hernias. There were 54 hand injuries and 62 foot injuries. Of the total number of 1,143 injuries, 646 were struck by flying, falling, sliding, or moving objects, while only 10 reported occupational disease. It, therefore, indicates that the greatest hazard comes from the stock piling, switching, and handling of materials. Of the total 1,143 accidents reported, there were 14,199 days lost.

What we somehow fail to consider and which presents a serious problem is the cost of handling first-aid work in the average plant. It has been impossible to determine what these costs are. In talking with many men in the warehouse industry, we find that there is a constant stoppage of work because of minor injuries. This type of injury is not reported to the Industrial Commission, but nevertheless first-aid must be supplied. Many companies employ doctors who come to their plants to take care of such minor injuries. Others have full and part-time trained employees for this purpose. The loss of time presents a substantial cost to industry.

Let us consider material handling as a safety first problem in steel warehousing. In performing a normal day's work, most of our employees are required to lift material by hand or with the assistance of some mechanical equipment which exposes them to crushing foot and hand injuries during a majority of the work turn.

As we have already stated many of the orders are small and it is not uncommon that we receive a hernia claim when a worker has attempted to lift or move what appeared to be a relatively small amount of material. At practically every piece of cutting equipment, it is necessary in almost every instance that the employee personally align the material on the shear or saw bed or table prior to cutting. Crushed fingers and injuries to arms and hands often result from these operations.

The unloading of material from railroad cars and stocking in racks or bins requires direct physical contact, since crane chains and blocking must be removed from the lifts, material guided into the racks or lifted and placed by hand in the rack as required and as feasible, depending upon weight and size.

Here are random statements from accident reports of some of the material handling injuries experienced recently:

1. "In removing hoist chain from a lift of grader blades, the injured caught his left hand on the block under the lift. As he pulled the hoist chain, the lift shifted, cutting off his finger at the first joint."

2. "Injured employee and helper were pulling a bar out of the rack when one end slipped from injured's hand and fell on his foot."

3. "Injured employee and fellow workman were turning angles preparatory to cutting. As one angle was turned, the employee's turning bar slipped out of his hand and dropped to the floor injuring his foot."

4. "Employee slipped when removing cold rolled rounds from a rack which resulted in a hernia."

There is a multitude of examples like these which could be cited; emphasizing the high percentage of time each employee spends in actual contact with the products during his work turn. This is in contrast to many operations in the iron and steel industry where, in spite of the proximity of huge machinery and similarly hazardous operations, employees are relatively safe due to remote controls and mechanical guards. It is the exception in the steel warehouse when the material can be unloaded, stocked, transported within the warehouse, and loaded for shipment, without an employee by necessity having direct physical contact with it.

Essentially, this type of injury may not be grossly different from those occurring in other companies; but it is signficant that experience has shown that accidents related to the handling of material constitute our principal hazard. This is not strange due to the nature of the steel warehousing operation, which, after all, is virtually 90 per cent handling of finished steel products.

A second problem with which we are much concerned relates to that of protective devices. It is difficult to conceive of any type of business wherein the necessity for the wearing of safety shoes should be more significant. In spite of aggressive safety committees, and a flood of promotional material, we have been unable to persuade a large percentage of our employees to take such personal precaution. Furthermore, there exists an accident exposure to the foot which extends beyond the toe, since many crushing injuries involve bones of the foot for which safety shoes in themselves provide no protection.

One of the chief complaints of our employees to safety shoes and to foot guards is brought about by the character of their work. Employees working around cutting equipment or within a rather closely defined area generally have little cause to object to this type of protection, but when their work assignment requires considerable walking, such as is necessary in the warehouse, or climbing into and out of railroad cars, between racks and piles of steel, and sometimes on the steel itself, it has been our experience that they, for reasons of comfort, and sometimes because of alleged cumbersomeness, object to the common type of safety shoe and guard.

The most obvious illustration is that of the crane operators in some of our smaller warehouses, who must come down out of their crane cabs from time to time and perform work on the floor. On such occasions they should, of course, be expected to wear safety shoes; yet, in the crane and in climbing to and from the cab, such protectives are unnecessary.

Other protective devices are, of course, important and often present a problem, but not to the extent of the aforementioned and probably not any more so in the case of any other business. The wearing of goggles for burning and grinding operations, the use of aprons by welders, and the use of special purpose gloves where required, are a few examples.

In many warehouses, a substantial amount of cold finished steel generally has a protective coating of oil to prevent the surface from rusting or pitting. The handling of this greasy stock always creates a hazard for which it is difficult to devise any specific protection. Gloves soon become saturated with the oils and rubber gloves are inappropriate since they would provide little or no friction for gripping. The rope slings on the hoist and chains accumulate a substantial amount of this grease and they, too, soon become difficult to work with. The importance of safety shoes and foot guards under these conditions is certainly obvious.

A third major problem which may not be peculiar to steel warehousing, but is one of major importance to us, is that of good housekeeping. The sloppy habits of workers and carelessness on the part of supervision often result in tripping hazards, greasy floors, blocked aisles, improperly and unevenly piled material, and a host of other everyday, simple but serious, conditions which tend to increase our accident potential.

Our records are full of first-aid and lost-time cases caused by scratches and puncture wounds from loose wires for which proper disposal procedures were not followed. Falls have resulted in deep cuts when employees were thrown against material piled adjacent to an aisleway on which a piece of scrap or an unreturned tool had been thoughtlessly thrown.

Many injuries result from material not properly and neatly stacked in the appropriate pocket, rack or pile. Eye inflammations have resulted on many occasions from unnecessary dirt in and about the machines or because some provided shield or screen had not been safely positioned.

The character of a steel warehouse, its size and relatively small number of employees, may in many instances remove the personal relationship often found in manufacturing operations between a particular machine or area and an employee or group of employees. In the absence of such a relationship, it is frequently hard to educate and expect employees to take a special interest in an area as large and as general as the one with which we are concerned.

It is a problem to get the average worker to place the scrap in the proper location, to remove and dispose of bundling wires, to replace pinch bars and other tools in their proper storage place, to wipe up excessive grease that may spill on the floor or otherwise become a hazard, and to give his personal attention to the many, many other everyday conditions which may at some moment become a real hazard to himself.

Safety programs constantly emphasize the need for "a place for everything and everything in its place," but the housekeeping responsibility too often is thought to apply to our personal lives only. It should have an equally important place in our industrial life.

In every business enterprise the mental attitude of its employees is of great significance for a number of reasons. Safety-wise, it represents our fourth problem. Our men must be familiar with many sizes, shapes, types, grades and finishes of steel and must know their way around the somewhat large area within which they are assigned to work during any given period. Actually, the ideal steel warehouse crew would consist of a very small group of highly versatile workers who could be shifted about from job to job as the customers' orders required; an objective almost impossible to achieve under today's operating conditions. Nevertheless, this principal is exercised to the greatest degree possible and has been recognized by most labor leaders with whom we deal.

But this industry practice makes it difficult to develop the proper mental attitude toward safety among our employees. The numerous daily job changes demand a safety consciousness always alert to existent danger. The variety of tasks performed by each employee during his work turn, and the different locations where he may perform these tasks, complicate the problem of safety education. Familiarity with a fixed set of circumstances in a constant industrial environment is one thing, but the varied, ever-changing character of our work pattern presents an entiely different problem.

Safety supervision at its best must be general since it would be highly impractical to have a foreman with each team of workers. They must be as self-reliant and acute safety-wise as they are business-wise, but the kind of overall experience and knowledge that develops these qualities is slow in maturing. New workers must be constantly transferred into new environments and employment conditions for some time before they have been generally exposed. Employees working with cold finished steel may meet an entirely new set of hazards when assigned to a job in the structural or plate division; shear operators must be on their toes when performing the responsibilities of a stocker, and a craneman enters a new industrial world when he steps down onto the warehouse floor.

Normally, upon each move, a safety refresher talk might be the answer, but visualize a situation wherein these moves are made some times as many as four or five times a day, depending on orders, material receipts, shipments, and amount of cutting required. Posters and safety signs, assignments to work with seasoned employees when possible, regular safety meetings and safety huddles are now employed as educational tools. But there is need for some fresh stimulants to help him bridge these occupational and environmental gaps. Concern for his personal safety as well as that of his fellow workers should become as automatic as the life itself to which it is dedicated.

This discussion was to pertain to problems of steel warehouse accident prevention; consequently, I make no reference to the other more common categories of difficult situations encountered by indusrty in general in the conduct of their safety and accident prevention programs. We, by no means, are immune to these problems either and are constantly striving to better ourselves through appropriate and more intensified safety measures.

I have attempted to define for you four problems which may be considered of primary significance in the steel warehousing business, although they in themselves are not strange to any other type of business activity.

Number one concerned the handling of material. This strikes at the very roots of the steel warehousing business, which, by its very nature, requires an unusual amount of physical contact between employee and material. It represents an activity which unlike most manufacturing and industrial operations today, depends for the most part on the actions of the worker himself who must of necessity be his own safety warden.

Number two emphasized the problem of adequate personal protection and the need for greater employee participation in safety shoe and other such programs. The significance of this problem is heightened by the close physical relationship between the employee and the product as discussed earlier.

Number three involved the problems of good housekeeping and the obvious fact that only in a neat and clean environment can we have a truly safe place to work. The principle of "A place for everything and everything in its place," becomes a keynote to safety in steel warehousing where the variety of sizes, types, grades and finishes of the steel carried in regular inventory is particularly great.

Problem number four was the employee's mental attitude in relation to the work pattern of the industry. The high degree of flexibility in daily job assignments, bringing about a constant change in duties and industrial environment, demands a general safety knowledge of the warehouse operation. This is difficult to establish except through experience gained during an extended employment period.

The Use of Wetting Agents to Control Dust in Industries

By G. A. MAU
Vice Pres., Johnson March Corp., Philadelphia, Pa.

Within the past two decades chemists have developed materials with properties similar to soap but without the limitations, resulting in a large number of compounds with remarkable physical properties. The behavior of these materials has suggested their use in a wide variety of industrial fields.

These materials are known as Surface Active Agents since their primary effect is at the boundaries or surfaces between two phases.

Reduction of interfacial tension, lowering of surface tension, increase of wetting power, deflocculation and emulsification are some of the results of this activity. The synthetic surface active agents first came into use in this country about 1930. In the few years since their introduction, they have become numerous and varied, and have found many uses in diverse fields. The surface active agents can be subdivided into five groups. Wetting agents, penetrating agents, dispersing agents, emulsifying agents and foaming agents.

Reference will be directed particularly to the first and second groups. Namely, wetting agents; producing increased wetting or spreading of an acqeous solution or suspension over a repellent surface and the second group, penetrating agents, providing more rapid passage of a liquid into a porous solid.

With the above brief discussion on surface active agents, or as I will refer to them from now on as wetting agents or compound, I intend to discuss the use of wetting agents to control dust in industry and particularly, the foundry.

I like the popular definition of a wetting agent, which merely states that a wetting agent added to water makes it wetter. Perhaps, we should state for the purpose of keeping the chemical terminology straight, that a wetting agent is a material which, when added to water, or to any other liquid, will cause considerable reduction in surface tension. Safety and health have been benefitted by the use of wetting compounds in many industries. Safety—in providing better visibility around plant and equipment, health by preventing the absorption or inhalation of dust.

Dusts, whether toxic of not, are harmful and an attempt to group dusts under the headings "active" and "inert" (with reference to effect on health) has proved unsatisfactory. Investigations have proven that practically all dusts may be harmful if breathed in large amounts over long periods.

In this country, dust diseases usually designated as "silicosis" is more or less common among workers in the mining, grinding, granite and foundry industries. According to Lanza and Vane, the estimated number of men exposed to Silica-Bearing Dust in various industries are as follows:

Process	Percentage of All Employees	Number Exposed
Metal mining	100	62,000
Anthracite coal mining	20	30,000
Quarrying of granite, ganister, sandstone, etc.	100	22,000
Smelting & refining	100	18,000
Foundry workers	100	200,000
Potteries, glass works, stone products	50	70,000
Grinders, buffers, sand blasters, vitreous enamelers		62,000
Estimated total for mining, quarrying and manufacturing industries.		450,000

In addition to these there are "thousands of workers who have been exposed to silica dust in these various occupations and are now engaged in other forms of work."

In order that we may better understand the purpose of this discussion on wetting agents for dust control it will be necessary to discuss the dangerous dust particle size and the wetting effect of raw water compared to wet water with the proper surface tension and group combination.

Not all of the particles of inhaled dust gain access or are retained by the human lungs. For these reasons, the size of the dust present in the industrial atmosphere should be determined.

Investigations have proven that particles greater than 10 microns in longest dimension, are very seldom found in the lungs, and that the particle size found most commonly in lungs were three to five microns. Due to gravity which causes rapid settling of suspensions and due to the protective action of the mucous surfaces of the upper respiratory tract, the larger particles do not penetrate to the terminal portions of the lungs.

Therefore, it is obvious that attention should be given chiefly to those particles which are less than 10 microns in longest dimension and which can enter the lungs.

This group particle size is very difficult to wet, and requires not only a low surface tension liquid but a fine atomizing spray nozzle. Dust control by wetting depends for its effectiveness upon the fact that, once the dust has been trapped in water or some other liquid, the particles are not easily dispersed again in the air, until proper disposal has been made.

Dust control by wet methods is attractive from the standpoint of cost but has not been highly successful in certain industries, with raw water. Many articles have been written quoting not too good results in such applications as grinding wheels, rock drilling, mining, etc.

Dust control with water is better than no wetting at all, but would not reduce the dust count sufficiently to be safe, and in the case of some dusts, could not be wetted at all, especially the sizes 10 microns or less.

To obtain better wetting, experimentation led to the use of wetting agents.

The physics of wetting is not entirely understood. The phenomenon is basically one of adsorption since a film of liquid must be adsorbed upon the solid before wetting can occur. A liquid will spread on a solid if the surface tension of the latter is greater than the sum of the interfacial tension between the solid and liquid and the surface tension of the liquid.

Therefore, the wetting power of a liquid increases with a decrease in its surface tension. Many dusts are wetted only with great difficulty because of the presence of another film already absorbed on the surface. This film might be adsorped air, which occurs in a dust cloud. Then wetting will not take place unless the spreading force of the liquid is great enough to drive off the air layer.

A wetting agent or compound of surface active agent groups will in most cases furnish the spreading force of the liquid to drive off the air layer and wet the dust.

Time will not permit a discussion of other than the high points of dust control in the foundry industry.

About three years ago, I was handed some foundry dust that was collected around the muller, and asked whether it could be wetted with a wetting agent. Much to my surprise, it was a combination of foundry dusts that did not respond to water or any single type of group of wetting agents known at that time. We finally found a compound of surface active agents that would actively wet this dust. Dusts difficult to wet can be wetted if the proper wetting compound is used and the application correct. One without the other will not work.

So far we have touched on a discussion of the types of wetting agents, that a liquid with low surface tension is best for wetting, providing the dust and liquid are compatible, that the size dust particle we should be most interested in is three to five microns or generally particle size less than 10 microns. This size compares to fog particle sizes.

The efficiency of wet dust control is dependent upon the degree to which the particles are wetted. Important factors that determine wettability or dusts are the proper wetting compound and the application of the proper particle size spray solution with nozzles designed for the application and spray pressures to create proper spray droplet size and pattern.

Another big factor for efficient wet dust control is the selection of proper type nozzles. It is common practice to employ "a nozzle" whether a solid or hollow cone or flat sheet spray. No matter how efficient the wetting compound may be, if the proper nozzle with proper spray pattern and angle are not at the right location, results cannot be obtained.

The methods usually employed to obtain fine atomization are high pump pressures, liquid with air misting nozzles and very low capacity nozzles.

High pressures are not desirable for dust wetting. The high pressure spray causes the dust to disperse beyond the spray area.

Liquid air misting nozzles are very satisfactory for spraying areas 10-20 ft. from the nozzles. A very fine fog or mist spray can be obtained with these nozzles provided sufficient nozzles are used for the spray pattern. These nozzles are recommended for top spraying of shakeouts, sand conditioning, crane shakeout, etc.

Low capacity nozzles can be grouped and used on medium pressures (40-70 psi) to obtain fine particle atomization, for close proximity dust concentrations near equipment or conveyor transfer points, etc. These nozzles are now available in capacities of 2 to 24 gallons per hour.

Most wetting agents are shipped in concentrated form and require dilution when used for spraying. Efficient, durable, automatic proportioning equipment is required for successful wet dust control. Proportioners meeting these conditions over a period of years are now available.

Wetting Compounds are of great benefit to foundries, not only for dust control but for such things as fire fighting, core knockout, cleaning castings, core wash, reconditioning the moulding sand, cupola smoke control, sand tempering, etc.

Dust control at crane and machine shakeouts, mullers, floors, sand conditioning, grinding and cleaning departments are the areas where foundries have proven wetting compounds very successful.

The application of wetting compounds on foundry floors or walks, prevents dust arising when rolling equipment or men travel over them. It keeps the floating dust particles from becoming airborne. For general use, where the sand is accumulating over large areas and is not regularly removed, wetting compounds are infinitely more effective than spraying with water.

Plain water wets the surfaces of the floor sand, causing mud, or may run to lower levels causing puddles and excess surface moisture in spots.

Because very little penetration takes place air currents absorb the moisture rapidly, allowing the sand to dry and become dusty shortly after the water application.

When applying wetting compounds to the floor a flat cutting spray nozzle has been found most effective.

Wetting compounds permit the wetting of floors in the melting and pouring areas because of quick deep penetration of the moisture in the sand and much less possibility that sand near the surface will be wet enough to cause spattering of metal. Penetration with water is difficult and evaporates quickly.

Crane shake out of castings usually involve large areas in the main bays of many foundries. While the shakeout periods might be confined to night or early morning hours, when few employees are in the area, most of the foundry becomes contaminated with airborne dust that is easily vibrated loose from the building structure and equipment when the full force of workmen are at work. A fine atomized solid cone spray applied from nozzles attached to the crane bridge over the shakeout area has been used successfully at a foundry.

At another foundry, a special portable stand was built with the fog air misting nozzles, which, is placed in a position at oposite sides of the working which might be 25 feet or more in diameter. This type nozzle is also used for spraying over the shakeout table.

The fog air misting nozzle is used successfully to supplement exhaust systems on shakeout machines. If the table is large and the dust is not being properly exhausted, the air fog misting nozzle has successfully controlled the dust in areas not exhausted. It might be over the ends of extra large work extending over the table, or due to sand not leaving underneath the shakeout fast enough.

The amount of dust produced by sand conditioning equipment is influenced largely by whether the sand is handled dry or moist. The sand should be moistened with wetting compounds to eliminate dust before processing.

Wherever sand is thrown from conditioning machines, direct pressure nozzles with capacities considerably larger than the average dust nozzles are recommended. This nozzle must have a fine atomized spray because wetting of the sand is necessary to properly control the atmospheric dust. Dependent upon bin capacity, we also recommend for large bins air fog misting nozzles over the storage area to control the dust and to revive the treatment in the event the sand stands long enough to become dry and dusty.

Wetting compounds are being successfully used to control dust arising during skip at hand loading of muller operations, which are not exhausted. Small capacity nozzles mounted over the muller bowl will wet the floating dust particles with very little or controlled moisture. If tempering of sand is required, the wetting agent is introduced in the water line.

Core knockouts may produce even greater variations in dustiness than shakeouts. Pneumatic chipping on large or small, irregularly shaped castings disperses enormous amounts of dust. Wetting compounds are effective in softening cores, making them dustless and much easier to remove from the castings.

There are many other applications for wetting compounds to control foundry dust, and there are certainly many more uses, such as tempering and penetrating agents. The few applications mentioned are merely to show the possibilities.

I trust I have explained: 1. The purpose of wetting agents, that practically any dust can be controlled with the proper wetting compound. 2. That dust particle sizes of three to five microns or sizes less than 10 microns require low surface tension liquids compatible with the dust. 3. That a wetting compound must be atomized to fine micron size droplets for dust control. 4. That correct nozzles for tempering and general wetting, and fool-proof equipment are necessary, automatic proportioning and nozzle control to make wet dust control a success.

The Administration of Safety Programs

By A. C. BECKSTEAD

Dir., Safety and Technical Employment, American Smelting and Refining Co., Salt Lake City, Utah

In order to properly administer a safety program, it is first necessary to establish the proper organization. This organization must have the support of all individuals in the company from the chairman of the board and president to the newest pay roll employee.

Second, a definite safety policy must be formulated by all levels of management in conjunction with all members of the safety organization. This policy should be flexible enough to meet changing conditions and emergencies without causing confusion or trouble.

Third, it is necessary that the importance and proper emphasis to safety be recognized by all levels of management and by every employee in the company including employees just being hired.

Fourth, a definite follow-up and check system through reports and on-the-spot inspections should be conducted constantly to follow the progress of the safety program and to prevent bad practices from developing and enlarging.

Fifth, individual plant safety departments must be provided with trained personnel and provided with the authority and equipment to do the job expected.

The following outlines the organization for the administration of a safety program as it is presently set up in the American Smelting and Refining Company. Here, safety is recognized with the same importance as production by all levels of management.

The committee on safety and technical employment is composed of the top executives of the company including the chairman of the board, the president, the operating vice presidents, and representatives from the financial and legal departments. The director of safety and technical employment reports to the president of the company and meets with this committee whenever conditions permit or whenever problems of such a nature arise and are of such importance to demand the attention of this company-wide safety committee.

The department of safety and technical employment is composed of a director, three traveling safety inspectors, and secretaries. The inspectors report to the director of safety and technical employment through regular inspection reports of visits to the individual plants throughout the United States and Mexico. Thus, the over-all safety program is coordinated through one individual to the president of the company and to the heads of the various operating departments. The most important factor in making our safety program effective has been the whole-hearted support and cooperation of the executives in charge of our company.

The functions of the department of safety and technical employment are first, to act in an advisory capacity to the various safety departments and to all plant managers of the smelting company and federated metals division. Its services are also available to the various mining divisions within the company if they see the need to call on us.

Second, traveling inspectors visit each plant in the United States and Mexico at least once each year and make a detailed report in connection with safety, welfare, housekeeping, and sanitary conditions as they exist in each plant. Suggestions and recommendations for correction or improvement of any problems or conditions are made to the manager through the director of safety and technical employment, who in turn works with the vice president in charge of the department directly concerned to correct the situation. If the problem is of a company-wide nature, it is taken up directly with the president and the committee on safety and technical employment for clarification.

In order that the individual plant safety directors may have a part in the formulation of policies and programs which are to be put into effect throughout the company, a general company-wide safety meeting of approximately 50 men representing each plant in the United States, Mexico, and the mining divisions, and with representatives from the hygiene and medical departments, is held once every two years in Salt Lake City. Recommendations, suggestions, and problems of each of the representatives are discussed by the group as a whole.

From these discussions, definite programs of action and suggestions in connection with policy matters are prepared for presentation and recommendation to the committee on safety and technical employment in New York. The committee considers these problems and suggestions, and, in turn, the director of safety and technical employment initiates the necessary procedures to put them into effect. They concern such matters as safety, records of safety and employment, statistics, reports, training programs, employee relations programs, employee welfare, equipment standardization programs, and any other matters which may be necessary. In general, the delegates at this meeting plan the course of action for safety, training, and employment to be followed the next two years.

So far, the outline and functions of the company's method of administering the safety program has been of a general nature and on a level above the individual plant. Of course, all safety men recognize that regardless of how many policies and procedures and plans are formulated, they are only as effective as the individual plants and individual foremen want them to be. Safety men know their success and the success of the safety program depends upon the actual cooperation of the foremen in direct charge of the operating employees.

At each of our plants located throughout the United States and Mexico, full time safety directors and assistants are employed. These men are in charge, not only of safety, but of employment, of training of all types, and of employee relations.

The management of the American Smelting and Refining Company has recognized that one of the best approaches to the problem of employee relations and employee good will is through the safety department. It has long been known that men will respond to proper working conditions and safe working conditions better than they will to a lot of talk and promises. The attitude of our company has been one of quiet action rather than promises and words.

The actual functioning of our plant safety departments is as follows. The head of the safety department has the rank of assistant superintendent. He reports directly to the superintendent of the plant involved. In some cases in small plants, he will report directly to the manager. The safety department at the plant level is actually responsible for the administration of the safety program through the operating heads and foremen.

From sound administrative and good labor policies we do not have direct criticism or discipline, by the safety department personnel, of the workmen involved in the violation of safety rules or safe practices. The safety inspector calls these matters to the attention of the foreman, and he in turn takes the necessary action to correct the conditions at fault.

If, through this channel, proper results are not obtained, the plant safety director has the responsibility of presenting the problem to the department head involved. If, after consideration at this level, the problem is not corrected, he will report the problem directly to the superintendent and manager of the plant for their action. At the same time, the department of safety and technical employment is usually notified of the problems concerned and is asked for any suggestions or help in solving the problem.

If the director of safety and technical employment thinks it necessary for one of the traveling safety inspectors or himself to visit the plant, this is done immediately in order to help in solving the problems concerned. It is possible to see from this type of organization that the safety department actually has methods at hand to correct unsafe practices and conditions or to correct attitudes of foremen and department heads in case it becomes necessary.

Everyone is aware that training the individual workmen, foremen and department heads is one of the most important problems in the proper administration of a safety program. Our company has been doing work along this line for several years.

Approximately four years ago, a very intensified program was started with supervision in order to prepare them with the proper approach and methods in dealing with the workmen. This program covered not only safety problems but the over-all employee relations problems which come up in the day to day contacts of workmen and foremen and department heads, as it is not possible to separate them. Throughout the entire program, the importance of safety is stressed in order that foremen will train each new employee in safety as he is being trained in his new job.

In training of any type, it has long been recognized that one good picture is worth a thousand words. As a result, the major part of the training program is based on films. Surveys of all the available films and picture materials are made in order to determine which apply in the best manner to the problems of our company. It was agreed to purchase all of the necessary equipment and tools to make this training program effective and to continue it. The program is put on by the individual plant safety and employment departments.

This program had been in effect approximately a year before any important results were noticed. After this time, however, several of the plants showed a very decided improvement not only in their safety record but in the number of employee relations problems which previously had been unsolved at the foreman level.

This program has been expanded and continued. A circulating film library has been established in the safety and technical employment department's headquarters in Salt Lake, and films are distributed from there to each of the plants as they are required.

These films are used not only to train foremen but also to train individual workmen. It has proved very helpful to the safety program in stimulating workmen to use safety equipment and to perform their work in the accepted safe manner to show them films followed by short explanation and discussion.

Throughout most of our plants we also make use of workmen's safety committees. These committees recognize that the responsibility for safety is solely the company's. These committees act in an advisory capacity and make suggestions to their foremen and to the safety director. The suggestions as made receive prompt attention. Within a very reasonable time, explanation is given to the men making suggestions as to what action they can expect.

In the administration of a safety program, in order to evaluate the progress and to keep track of what is actually occurring at each plant, the local safety director sends to the department of safety and technical employment a complete report of each accident as it occurs, assigning a breakdown of responsibility and stating in definite detail what steps are being taken to prevent a recurrence of this accident. These reports are followed up by actual on-the-spot investigations by the traveling safety inspectors and by the safety director when the plants are visited.

Also, a monthly recap of what has taken place so far as absenteeism, labor turnover, accidents to all personnel of a first-aid, non-disabling nature and of a disabling nature is made. These reports are prepared and combined for distribution to the entire company each month. Thereby, each plant knows exactly its standing so far as the safety record is concerned with all the rest of the plants.

A recap of every accident in the division is circulated to all plants. By accumulating and studying all accidents of any nature in the company, it is possible to spot trouble in many cases before it becomes serious. Also, a complete picture of what is happening at each plant in connection with accidents gives a basis for over-all planning for elimination of trouble spots on a company-wide basis.

In order to make the administration of our safety program effective, the cooperation of everyone in the safety department with the medical department and with our hygiene department is required.

The American Smelting and Refining Company has been one of the leaders in the field of industrial hygiene. This department has cooperated with and helped the safety department with the many problems which are common to both. Every safety man recognizes the importance of the medical department to the success of his program. He realizes that proper medical treatment and proper medical education of employees is one of the keys to the success of the program.

As a result, the medical and hygiene departments are consulted constantly in connection with our problems and their suggestions are sought and used. Also, they participate actively in our safety meetings which are held every two years. They have a definite hand in the formulation of over-all company safety policies, as in most cases the welfare and health of employees is definitely concerned with safety.

It is always a very difficult problem to evaluate successfully the administration of a safety program. For a long time this has been done by the use of statistics which are accumulated by the individual plants. However, everyone recognizes that statistics have a very limited use as the methods of computing and reporting accidents vary from company to company. As a result, it has been the policy in our company for each plant to compare its record for this month to the past month, and for this year to the past year, with itself and with other company plants.

The figures in connection with frequency which will be given are based on the National Safety Council method of reporting lost time accidents. Our company reports an accident as disabling, lost time, if the man cannot return to his regular job on his next scheduled shift.

Starting in 1947 with the Smelting Company plants, the frequency rate for the year 1947 was 15.9; 1948 showed a reduction to 11.8; 1949 a further reduction to 8.8; 1950 a small reduction to 8.2; and the record so far for 1951 is 6.0. You can see we have had a reduction from approximately 16 to 6.0 in a period of four and a half years.

The Federated Metals Division of the company in 1948 had a frequency rate of 40.1; in 1949 they had 33.0; in 1950, 22.4; and to date in 1951, 22.5. The reason for the difference in the frequency rates between these two divisions is that Federated has a different type of operation requiring a great deal of hand handling of materials in which bruised fingers and broken toes are the result. These accidents are reported in our frequency tabulation even though the man misses only one day from work.

These figures have more significance when the fact is recognized that many state industrial commissions have become very liberal in making awards to men for non-disabling accidents in which no time is lost from his regular job. Our frequency figures include all of these awards, and they are figured in our frequency rate in the same manner as if the man had lost time. When the award is made on an accident which occurred in a prior year, it is taken up in our figures at the time the award is made.

You have all been aware of the necessity in a good safety program of eliminating the no-lost-time and first aid cases as well as the disabling accidents. Our program has been geared to take care of these problems also. We are endeavoring to plot jobs and departments where several non-disabling accidents occur in order that job operations may be studied along with working conditions in order to eliminate this type of accident as we all know a department reporting a large number of non-disabling accidents is certainly due to have a serious lost time accident.

In summary, I would like to point out the following requisites to the proper administration of a safety program:

1. Secure the cooperation and participation of all members of management and supervision in your company from the president and chairman of the board down to the newest employee.

2. In the formulation of policies and procedures which will affect the over-all safety program of the individual plants, set up machinery whereby the individual plant safety inspectors may have a definite part in the formulation of safety policies and procedures which will affect the entire company and their jobs. Also, in connection with this, make provision for the safety director to make use of the foremen and the plant department heads in gathering their ideas and problems in connection with the formation of the over-all safety program, as it is necessary for the men closest to operations to have a definite part in policy formation and program plans.

3. Make certain that the safety personnel at each plant is properly selected, properly trained, and has the authority and enthusiasm to do his job regardless of the obstacles he may encounter.

4. Set up the proper training procedures and media through which all members of supervision including managers, superintendents, department heads, foremen, and workmen can be trained. Also, make certain that in turn each individual workman is trained thoroughly and followed up in proper safety methods and practices.

5. Provide help and suggestions to individual safety directors as they need help.

6. Provide a method whereby the progress of the safety program on a company-wide basis and also the progress of the safety program on an individual plant basis may be evaluated and followed carefully.

The success of the administration of our safety program is definitely attributable to the cooperation and participation in the program by all levels of management from the chairman of the board, president of the company, the vice presidents, down through plant managers, plant superintendents, and safety inspectors. Most of the credit, however, is due to the foremen who are the ones who actually administer and put into practice the functioning safety program.

Safety in Handling Magnesium

By WALTER BONSACK

Vice Pres. and Dir. of Research, Magnesium Co. of America, East Chicago, Ind.

Magnesium, when molten or when finely divided, oxidizes rather fast under development of heat, i.e., it will burn if certain precautions are not taken. The fire danger which some people associate with magnesim probably is caused by its early application in flash powder in fireworks and more lately in incendiary bombs. Most people do not realize, however, that the starting mixture in the magnesium bomb is aluminum and iron oxide and the amount of aluminum burned in this bomb is probably just as large as the magnesium.

The so-called "danger" associated with handling magnesium is no greater than handling coal, wood, aluminum, grain, or any number of common materials. Coal dust, flour dust, wood dust and aluminum dust are easily ignited and are explosive—so is magnesium dust. Wood shavings, coal, aluminum shavings and similar material will sustain a very good fire if allowed to ignite—so will magnesium shavings. Large boards and lumps of coal are difficult to ignite. Large aluminum or magnesium pieces are not easily ignited because they conduct heat away rather fast. The fire danger of magnesium depends on the prevailing conditions as with all other materials. Underwriter's laboratories issued a report to the effect that magnesium alloys are safe materials to use in housings of portable electrical appliances under all ordinary conditions. If the alloy is at least .080 inch thick, danger from fire is very small.

Magnesium in its production and use is handled in two very distinct phases which have their particular safe handling methods. These two are the liquid and the solid phase. The liquid phase predominates in the manufacture of the metal, its alloys and some of its semi-finished and finished production, as billets and castings production. Therefore, the handling of liquid metal will be discussed first.

The raw metal magnesium is mostly produced electrolytically from magnesium chloride. This magnesium chloride may be produced from ores such as dolomite, from salt brines as found in Michigan or Ohio or from sea water which is an unlimited source of magnesium. The electrolytic process is carried out in a "cell furnace" and at regular intervals magnesium metal is withdrawn from the furnace. This metal, although liquid and quite hot, does not "burn" because it is protected from oxidation by sulfur-dioxide.

There are two more processes which were used during World War II. Since both produce the metal less economically than the electrolytic process, they were not used after the war. Some of these plants, however, are being reactivated at the present time to provide a greater supply of magnesium.

Of these two processes, the Pidgeon process is the one used to the greatest extent. This process reduces magnesium oxide or even dolomite, the ore, with the aid of ferrosilicon in vacuum. The magnesium formed is in vapor form and is condensed in crystal form in the water cooled end of the reaction pipe. Periodically the tubes are opened and the accumulated magnesium crystals are removed. Since these crystals represent a large surface, it is advantageous to melt them into ingot form to prevent oxidation. Nevertheless, many carloads of crystals have been stored for long times without danger. During the melting of the crystals, alloying also is done as previously mentioned.

The third process, the Hansgirg process, reduces magnesium oxide with carbon at high temperatures under vacuum. This process has had the least application because it is very difficult to handle. Again, the product has to be remelted to be poured into usable shapes.

In the last two processes the magnesium formed in the reactions is in vapor form in a vacuum. The condensation and crystallization of this vapor is very important. If the magnesium would condense in the form of a very fine powder, it would become easily oxidizable and burn. By proper crystallization this danger is eliminated completely. Metal vapors and metal dusts are dangerous just as coal dust, flour, or wood dust is. Since vacuum is employed, air is excluded and no burning or oxidation can occur. Getting a good vacuum is, of course, a prime requisite and holding it till the reaction units are cold are safety requirements.

The raw magnesium is remelted for removal of non-metallic impurities or to alloy other elements with it to make it into useful alloys. As with most other metals, magnesium seldom is used as pure metal. Most of its applications are in the alloyed state. The most common alloying elements are aluminum, zinc, and manganese.

In the last few years, new alloys have been developed which contain zirconium, cerium, and other rare metals. Although they are still in the development stage, these new alloys already have found extensive application in aircraft construction.

Preparation of alloys is a batch process, usually carried out in large steel pot furnaces. Since magnesium does not attack or react with carbon and silicon carbide, open hearth type furnaces constructed of these materials also can be used. The metal is melted and because it oxidizes very easily and since the oxide formed does not protect the metal underneath, as aluminum oxide protects molten aluminum, it must be protected by fluxes which consist of chlorides and fluorides of alkali and alkaline earth metals.

Magnesium melts at 1202 degrees F. and addition of alloying elements lowers this melting point somewhat. At temperatures just above the melting point the metal can be handled quite safely without oxidation. At higher temperatures fluxes or inert gases protect magnesium from burning. Addition of beryllium or calcium in small amounts will reduce the burning tendency considerably, but since these two elements may affect some properties adversly, they are not always applicable. Since magnesium does not attack iron, it can be melted safely in iron or steel vessels, the furnace tools can be of iron and the metal and alloys can be transported by pumping through iron pumps and pipes.

Because magnesium is a very reactive metal and since it will reduce most other metals from their oxides or compounds, it is necessary to see that all iron and steel f--nace tools and implements are free of heavy oxide scales. The fluxes used in the melting of magnesium are very hygroscopic. Tools which are covered with flux and have not been dried properly may cause dangerous spattering of molten magnesium, as it would with any other metal.

The difference between magnesium and other metals is that the spatters of magnesium will oxidize rapidly or burn while most other metals will just solidify and give off their heat. This means that the same precaution to use only preheated dry furnace tools is necessary for all molten metals, but particularly is necessary for magnesium because its fluxes attract water so easily. The safe practice is to have a flux pot with molten flux handy in which furnace tools will be preheated to a safe temperature and in which they can be washed clean of adhering oxides and fluxes.

The steel pots in which magnesium is melted will become oxidized on the furnace side and a heavy scale of iron oxide forms. This scale breaks off the pot and accumulates in the furnace bottom. It is necessary to remove this scale frequently through the ports provided for this operation. The reason for this precautionary measure is the fact stated before that magnesium reacts with most metal oxides and with iron oxide it could react explosively.

In case a pot breaks or begins to leak heavily, an accumulation of scale in the furnace bottom would provide a dangerous situation. If no scale or only very little is present, no danger exists. Loading the leaking pot heavily with flux will cause flux to leak rather than metal, or you may "freeze" the metal in the pot by adding cold flux and metal, both good safety measures.

To prevent the occurence of pot breakage, the pots are removed every week from the furnace and thoroughly cleaned. The scale is removed by hammering. The pot is then inspected for defects and its wall thickness is measured. If the thickness has decreased to one-half of the original, the pot is discarded.

Since all magnesium used has been handled at least twice in the liquid state and since we are using thousands of tons of magnesium yearly, many people have learned to handle the liquid phase quite properly. It is necessary only to recognize the characteristics of this metal and to use common sense and the few special precautions shown as dictated by the metal.

The liquid metal or alloy is cast into ingots for the foundry or into billets for the rolling mill, the extrusion process of the forge. For extruding and forging usually round billets are poured, but for sheet and plate rolling flat billets are poured. This pouring may be done with a hand ladle, with a tilting furnace or the metal may be pumped into the molds. In any case, the molds are filled first with an inert gas, usually sulphurdioxide, and the metal then is poured replacing the gas in the mold. In this manner, oxidation has been stopped during the pouring process.

During solidification the billet or ingot casting is kept in sulphurdioxide atmosphere or sulphur and boric acid is dusted lightly over the surface exposed to the air. The burning sulphur will form sulphur dioxide and prevent oxidation.

Ingots obtained in this manner will go to the foundries to be turned into castings. There are three common casting processes in use today. They are sandcasting, permanent mold casting, and die casting. Each of these processes has its particular application which usually is determined by the complexity of the casting design and the economy of the processes.

Mass production of a fairly simple design and relatively small dimension will call for die casting. Very complicated and/or large castings of which only relatively few are needed certainly demand sand casting. Between these two extremes permanent mold castings find a very good application. Permanent mold castings also are mass fabrication products.

Dies and permanent molds are made of steel and iron respectively. In the first method, the die casting, magnesium is poured into the die at high speed and high pressure, i.e., pressures of 2000 lbs. per inch square or more and speeds of 200 ft. per sec. or more. The metal is cast at low temperatures, usually below 1200 degrees F. Since magnesium does not attack steel, no reaction occurs between the die and the metal. The metal shot into the mold freezes instantly.

With magnesium as with all metals in die casting, precaution must be taken that metal which may be forced out of the mold during the initial shot does not injure personnel. The wearing of face shields and gloves is necessary and flash shields must be provided as usual. Since pouring temperatures are very low, the metal shows very little tendency to burn. The metal in the holding furnace is protected by sulphurdioxide gas.

Pouring of permanent mold castings depends on gravity. The filling of the mold cavity therefore is much slower than in section thicknesses and much heavier in weight than die castings. The metal usually is poured at higher temperatures in order to fill the mold. All these factors require a neutral atmosphere for the metal, again sulphur dioxide is used.

Before each pouring the mold is filled with sulphur dioxide gas which is heavier than air. Since the alloys for permanent mold casting are cast at a temperature usually higher than 1250°F. they are protected from oxidation in the furnace by flux rather than by sulphur dioxide gas. To prevent flux contamination of the castings, the metal is handled in a bottom pour or special ladle.

Contrary to the die casting practice, the cavity of the permanent mold is coated with an insulating paint or wash. This is used primarily to regulate the heat flow from the metal to the mold. Logically, it does not react with the metal. As soon as the metal has solidified, oxidation or burning possibilities have stopped.

It has been shown that in these two casting processes the metal has no opportunity to react with the molding material. In sand casting, however, this possibility is quite real. Usually the molds are green sand molds, i.e., they contain three to five per cent moisture. The moisture will form steam with the hot metal, the steam will be decomposed by the metal, and the hydrogen liberated can form explosive mixtures. Magnesium can react with the sand in the sand mold and form silicon or magnesium silicide under the liberation of considerable heat.

It is necessary to prevent these reactions and it is quite possible to do so by the addition of inhibitors to the molding and core sand mixtures. These inhibitors usually are ammonium fluoride, boric acid and sulphur and similar compounds. Diothylene glycol is used to replace part of the water. With these inhibitors present in proper amounts, the green sand mold offers no more danger than any other metal poured in green sand.

Again, to prevent rapid oxidation or burning of the surfaces of sprues and risers which are exposed to the air, these are sprinkled with sulphur flour to exclude the atmosphere.

There is one more process in which liquid magnesium is used and the process is welding. Arc, gas or electric resistance welding can be used. Magnesium is mostly arc welded in a protective atmosphere of helium or argon gas. The materials which are welded together generally are of considerable volume or area or both and, consequently, carry the heat of the electric arc away fast enough so that metal outside the area of protection of the gas never reaches a temperature at which it could ignite.

As in heliarc welding, the only protective devices necessary are those common in any welding, i.e., welders are trained to handle magnesium and shields between welders protect them from light and flashes created by welding. The liquid metal is the metal in the bead and as stated before, it solidifies rapidly. Spot welding also is done but the temperatures are never high enough for ignition.

Magnesium castings often are heat treated either to enhance their properties, or they are annealed to be processed into wrought materials. In both cases the metal is brought up to high temperatures in furnaces. Because of segregation in composition it may be possible to cause slight incipient melting of eutectic. If the furnace atmosphere is not protective the castings or materials may start to burn. Again sulphur dioxide is used for protection. Sulphur dioxide controls constantly check the concentration. Carbon dioxide also can be used but it appears to be slightly less effective and more costly.

If the temperature control does not function properly, it is possible to melt the castings in the furnace and then fires are possible. This occurs rarely since double controls are used. If it should happen, it is necessary to kill the fire with G-one powder or flux and let the mixture cool off in the furnace. It may mean a new furnace lining and new heating elements but beyond this there is no danger greater than molten aluminum alloys in a heat treating furnace.

The Dow Chemical Company recently reported that borontrichloride gas is a better extinguisher of magnesium fires in heat treating furnaces. Research experiments indicated its effectiveness and the actual test in a 1000 lb. magnesium fire confirmed that it is better than G-one powder.

When magnesium burns in a furnace, it is flooded with boronthrichloride gas with the furnace fan on to insure good, even distribution, adequate precaution has to be taken not to get exposed to borontrichloride gas. Although it does not appear seriously injurious to health, it decomposes into hydrochloric acid and boric acid fumes.

Finishing products may involve a number of operations not mentioned above. In some of them heat again is applied to the material but in general the temperatures are much lower and usually of shorter duration.

To mention some examples, deep drawing, press breaking and forming, stress relieving and stabilizing which for magnesium require temperatures of up to 600°F. Paint baking also applies heat to the product but in each case the temperatures are so low that there is no danger of ignition.

Castings, extrusions, sheets, plates and other shapes are subjected to sawing, grinding, routing, shearing, boring, trimming, and other similar operations in which material is removed in the form of chips or even finer particles such as dust. The smaller the particle, the greater is its surface. This large surface can oxidize very rapidly and if properly suspended in air may even cause explosions.

This is true of any combustible dust. It is therefore of importance to prevent any accumulation of fine magnesium particles.

An example is in grinding. Care must be taken that the grinding leavings are collected in water constantly. The collectors have to be cleaned daily. If the proper wet collection system is not available, the only safe way to grind magnesium is to grind it in water or wet.

Chips as produced by saws, drills and other similar tools are not an explosion type hazard, but still a substantial fire hazard. In all cases sharp tools and heavy cuts are the safest way of machining.

No water or water solution cutting compound can be used. If any coolant is necessary oils should be used. Turnings or borings may be ignited by a spark, a cigarette or the like. Therefore, smoking must be prohibited in these areas.

Areas in which machines produce chips must be cleaned frequently and thoroughly. The chips are put in covered metal drums and stored outside buildings.

Fine particles and grinding dust should be disposed of as soon as a drum is filled, fine particles by burning and wet dust by burying or by drying in a magnesium fire and burning.

Large turnings and borings or scrap of this order also are handled in tightly closed steel drums. As long as they are kept dry they are safe. These can be sold to competent smelters to be remelted and salvaged as can all larger magnesium scrap pieces.

In all these operations in which fine particles of magnesium are formed, it is best that the worker and personnel in the department wear safe clothing. Proper clothing is that to which the dust will not stick, into which dust will not penetrate, and which does not have folds like cuffs or pockets in which dust or chips may accumulate. Hard surface clothing then is recommended. Caps should be worn so that the hair does not become filled with magnesium dust. Frequent thorough cleaning of all clothing is highly recommended. Also, the clothing worn should be so designed that it can be taken off quickly.

Water is not used for magnesium fire fighting. The main reason for this is the fact that water poured on burning magnesium usually infuriates such fires up to explosions. The reaction which occurs explains this behavior. Burning magnesium plus water gives hydrogen and magnesium oxide. Hydrogen in proper mixture with oxygen is very explosive. This same reaction occurs when finely divided magnesium dust gets wet. It corrodes rapidly under development of hydrogen and heat. At proper conditions the mixture will ignite spontaneously and a fire has started.

If a large amount of water covers the dust as in wet grinding, then there is no danger. Also, if large amounts of water could be thrown instantly on burning magnesium to quench the fire and cool the hot magnesium below the melting point, no danger would exist. It is very seldom that so much water is available so it is much safer not to use any. The best method is to use powders, fluxes, or even dry sand and dry, clean iron filings. The main object is to smother the fire by separating the magnesium from the oxygen supply of the air.

Since burning magnesium does not develop toxic fumes, it is perfectly safe to go into the room in which magnesium burns and to remove either the burning magnesium with a dry shovel or to remove the magnesium around the burning part and let the fire burn itself out or kill it with sand, G-one powder, etc.

Magnesium properly handled poses no more of a fire danger than many other metals or materials. Magnesium is safely handled if its characteristics are known to the people handling it. The few basic safety rules must be vigorously enforced. Fire fighting must be taught to the supervisory staff and to the men in critical areas. The proper equipment always must be available and handy. Good housekeeping, though, is always the best means of fire prevention.

The Part Management Must Play in the Safety Game

By L. F. REINARTZ

Vice Pres. in Charge of Special Operating Developments,
Armco Steel Corp., Middletown, Ohio

If industry wants to continue to make real, lasting progress in the safety of its employees, top management must accept its personal responsibilities for the safety of its employees—"lip service" will not do. Employees soon learn the difference between genuine interest and the "phoney" kind. Top management must be willing to spend time, money and effort to help carry on a worthwhile safety program.

I have always believed that plant safety programs are peculiarly American. They are part of our free enterprise system, because their success is based on cooperation between management and workers. These safety programs are not old. Seventy-five or more years ago, prior to the advent of the industrial age, large mechanized plants did not exist. It is true that there were many accidents on the farm and in small shops. Little was done about eliminating them. In fact, in a sort of fatalistic way, they were taken for granted.

With the dawn of the industrial era, many operations were carried on under one roof. Heavy machinery came into being. Very little attention was paid to design from a safety angle. Hazards, and serious accidents, especially in steel plants, increased by leaps and bounds.

Mr. Charles R. Hook, Chairman of the Board of Directors of Armco Steel Corporation, was a pioneer in the improvement of the safety of workers in the steel industry in the United States. Having always been interested in the employee first, as an individual, it was only natural for him to take an active interest in safety when the National Safety Council was organized in 1912. In those days it was an up-hill battle. Equipment was inefficient; guarding of machinery was nil; safety apparel had not been invented; housekeeping was terrible; cooperation between management and workers was far from ideal, and training was nonexistent.

Mr. Hook's enthusiasm and interest, once aroused, could not be dampened despite the stony stares of supervisors. Instead of losing his temper, when his best efforts went for naught, he calmly and tactfully continued to teach and sell safety to his key men. He said that there could not be any consistent quality and tonnage production until men felt they were reasonably secure from accidents. He meant it! And the men knew he meant it when they saw him shut down vital machinery in production units which were not properly guarded or unsafe to operate.

As time went on, supervisors saw proof that safety was simply good, sound business. They caught the spark of his enthusiasm for safe operations, and began to preach the gospel of safety themselves.

In the early days of safety, the spectacular revival type of approach was tried: first aid teams, banners, slogans, contests of all kinds, prize awards. They helped, but results were not lasting. Gradually management saw that this safety job could not be started with a big, dramatic push and then simply delegated, with a shrug of the shoulder, to the foreman and the individual worker.

During the last ten or more years, supervisors at Armco, and many other steel plants, are held strictly responsible for safety, ahead of quality, production, and costs.

Safety engineers have been important cogs in the safety program. They plan, check and exhort, as well as encourage the supervisor and his men in safety. But in the final analysis, the job is done by the supervisor.

A down-to-earth practical plant safety job must be done by the foreman's contacts and observations; machinery must be designed with practical and effective safeguards; equipment must be kept in safe operating condition by proper preventive maintenance; standard safety practices must be understood by all who use them; the supervisor must be sold on good housekeeping, and, finally, the men must have interest and enthusiasm, and want to work safely.

No company will make the best progress in safety until its general and works management accepts its full responsibility for safe working conditions and practices, that is, really puts safety *first*.

Top management is watched very closely by lower ranks of supervision, the foremen, and by the men. The price of cooperation is genuine interest in men, and a consistent policy to win their regard and good will. Without that a successful safety program is impossible. You can't force a man to be safe. You must teach him to want to be safe for his own sake and for his family's welfare.

In industry, if there is cooperation and understanding between management and workers, you can solve almost any problem, including accident elimination.

Management has some very definite responsibilities toward safety. It must provide a safe plant. A safe plant means good housekeeping. It means fume and dust control, proper lighting, sanitation and ventilation. One of the major causes in the early days for accidents was poor lighting. All of these things cost money, time and effort, but they pay off in safety, which, in turn, helps pay off in making profits, the life-blood of business.

Safe-guarding machinery: this problem is not as serious as it was in former years, because most steel plant engineers have become safety conscious, and usually incorporate ample guards in the original design. Nevertheless, it is essential that a safety engineer scrutinize and approve all new designs and drawings for inclusion of adequate safe-guards. Management should never put new machinery or equipment into operation until it has been checked and approved for safety by the construction engineer, the maintenance and operating superintendents, and the safety engineer.

Management must maintain an adequate system of preventive maintenance that includes a thorough search for hazards. This program is the direct responsibility of superintendents and foremen.

Train, educate and enthuse safety-minded supervisors to plan and arrange all processes with careful attention to safety, and teach them how to spot accident hazards, be safety conscious. It is advisable that supervisors use note books and write down their observations. A check-list of possible accident hazards in his area to be investigated will help the foreman do a good job.

Management, as represented by the foremen, must then train, educate, and enthuse employees to be safety conscious. We must play up the personal side of safety, the fact that "You must not get hurt—so that you will not lose wages and security, and that you will not have pain or sorrow."

A practical foreman once told me, when explaining his own long-time safety record, "I look out for No. 1—and keep my eye on No. 2." That's a splendid safety policy for everyone. If we are to have the best success, we must bring the employees into the safety program.

No better way has been found to enlist their aid than through a suggestion system which pays employees for ideas, safety, or otherwise. It is the foreman's job to interest his men in making safety suggestions. Incidentally, it is a good check for foremanship, also. Few employees will make suggestions in a group which is not on a good working basis with its foreman.

Show employees, by means of bulletins, pictures, films, through every selling scheme why it pays him, personally, to be safe. When an employee does make a suggestion, it pays dividends in good will if the supervisor makes speed in rejecting or adopting the idea. It shows the employee that his foreman is vitally interested in the employee's safety.

Management must investigate all major and minor accidents, even those in which no human loss has been sustained. There is only the difference of a split second, or a fraction of an inch, between minor and major accidents. Get all the facts. Be fair in your investigation of an accident. Profit by carefully studying the record of past accidents.

Plan major jobs carefully, ahead of time, and brief every participant in what must be done and how it will be done. That is a sure way to help prevent accidents. When that is conscientiously done, accidents seldom occur.

Those, in my opinion, are management's primary safety responsibilities. In order to help meet those responsibilities, alert managements are using every practicable means at their disposal to sell the value of safe practices. At Armco Steel Corporation, our general management holds the manager of each division strictly responsible for the accident prevention program in his division. In carrying out this responsibility, he has a meeting on the first Wednesday in every month with his division heads, personnel assistant, chief engineer and safety engineer. The entire afternoon is spent in analyzing the cause or cure for lost-time accidents of the previous month, unsafe practices, equipment, planning and selling policies for future accident prevention activities.

Then, on the second Wednesday afternoon of the month, the division heads carry these safety messages and directions to their respective superintendents, and secure their suggestions, advice and counsel.

On the third Wednesday each superintendent meets with his own foremen and again carries the safety message down the line.

During the 4th week, the foreman, in turn, devotes the entire time of his weekly meeting with his employees to the subject of safety. Normally, these meetings last one half hour. The company pays for 15 minutes, and the employee donates 15 minutes. In all these discussions, which are entirely on a voluntary basis, the emphasis is laid on the fact that a safety program, to be successful, must be a two-way street, ideas must go from management to the workmen, and suggestions how to improve safety must be forthcoming from the workers up to general management.

Here's one of the results of Armco's safety program: In 1917, with 3,500 employees, Armco had 432 lost-time accidents in its East Works at Middletown. In recent years, with 1,000 more employees on the payroll, the number of accidents has been cut down to an average of 26 per year, a reduction of over 93 per cent.

Several years ago, it was my privilege to be given charge of Armco Coal Mine Operations in West Virginia. The public has been led to believe that not much can be done to decrease the distressing number and severity of accidents in the coal mines.

The fact is that Armco, as one company in the steel industry, by following sound personnel and safety policies and practices, has been able to make great progress in recent years in reducing the number and the severity of accidents in its mines.

It is my firm belief that, with the cooperation we are receiving from the management of our coal mines and our miners, we can and will bring these operations up to the high safety standards of Armco manufacturing plants.

In the final analysis, we must continue to talk, talk, and talk safety until it becomes an ingrained habit with management and men. It has been my observation that, when we begin to rest on our oars and think we have arrived at a good safety performance, we had better look out. Old Man Accident is lurking around the corner to trip us up. We must keep everlastingly at this safety job!

Remember, as business leaders, we must produce profits for the stockholders of our businesses. Entirely outside its humanitarian aspects, the practice of safety is good business. It has been proved, over and over again, that it pays in cold cash. You can't afford to have accidents!

The greatest responsibility, of course, for safety, rests with top management. We must carefully screen and select those who will lead our workers. They must be properly trained to put the safety of the worker first. They must know what to do and how to do it. They must enlist the minds and energy of those entrusted to their care to produce with safety a quality product at reasonable cost. Their goal must be no accidents at all. It is up to us, as management, to strive constantly toward this goal!

Safety is a Way of Thinking

(A demonstration lecture on the use of gadgets in the promotion of accident prevention)

Chairman: ROBERT S. B. HOLMES, Director of Training and Safety, National Tube Co.

Participants:

ARTHUR D. MURPHY, Director of Safety and Suggestion Plan, Crucible Steel Co. of America.

KENNETH I. WARD, Ass't. Supvr. of Safety, Eastern District, Youngstown Sheet and Tube Co.

WILLIAM H. WILSON, Supvr. of Safety, Ambridge Plant, American Bridge Co.

EDITOR'S NOTE: Because of the nature of the presentation, the following edited version of this program is limited to orally presented material. The demonstrations presented by members of this committee have been omitted due to printing and space limitations.

ROBERT S. B. HOLMES: It is indeed a pleasure for the Visual Aids Committee to have this opportunity to talk with you this afternoon, and to summarize the 1950-51 activities of the Committee. As Chairman of the Committee and speaking for the Committee, I can tell you that considerable thought has gone into the selection of the title for this meeting—*Safety is a Way of Thinking.* We believe that safety is first and foremost a "way of thinking," therefore, we are interested in giving to each industrial worker that "way of thinking" which will carry him safely through each working day. This objective has many facets. It has the problem of selecting the right person; the problem of giving him the needed training and experience; the problem of giving him adequate supervision; and the problem of motivating him each day to his greatest safety effort. Yes! "safety is a way of thinking." It is a "way of thinking" which causes a man to close automatically the cover on a packet of matches before striking; it is a "way of thinking" which causes a man to reach for the handrail when going up or down stairs; and it most certainly is a "way of thinking" which forces each of us to stay within the confines of safe working procedure and to make a reality of the slogan, "Safety First."

You are now entitled to ask, "How do visual aids fit into the development of 'ways of thinking'?" Your Committee believes visual aids fit in just as any other method of teaching, or segment of experience fits in. Visual aids contribute to our store of knowledge, they aid retention of important points, and they tend to impress key points upon the mind, to the point where the mind considers them. Ideas which the mind considers, the mind acts upon. When the same idea is acted upon frequently, it becomes habit. Our goal is the formulation of safe work habits. We need both the conscious and the unconscious mind working at all times toward the prevention of accidents.

The human eye is so designed that it sees anything that comes within its range of vision, but only when that vision is registered on the brain do we have perception. Perception then is recognition; it is toward the perception of unsafe conditions and unsafe practices that safety objectives are directed. Vision alone is not enough. We, therefore, are faced with the problem of using visual aids in such a way that recognition of the hazard results from knowledge of the cause.

Let us look to another aspect of safety as a "way of thinking." Accidents are no respector of persons, nor do they have any respect for the element of time, they occur in a split second with the guard against this split second happening being a "way of thinking" which prevents all the factors leading to an accident from coming together at the same time and in the same place.

In industry, we have what is known as "feel." We say that a machinist has the "feel" of his trade, a roll turner has the "feel" of his lathe, and a roller has the "feel" of his mill, but what is "feel"? "Feel" is knowledge, experience, and many long hours of guided practice; all of these —knowledge, experience, and practice—add up to job "know-how." Job "know-how" is passed from one to another by communication. Perhaps the communication may be of the type often cited where the old Roll Turner *taught his son the "tricks of the* trade" by lantern light, or it may be some other type.

Visual aids can and *should* be one of the best tools that a safety engineer can use. The intelligent use of a visual aid in the *right* place at the *right* time can often reach the employee with a valuable lesson when other means have failed.

We cannot pass over this subject of communications without calling your attention to other means of communication that are equally effective. On the platform, there are two exhibits which are here through the courtesy of the Youngstown Sheet and Tube Company, and the American Bridge Company. I am going to ask Mr. Ward, of Youngstown Sheet and Tube to tell you about this means of communication which Youngstown Sheet and Tube employs. Mr. Ward, will you tell us about your releases?

K. L. Ward: Referring back to the opening remarks made by the Chairman, relating to the necessity of putting safety across first to the foreman, and then to the worker, we assume that each of you have had the same problem confronting our department for a number of years. This is the continual cry by the foremen for material to use in their safety meetings. With this thought in mind, our department developed a paper in which could be printed just such material. Since the advent of this paper, known as the *Foremen's Safety News*, ten years ago, we have learned a lot that will be of benefit to anyone attempting this same program.

At the beginning, the paper was in the form of a newspaper, full of facts, suggested procedures, etc., many of the articles of quite some length. The first issues were mailed to the foremen via our company mail. We soon learned two things—long articles were not read, and the paper when mailed to the supervisor's department was often lost, often put aside and forgotten and in general the paper was not used to advantage.

Later we began to mail it to the homes and found more success. Still later we began to use a front page of brilliant color, using a picture that would portray a good thought from which they could build an interesting talk. We also strive to keep all articles short and make sure they are written in everyday language, and easily understood by all of the foremen. Most of the material used in the *Foremen's Safety News* is written in our own department from ideas gathered from foremen's reports of injury, newspapers, unusual incidents, Seven Company Exchange information and exchange publications. We do not hesitate to publicize information on any idea, regardless of who presented it, just so it relates to safety.

The paper is edited and made up in our own department, printed in the Company's print shop, then mailed out by members of our own department. A special envelope is used to mail the *News*. We mail approximately 1,000 copies to the homes of our foremen and approximately 80 copies to people outside of our own company.

The extent of the use of the *Foremen's Safety News* by supervision at safety meetings is reflected to us when we read the minutes of safety meetings and reference is made to the *Foremen's Safety News*.

Mr. Holmes: Thank you, Mr. Ward. On the other side of the platform, there is displayed the material which the American Bridge Company uses. Mr. Wilson, will you tell us about this material?

W. H. Wilson: The *Safety News*, which is the American Bridge Company's monthly safety circular, is distributed to all plants of the Company, as well as our erection department. We originally started with 80 copies for Ambridge plant supervision. Our thought was to sell the safety message by means of pictures instead of so many words. The publication met with so much success that we increased the publication to 3000 copies per month, for plant-wide distribution.

We later took in all plants of the Company and made it company-wide distribution and various safety messages and instructions are featured every month. These safety circulars are carrying our message to the worker. By the aid of the multilith we are able to reproduce photographs which have added much to the effectiveness of this little publication. No safety program is complete without housekeeping. The relationship between the title of this presentation, "Safety is a Way of Thinking" and housekeeping can best be illustrated by a very common situation familiar to most of us. You all recall, no doubt, the early years of your married life and the change in thinking which took place when the first child arrived. For some time thereafter, your housekeeping was entirely devoted to one principle—that principle being "Keeping things out of Junior's reach."

This is a "way of thinking" which has as its objective the prevention of injury to the child and the elimination of the possibility of breakage of priceless possessions. So, even in the home, there is a relationship between safety and housekeeping. In fact, many of us subscribe to the belief that safety performance will rise and fall in a curve parallel to housekeeping performance.

Housekeeping is not too difficult if one remembers two very simple and very elementary rules. First, there should be a place for everything and everything should be kept in its place, and secondly, those who make the "mess" should clean it up.

Consider for the moment the general aspects of housekeeping and the manner in which general material currently available to you from the National Safety Council can be used. We have here the Safety Graph on Housekeeping as prepared and published by the Council; while we do not have time to run through and discuss all of the sheets of this Safety Graph, I am going to ask Mr. Ward to tell you how this general material can be adapted to specific situations in a steel plant. You, no doubt, will want to make mental notes of how it can be adapted to your own industry and your own company. Mr. Ward, will you take over?

K. I. Ward: I have here a "Safety Graph," entitled Housekeeping, one of the many produced and distributed by the National Safety Council.

However, as important as the subject is, I do not intend to discuss the contents of this chart with you, but rather, to discuss a new approach to the use of these graphs which we think will prove beneficial to your foremen in their discussion of the charts' contents with their men. As you can see, the chart is placed in a frame at the front of which is a light focused on the page of the chart only.

The light focused on the page under discussion draws the attention of the audience more to the material and less to the discussion leader, allowing him to read the discussion material from the back page of the chart without the feeling of stage fright so often experienced.

Mr. Holmes: I should like to point out that Mr. Ward has not spoken about the material contained in the Safety Graph, rather, he has talked about the method of presentation—this is both fitting and proper when the controlling subject is visual aids because visual aid means exactly what the name implies—a method of assisting the speaker, the instructor, or the discussion leader to put across the points of his presentation. A visual aid is literally something to lean upon and must definitely be subordinate to the material and the objective, so I consider it right that Mr. Ward's remarks be confined to the method and not the material.

Behind the use of visual aids in safety, there must be an overall plan. This plan must be worked out in advance and then the plan must be made to work in practice. Simply stated, it means, "plan your work, then work your plan." Apparent in this relationship of planning the work and working the plan is the problem of analysis. Because of the very significant position which analysis holds in the safety movement may lie the reason why so many safety people are engineers.

The Committee does not mean to infer that analytical thinking is a privilege reserved solely for engineers, rather, we do mean that people engaged in safety work must be able to analyze, to judge, and to decide. Mr. Ward, will you discuss this matter of analysis?

MR. WARD: Often, accidents seem to stem from uncontrollable factors, and the apparent cause is that the accident was due to a hazard inherent to that peculiar job or occupation.

Now, in safety work, such identification is not sufficient. Since we are interested in the elimination of unsafe acts and unsafe conditions, we must go further. We must seek out the real cause of the accident. This can best be done by the application of logic.

We must take what we have learned of the real cause and set up our objective—the correction of the factors which caused the accident. Accident investigation has no value, whatsoever, if it does not succeed in developing a safer method of doing the job on which the accident occurred.

Thus, we have completed three points in our accident analysis program. We have looked at the apparent cause; we have searched out the real cause; and we have established, and set up our objective. But the full accident analysis, as we see it, is made up of four points. We must establish responsibility; not necessarily responsibility for the accident that has already happened, but rather, responsibility for the correction of the conditions that caused the accident. We've all heard the old proverb, "Something that is everybody's responsibility is nobody's responsibility." It never had a better application than it has in accident prevention.

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