PLAINTIFF'S EXHIBIT

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Volume 5

CHEMICAL and FERTILIZER INDUSTRIES

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COAL MINING



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Volume 9

ELECTRICAL EQUIPMENT

NATIONAL SAFETY COUNCIL
425 N. Michigan Avenue
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specifications which you have established on firm electrical principles, will insure against unfortunate and avoidable electrical accidents or fatalities. Most basic of all is vigilance and constant checking of equipment and installations.

ARE ELECTRO-MAGNETIC HOISTS FOOLPROOF?

By MYRON L. MILLER
Supervising Safety Eng., Westinghouse Electric Corp., East Pittsburgh, Pa.

With over 25 years experience in the use of electro-magnets, with almost half of this time being spent in miscellaneous material handling applications, we have yet to experience a magnet failure which resulted in a disabling accident.

Until October, 1963 we had not had a disabling accident which involved an electro-magnet hoist. In October last year we had our first one; however, it was not due to magnet failure but rather to human failure.

A "hook-on" man was loading small steel plates side by side on a pallet by use of an overhead electro-magnet crane hoist. He failed to stack the plates evenly which caused the magnet to slide off the pile when the power was released. The sliding magnet struck the man and fractured his leg. He was involved in two unsafe practices which were within his power to control, namely, unstable stacking and failure to stand clear of the load.

Electro-magnet hoists have been used safely in steel storage yards and over iron scrap areas for rough handling for many years. Power failure has not been considered a significant factor because the areas were isolated and with little or no exposure of people. Safety men have been reluctant however, to consent to their use in manufacturing areas.

About 12 years ago we faced a problem of handling parts and scrap material from our large automatic burn-out tables where we were flame-cutting irregular shapes from heavy steel plate. We were using chains, wire rope slings, safety clamps, and miscellaneous special handling devices to move the cut-out parts and to pick up the remaining scrap to load into gondola cars. This was hazardous work and we were experiencing frequent accidents resulting in serious injuries. In fact, during this period, the incidence of hook-on accidents was the highest of any occupation in our plant.

After a survey of others' experience in this area of material handling, we decided to try an electro-magnet hoist. We have been pleased with the results. In the past 12 years we have extended the use of the electro-magnet to many handling jobs.

It is our feeling that with properly controlled work conditions and with strict adherence to safe work practices, many material handling jobs can be done quicker and safer with electro-magnet hoists.

Let's consider a few applications.

Heavy steel plates may be handled safely and quickly by single unit magnets. The usual capacity range of this type magnet is from one to thirty tons.

Where heavier or more bulky loads are to be handled, two or more magnets may be arranged with spreader bars to distribute and to stabilize the load.

When handling long, thin steel sheets it may be necessary to use magnets of large, cross-sectional area separated by a spreader bar to distribute the load and prevent "peeling-off."

Either small battery-energized magnets or large overhead crane magnets may be used to load steel plates on burn-out tables. After the parts have been cut-out, they may be removed by the magnet and the remaining scrap may be picked up as well.

The electro-magnet provides a safe means to load ferrous metal scrap into railroad cars. Our experience over the past 10 years has proved this to be much quicker and much safer than by other conventional methods.

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INDUSTRIAL SAFETY

(Subject Sessions)

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Volume 11

GLASS and CERAMICS; RUBBER INDUSTRIES

NATIONAL SAFETY COUNCIL
425 N. Michigan Avenue
Chicago, Illinois 60611

WHERE DO YOU GO FOR THE ANSWERS?

By W. E. SEBESTA
Chief Industrial Hygienist, Republic Steel Corporation, Cleveland, Ohio

This question has probably arisen many times for innumerable organizations whose employes have become concerned with the conditions under which they work. Of course, there may be reasons, other than those which may irritate an employe's physical health, which may generate a criticism from the employe or group of employes, in which one's health is questioned. However, since we are concerned here with industrial health, let us delve into the various paths of investigating an industrial health problem.

There are several air sampling procedures which are recommended by various individuals and organizations. Some prefer taking air samples by a midget or micro method, such as, evaluating the dust concentrations in areas, using the midget impinger system. Others prefer using a sampling method which is related to the breathing rate of an employe engaged in moderate labor.

Basic air sampling procedure must consider the type of contaminant, the method of sampling, the possible interferences, and the degree of hazard of the exposure to the contaminant.

One must first consider whether the problem is a dust, fume, mist or gaseous contaminant. If it is a dust problem, the contaminant should be collected in distilled water; if it is insoluble. If the dust may be water soluble, a non-dissolving liquid is recommended.

Dusts have also been captured during air sampling by electrostatic precipitation, by filter paper sampling, and thermal precipitation. Once the dust has been collected, it is counted as soon as possible (if it has been collected in a solution). If the dust has been captured in the dry state, the dust is redispersed in a suitable liquid in the laboratory for counting.

Sometimes, dusts are analyzed in other ways; various microscopic procedures, by change in color of the filtration medium or by gravimetric means. After counting, the dusts may be analyzed for particle size distribution or analyzed chemically for other reasons.

A fume, which is a contaminant resulting from the condensation of a volatilized material, may have to be captured using a sampling procedure capable of collecting the particles in that particular size range. Some fumes have to be sampled by use of the electrostatic precipitator.

Sampling for gases may be performed using (1) indicator tubes (if available), (2) use of a scrubbing liquid, or (3) capture a quantity of the workroom atmosphere by means of a vacuum system. The indicator tubes are susceptible to interferences, which are listed by the respective manufacturers. Scrubbing mediums can sometimes be devised to capture the suspected gaseous contaminant, this medium being analyzed in the laboratory for the specific gas.

The vacuum system refers to the capture of a sufficient quantity of the workroom atmosphere in a bottle or other container. This container was originally evacuated in the laboratory and the air sample secured in the field by opening the cylinder closure and permitting the workroom atmosphere to be drawn into the previously evacuated cylinder.

There are also other sampling methods for dusts (most of which involve filtration): a) Owens Automatic Air Filter—a paper tape device which filters the dust from a definite volume of air through a small area of white filter paper tape; b) the *Konio gravimeter*; c) the paper thimble method; d) the bag test, which is similar to method (c) above; e) the sugar tube method; and f) salicylic acid filter, which like the sugar tube, uses a crystal mass to retain the dusts.

There have been several methods developed for the capture of dust aside from the methods mentioned earlier. They are: Koniometer, Minnesota Dust Counter, Owens Jet Dust Counter, the modified impinger and cascade impactor. These are modifications of the general impingement method; the variance providing the separation of the dust into fractions which can then be observed separately.

PREVENTIVE MAINTENANCE TO PREVENT ACCIDENTS

By D. W. FLAGLER
Supt. of Maintenance, Davison Chemical Div., W. R. Grace & Co., Bartow, Fla.

When organizing a plant operation, management, among numerous objectives, such as showing a profit, usually desires to set up a preventive maintenance program and an accident prevention program. Today we will discuss the relationships of these two programs.

First of all, let's define preventive maintenance as a method of controlling outages of equipment so that they occur at the most advantageous time for operations and maintenance. A polite term for a "breakdown" is an "unscheduled equipment outage."

Plant design can help a program of preventive maintenance by building into the plant in-place spares and by-passes so that equipment can be repaired while the plant is operating.

The degree of maintenance always must be at some point between the absurd extremes of having a complete spare plant, and repairing everything after failure. In the final analysis, this degree of maintenance is what management wants and for what it is willing to pay.

The closer operating factors are desired to 100 per cent, the more spare parts must be carried in inventory; the higher the caliber of supervision and workmanship, and the higher the numbers of maintenance people, and the total hours spent on the job.

Economically, management must be willing to settle for something less than perfection. Total preventive maintenance, which means dismantling each piece of equipment at frequent and regular intervals, is something few plants can afford because of excessive down-time and excessive labor costs.

Practically, the program arrives, through experience, at classifying equipment into groups which need inspection at daily, weekly, monthly, or semi-annual intervals. When equipment is scheduled for inspection sufficient time must be allowed to make such repairs as may be needed, or sometimes a temporary repair until parts and time are available.

The experienced maintenance man, whatever his title, will make daily trips by the equipment for which he is responsible. He will use his skill, and experience, and his senses of hearing, sight, smell and touch to anticipate the condition of most machinery quite accurately and will know fairly well what to expect when the equipment is dismantled. He should have on hand, or know where to quickly obtain, the parts and materials he will need for the repair.

Most maintenance men seem to have the inborn instincts of a "pack rat" and by over-ordering spare parts usually manage to accumulate enough material to put together whole assembled units. This procedure not only reduces down-time for repair, but also allows the rebuilding of assemblies as fill-in work.

Needless to say, when maintenance supervisors are assigned so much paper work, expected to attend so many meetings, and required to talk to so many visitors that they rarely visit the plant, the preventive maintenance program is bound to be ineffective.

So far we have been talking about material things. Now let's apply this same type of thinking to accident prevention to the welfare of human beings.

While management will evaluate a preventive maintenance program and go on record as to the operating factor they expect—which may be as low as 60 to 70 per cent in a multi-product plant which can economically switch to an alternate product temporarily; when it comes to accident prevention, the position must always be that only 100 per cent performance is acceptable.

It follows that accident prevention means that we will attempt, in every way, to control the unscheduled event resulting in personal injury or worse, which we term an "accident."

Plant design can help an accident prevention program by building into the plant all possible safeguards.

A Complete Safety Program

INTRODUCTION

By L. B. WORTHINGTON
President, U. S. Steel Corp., Pittsburgh, Pa.

One of the Council's early press releases on this morning's session said that I would describe U. S. Steel's safety program and demonstrate how we apply it in all of our plants and operations. That's a pretty big order.

But I have a deep respect for the ability of our safety people. When it comes to describing the actual day-to-day workings of safety in U. S. Steel, they have no peers. So I have asked our director of safety and his associates to "do the honors," so to speak, with regard to the what, and why, and how of our safety program.

Before introducing them, however, I'll set the stage by telling you a few things about U. S. Steel and the attitudes toward safety which have been distilled out of almost 60 years of conscientious effort in this very critical field.

Any discussion of safety in U. S. Steel has to begin with Judge Elbert H. Gary, first chairman of the board. If you know or have read anything about the judge, you are aware that he brought to the industry a set of high standards and some ideas which, in his day, were quite new.

For example, he believed firmly in the public responsibility of large corporations. He was a leader in instituting welfare and safety programs for the betterment of working conditions. Among the new widely known "Gary Principles," was one which stated his belief that "no industry can permanently succeed that does not treat its employees equitably and humanely."

Generally speaking, the policies established back then remain substantially in effect to this day. U. S. Steel continues to place great emphasis on responsible management, recognizing its importance to the well-being and continuity of our corporation. As stated more recently in our creed of human relations, "We believe in the dignity and importance of the individual employee and in his right to derive personal satisfaction from his employment." Also spelled out in this creed is our belief that "The safety of employees continues to be the first consideration in the operation of the business."

Those of us now charged with managing the affairs and facilities of U. S. Steel recognize that we enjoy a rich safety heritage—a heritage that includes the dedicated work of such safety pioneers as Charles L. Close. We take pride in the role played by Charlie Close and other U. S. Steel people in helping to form the National Safety Council half a century ago.

We are proud that one of our predecessor companies originated the phrase, "Safety First." Incidentally, that phrase remains today as the cardinal factor that governs our total approach to safety in U. S. Steel. We are aware that the precedent for engineering safety into our facilities and processes, and for correcting hazards promptly without regard to cost, was established coincidentally with the first direct efforts to reduce hazards and increase safety within our mills and operations.

So you can see that our safety program has been a long time in the making, and that it was founded on a very sound base. As the program is unfolded this morning, it will become evident, I'm sure, that it is backed by a great weight of experience built up through an hour-by-hour, day-by-day effort to find the ultimate key to eliminating all injuries, which is the goal of every safety effort.

May I say at this point that my use of the pronoun "we" is not a reference to safety and other management people alone. To the greatest extent possible, we have always tried to make safety a cooperative effort between the employees and the management of U. S. Steel.

There is probably no more crucial part of any safety program, however, than that

of the people who operate those facilities, through extensive and often expensive training.

None of us, I'm sure, would ever place a dollar sign on human life and limb. But just as we believe that no man has the right to jeopardize, by his own disregard for safety, the life or the future of another man and his family, so I hold that no management has the right to jeopardize, by failure to provide sound programs of safety, the investment its company has placed in training a valuable employee.

If this morning's program provides even a small amount of assistance toward strengthening these beliefs, the effort that our people have put into preparing this presentation will have been justified manifold.

And so for this purpose, it is my pleasure to turn the program over to a man who has been deeply involved with U. S. Steel's safety efforts for almost 20 years and who is well known, I'm certain, by many of you for his service to various industrial safety groups and committees — our director of safety, Dan Darrell.

U. S. STEEL'S SAFETY PROGRAM

By DAN FARRELL
Director of Safety, U. S. Steel Corp., Pittsburgh, Pa.
(With help from associates)

United States Steel has one safety program, which is used in all of its operations, regardless of size, location, or product. It is a dynamic program, which has evolved over a long period of time, and which continues to develop as experience and research point the way to further refinements.

The techniques — or management safety tools—which it now includes are those which have proved to be most useful in the conduct of effective safety activities. They will be described individually, but in such a way that the relationships among them, and the place of each in the total program, will be obvious.

The only true test of any safety program is the simple, cold, hard fact of how well it works in practice. Therefore, it is appropriate at the outset to see what this program has enabled United States Steel's production management to accomplish in its steel operations.

Today, safety performance in steel operations, as expressed by the Disabling Injury Frequency Rate, is an 81 per cent improvement over 1948—(1948 was the year in which the first of the several techniques which now constitute United States Steel's Safety program was introduced).

These results prove the value of the specific safety techniques which United States Steel has developed and which, in total, comprise the corporation's safety program. These techniques are:

1. Job safety analysis and safe job procedures,
2. basic training, individual contacts, and safety observations,
3. employee record cards,
4. accident investigations,
5. awareness charts,
6. physical conditions and safety inspections,
7. activity reports, and
8. safety audits.

Each of these management safety tools depends for its maximum effectiveness upon all of the others and, together, they form a highly coordinated and effective program of safety activities.

The key to the program is employee training in the safe work methods for each occupation . . . with the details of this training spelled out so clearly that no matter which foreman does the training each workman receives the same instructions for the same job. United States Steel's concept and working plan for safety training will be discussed by Bob Holmes, assistant director of safety.

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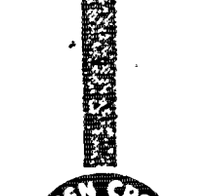
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Ordinarily, no fire hazard will exist if the solvent vapor concentration in air is kept below 1%. This figure is rather empirical however—there is only one solvent in the above list which is below 1% by volume. This is turpentine. The amount of ventilation required in various sizes of tanks to keep the concentration below this limit is shown in Table V.

2. Since the solvent vapors are heavier than air, they have a tendency to concentrate in the lower portions of a tank or closed structure. Therefore, the suction blowers should be operated in such a way as to prevent pockets of solvent vapor being concentrated in the lower portions of enclosed spaces. This can ordinarily be accomplished by sucking the air from the bottom of the tank so that the circulation is from the top manholes or openings down through the tank and up through the blowers. In this way the solvents are swept down and immediately sucked away from the bottom portion of the tank, eliminating any pockets of solvent vapor which might be above the explosion limit.

3. Maintain ventilation in the coated tank until the coating is sufficiently dry so that any remaining solvents cannot build up to the explosive limit. See Table IV.

4. The fourth precaution to be observed is the use of spark proof and explosion proof equipment. Electrical equipment and lights should be explosion proof; tools and shoes shall be spark proof. The use of such equipment has been common practice in the application of synthetic coatings for a number of years.

5. All smoking, matches, fire, flames, or torches shall be prohibited within 50 feet of the area where coatings are being applied.

6. All men working in enclosed areas should wear compressed air type masks to supply them with a flow of clean air at all times.

7. Where epoxies, epoxy coal tar, coal tar or phenolic resins are applied, protective clothing should be worn to eliminate contact with the liquid coating.

If these simple rules are followed during the application of any coating to enclosed spaces, the hazard from fire, inhalation of fumes or contact with the liquid should be maintained at a level which will provide maximum safety to the individual workman.

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VENTILATION FOR HEALTH HAZARDS CONTROL IN THE CONSTRUCTION AND REPAIR OF SHIPS

By G. S. REICHENBACH
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Shipyard ventilation prior to World War II was usually limited to locations where the heat stress upon men due to the high ambient temperatures and additional radiant heat could interfere with their productivity. During and subsequent to the war, however,

developments in welding, surface preparation and coating of ships extended the requirements for ventilation.

A national conference on safety and health in shipyards holding contracts with the United States Navy and Maritime Commission was conducted in Chicago on December 7 and 8, 1942. As a result of that conference, unanimous agreement was reached on certain minimum standards for safety and industrial health which were later approved by the Navy on January 20, 1943, and by the Maritime Commission in February, 1943.

Section H (14) of those standards had to do with ventilation. Subsection 14.1 stated, "Ventilation is required to control temperature and to remove air impurities, as from welding and paint spraying." Section 14.4 referred to the type of equipment needed, "In ship construction, two types of ventilation are used—local exhaust as for removal of welding fumes at the point of origin and general ventilation, to supply fresh air to confined working spaces."

Another section recommended that local exhaust be used for control of welding fumes. In those cases where it was not possible to furnish a local exhaust system to a welder, it specified that a minimum of 400 cubic feet of air per minute per welder be supplied to a work space such as a deep tank where general ventilation was used alone.

In the spring of 1943, a number of workers engaged in new ship construction complained of respiratory symptoms. According to Public Health Bulletin #298, "Health of Arc Welders in Ship Construction," most of these complaints seemed to arise from arc welders who performed their work in inner bottoms or in other confined spaces of vessels under construction. This symptom complex was commonly referred to by the shipyard workers as "shipyard cough," "welder's wheeze," or "welder's bronchitis."

As a result of these complaints, the Maritime Commission in August of 1943 requested the United States Public Health Service to cooperate in a survey of shipbuilding yards to evaluate the severity of these complaints and to determine the etiology from extensive field studies.

The result of this study were published in 1947 and have particular significance to shipbuilders and ship personnel. One of the prime findings of this survey was as follows, "It has been found most satisfactory to use general ventilation as far as possible. Local exhaust ventilation requires the welder to cooperate in its use; and since this cooperation is frequently not forthcoming, the ventilation suffers accordingly."

The final paragraph of Public Health Bulletin #298 stated, "Based on the observations of this study it may be concluded that gases and fumes generated by welding of mild steel as practiced in Maritime and certain Navy-contract shipyards induces an upper respiratory symptom complex and other possibly related changes such as arc-welder's siderosis and a slightly lowered blood pressure. It would seem that these alterations as demonstrated statistically are of clinical importance so far as temporary disability, differential diagnosis, treatment and prognosis are concerned; the observations, however, indicate that these changes have not led to permanent disabling residual effects. Safety measures in the form of eye and skin protection and ventilating practices have undoubtedly aided materially in keeping all industrially related clinical findings at low levels of significance."

The next publication of interest for ventilation for welding was that of Committee Z-49 of the American Standards Association which was sponsored by the American Welding Society. Their first publication was Z-49. 1-1950. Section 8 of that publication, entitled "Ventilation and Health Protection," emphasizes the problems of welding on lead, cadmium, mercury-bearing or mercury-coated material, or zinc-coated material, and also of using fluoride-bearing fluxes.

In each of those cases, air supplied respirators were specified for use by the welders. Additional requirements and/or limitations, were stated in Section 8.41 "Mechanical ventilation shall be provided when welding or cutting is done on metals previously not covered when : a) in a space less than 10,000 cubic feet per welder; b) in a room having a ceiling height of less than 16 feet; c) in confined spaces or where the welding space contains partitions, balconies or other structural barriers to the extent that they significantly obstruct cross ventilation."

Section 8.42 states, "Such ventilation shall be at the minimum rate of 2,000 cubic feet

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per minute per welder or four air changes per hour, whichever is the greater, except where local exhaust hoods and booths as per Rule 8.5 or air-line respirators approved by the U. S. Bureau of Mines for such purposes are provided. Natural ventilation is considered sufficient for welding or cutting operations where the space restrictions listed in (a), (b) and (c) above are not present."

The subsequent revision of this publication in 1958 changed nothing with regard to ventilation requirements but did take cognizance of the fact that more exotic metals and materials were being used both in rods and coatings. Where these materials were being used, the use of Bureau of Mines approved air-line respirators was required.

In Bethlehem Steel Company, responsibility for the health and safety of the individual employe is the responsibility of his immediate supervisor; hence our company slogan, "Production with safety." At all levels of supervision, staff services are provided to advise, train, and otherwise assist the line supervisor, but his is the ultimate responsibility for health, safety, as well as production.

The shipbuilding division, in the late 1950's, requested the Industrial Relations Section to assist it in preparing a manual of recommended practices for ventilation of burning and welding operations. A committee representing the disciplines of ventilation, welding, safety, and production wrote the manual.

The manual, four by six inches in size, is a convenient one for supervisors to carry in their pockets. It is twenty-six pages with the scope being covered under A) production; B) responsibility; C) personnel planning procedures; D) ventilation requirements; E) equipment and installation; and F) special problems which might be faced by the immediate supervisor.

Section (D) on ventilation requirements is divided into a discussion of fundamentals, principles of air flow, fans, blowers, and lastly, the ventilation required for welding and burning. Under Section (E) on equipment and installation, the general types and characteristics, fan and duct selection, and how to place equipment aboard ship are covered. The ventilation requirements as set forth in this manual were those that had been established by the American Standards Association.

The acceptance of this manual has been excellent, and it has been one means of providing for uniform ventilation for welding and burning operations in the shipbuilding and repair yards of Bethlehem Steel Company.

Although the large-scale introduction of welding in shipbuilding and repair required ventilation to a much greater degree than had been previously practiced in shipyards, it was the forerunner in the ventilation for preparing and coating of surfaces.

Many factors were involved in the changeover from the application of "paints" to ships by means of brushes to the now almost universal practice of spraying of "coatings." Two of the major items influencing the changeover from brush to spray were the increasing cost of labor and the advances in paint technology.

Painting and coating manufacturers developed materials that would give proper adherence, film thicknesses, and subsequent over-all life when applied by means of a spray gun. However, since the scope of this paper precludes further elaboration on the reasons for the changeover of brush to spray painting, it shall suffice to say that this transition created a major ventilation problem.

The spraying of coatings in the early stages of its development with regard to ship applications was not entirely satisfactory as far as the length of coating life. Subsequently, research by manufacturers, applicators, and owners found that the preparation of the surface prior to the application of the coatings was extremely important.

This meant that the specifications for these coatings jobs generally required that the surfaces be blast-cleaned prior to the application of the coating systems. Due to its effectiveness and low cost, the commonly-used abrasive for the blasting was silica sand, which created a potentially severe industrial health hazard.

In the Baltimore yards of Bethlehem Steel Company, it became obvious that much of our coating work would require the blasting of surfaces prior to coating. Together with the production personnel, the Industrial Health Engineering section began to investigated substitute materials for sand. After a number of trials of various materials, we were able to find a competitive product which

contained less than 1 per cent free silica, and in which the lead and zinc content was also below hygienically significant amounts.

The material that we used also met all of the requirements of the line production personnel. We have used several different substitutes equally satisfactorily in the Baltimore area both in ship building and in ship repair work. As a result, the amount of sand that is used for abrasive blasting in the Baltimore area of the Bethlehem ship building division is negligible.

The next problem that arose from the new spray coating systems was the solvents that were necessary to give the rapid drying time required for spray operations. Where formerly, turpentine, mineral spirits, and other much less rapidly drying materials were satisfactory for brush coating operations, we now ran into materials that were much more volatile and, of even more importance to industrial health personnel, had quite significant health aspects in many cases.

In April, 1951, Dr. Allen Brandt presented a paper to the marine section of the National Safety Council at the Greater New York Safety Conference in which he discussed the safe use of solvents in shipyards. This paper was probably the first in which cognizance was taken of the rapid changes in shipyard use of solvents. I should like to quote at this time one paragraph of Dr. Brandt's paper which will set the tone for the remainder of my article.

"Before getting into the meat of this paper, I should like to mention briefly one other point of misinterpretation or lack of knowledge which frequently leads to erroneous conclusions. This is the misconception of so many people in fire prevention work that if the atmospheric concentration of a flammable vapor is kept below the lower explosive limit (or 20 per cent of it as is common procedure) no health hazard exists.

"Nothing could be farther from fact. Gasoline is a relatively harmless solvent—its safe concentration being 500 ppm (parts of gasoline per million parts of air) as compared to 25 ppm for benzol, and it is an extremely flammable one. Yet 20 per cent of its lower explosive limit is 0.26 per cent or 2600 ppm which is more than five times its safe limit from a health viewpoint.

"Consequently, it can be seen that the truth is the exact reverse, namely, if the atmospheric concentration of a volatile solvent is kept below the safe level from the health standpoint, it will be much below the lower explosive limit."

One of our first interior spray coating jobs using the then so-called new or exotic coatings was performed in the Baltimore Yard in the summer of 1950. The owners of this Victory-type ship specified that the No. 4 Hold deep tanks were to be sandblasted and sprayed. The tank dimensions were: 1) port forward 45 feet by 25 feet by 11 feet for a total of 12,300 cubic feet; 2) port aft 36 feet by 18 feet by 11 feet for a total of 7,100 cubic feet; 3) starboard forward 45 feet by 23 feet by 11 feet for a total of 11,400 cubic feet; and 4) starboard aft 36 feet by 16 feet by 11 feet for a total of 6,300 cubic feet. The tank hatches were 14½ feet by 18½ feet; trimming hatches were 4 feet by 4 feet. The necessary scaffolding was erected in each tank for the blasters.

Each of the foreward deep tanks was ventilated by two vane-axial fans, each of which had a capacity of 5,000 cubic feet per minute and 3 inches of water static pressure. These were U. S. Navy standards size 8-6-D-1-W-5 which were driven by 5 HP direct drive motors.

The fans were installed on planks placed over the hatch openings so that they would exhaust the tanks. The remainder of the hatch opening was covered with tarps and boards to make the hatch as air tight as possible in order to eliminate bypassing of the air. Trimming hatches were left open in order to provide access to the tanks and to allow air to be supplied to the tanks exhausting. Canvas exhaust ducts, 24 inches in diameter, were connected to the fan discharge and these were extended to the weather deck hatch coaming. The inlets to the fans had metal ducts installed with the intakes at different levels to eliminate stratification of the air.

Use of the fans as exhausters rather than suppliers gave two important safeguards. The first was that the access ladder was being swept at all times by uncontaminated air. The second was that by carrying the exhaust above the weather deck hatch coaming, recirculation and buildup of dirt and dust during blasting were avoided, and during the coating operation between deck spaces

and lower holds were not contaminated with solvent vapors.

This arrangement of ventilation was checked during the blasting operations, and the distribution in the tanks was found to be excellent due to the high velocities of air through the trimming hatch and the location of the exhaust inlets. Air volumes being handled by each fan were in the range of 10,000 cubic feet per minute which gave a velocity of 12,000 feet per minute of air entering the tanks through the trimming hatches.

When coating work was begun, the area around the No. 4 Hold was posted with signs forbidding hot work and smoking. A fireman was assigned to enforce these prohibitions. All matches and lighters were removed from men working in the area. Workmen's shoes were examined for protruding nails, and rubbers were provided to those men whose shoes could provide a spark. Lighting was provided by explosion-proof, portable lamps with connection boxes installed on the main deck. Suitable hoses with fog nozzles and applicators were connected and placed on the main deck; fire extinguishers were on hand.

From the ventilation measurements made during the blasting cycle, it was determined that sufficient ventilation could not be provided to the tank to eliminate the possible toxic hazard of the solvent fumes. These fumes were methyl isobutyl ketone and toluene and were typical of the vinyl coatings being applied.

Since the ventilation as determined by the measurements was practical only to the extent of control of the explosive hazard, all painters were supplied with airline respirators. Foremen, chemists, and other personnel who were required to enter the tanks were furnished chemical cartridge respirators. All respirators used by the Bethlehem Steel Company are approved by the U. S. Bureau of Mines for the specific application.

As a further safeguard on the measurements and calculations made with regard to the coating system, a chemist certified by the American Bureau of Shipping was retained to make constant readings of the explosive content of the air. A sample of the coatings has been furnished to him in order that he might calibrate his instrument for the appropriate explosive range.

The testing procedure used was to start one painter spraying in a tank and to take readings on the explosimeter in his vicinity. Typical readings were as follows: 1) average reading near sprayer—20 to 30 per cent of the lower explosive limit, 2) six feet beyond the sprayer—negligible—2 to 3 per cent of the lower explosive limit, 3) discharge from the canvas duct—negligible.

A second man was then started spraying in the same tank. When the sprayers were in opposite portions of the tank, the readings were comparable to those cited; but when they came close together in the cycle of work, the readings rose to over 50 per cent of the lower explosive limit in the direct exhaust. After this check, only one painter was used in each tank.

The required four coatings were applied to all tanks routinely with production rates being five gallons per sprayer per hour for the first and second coats and seven gallons per sprayer per hour for the third and fourth coats. These rates are similar to those given by spray gun manufacturers, but are misleading for ventilation calculations because these are average rates. Therefore, they include times for shifting lighting, moving around scaffolding and other painting tasks. However, the ventilation furnished was advantageous in that no time was needed between paint coatings for curing. This made it possible to complete the job in less than the estimated time.

A recent survey of five different manufacturers' primers showed that they contain as volatile solvents: 1) methyl ethyl ketone with a small amount of xylene, 2) toluene and xylene, 3) toluene and xylene, 4) toluene and methyl isobutyl ketone, and 5) methyl ethyl ketone, methyl isobutyl ketone, and xylene. These are similar to those encountered in the 1950 work. These coating systems have met with rapid acceptance among ship owners as considerably greater size tanks have been and are in the process daily of being coated with a veritable witch's brew of materials.

In recent years, an additional control of the environment has been required by the coating manufacturers because of the narrow range of specified temperatures and humidities during the coating application and curing. This has required the development of a push-pull type of general ventila-

tion in which the makeup air, which had been merely the ambient air in the case described, now must be controlled within these specified limits of temperature and humidity. The expense of tempering makeup air makes it economically infeasible to attempt to control the health exposure exclusively by means of ventilation.

Several years after the preparation of the company's manual on welding and burning and its acceptance and use by the line supervisors, the shipbuilding division requested personnel from industrial relations to assist in the preparation of a ventilation manual for the preparation and coating of surfaces. A similar manual to that for welding and burning was prepared with headings of an appropriate nature.

In the section under ventilation requirements, the portion on fundamentals was repeated from the previous manual. The section on local exhaust ventilation was eliminated and several typical cases were listed which had been controlled by general ventilation.

A simple formula for determining the general ventilation required when spraying in a confined space in order to control the fire and explosion hazard was given:

$$Q = \frac{8000\,(s)}{(x)\,(y)}$$

where Q = ventilation rate in cubic feet per minute

s = coating consumption in pounds per 8 hour day

x = molecular weight of coating (or primary solvent in coating)

y = lower explosive limit of coating in per cent (or of primary solvent coating).

Rates established by the above formula will give adequate control of fire and explosion hazard with proper circulation of the air in the confined space. However, higher rates may be justified from the production standpoint in order to minimize fogging and improve visibility. Additional production benefits may be obtained from more rapid drying of the coating. This manual has been part of the training facilities made available for line supervisors in our company.

The Sparrows Point yard, which is primarily a new ship construction yard, has minimized its ventilation requirements by the installation of a facility which blasts scale from plates by steel shot and then sprays the prime coat utilizing an electro-statically charged paint spray. This is an automated line with complete fire and explosion protection and safeguards.

In addition, whenever possible, subassemblies are blasted and coated on the ground fabrication tables prior to being assembled on the ways.

In summary, with regard to spray coating, this method of application has caused serious potential problems from the safety and health standpoint for the following reasons: 1) the increase of the application rate of the coating; 2) the increase of the solvent content of the coating due to the need for less viscous materials for spraying; and 3) the increase in inherent toxicity of the solvents due to the development of the various plastic-type coatings which require more complex chemicals as a solvent material.

The control of these coating applications requires individual respiratory protection for men when they are working in confined areas. They require ventilation rates of sufficient quantity so that 20 per cent of the lower-explosive limit of the applicable solvent is not exceeded.

The safe and healthful application of coatings depends upon the cooperation of the owner, vendor, and the yard. As to the owner, he must select the coatings in time so that proper precautions for applying the coating may be taken. From the vendor's standpoint, he must supply sufficient information with regard to the composition of the coating so that the yard may take the necessary precautions with the coating. The yard's responsibility is to assemble the information and furnish the equipment and personnel required to perform a safe, healthful and technically excellent job.

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MINING

NATIONAL SAFETY COUNCIL
425 N. Michigan Avenue
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cies, information and aid are supplied the unit by the Department of Safety and Technical Employment Office in Salt Lake. The pit safety program is aimed at providing safe conditions and getting as much information as possible to the equipment operators, teaching them the safe way to operate their particular equipment under all conditions and situations and seeing that safety instructions are carried out.

The Mine Superintendent has the direct responsibility for pit safety and in turn, each Pit Supervisor is responsible for the Safety of his men. It is up to him to see that they get the information, learn the safe operation procedures and to see that the safety orders are followed. The Safety Department helps him by supplying information, planning training, holding safety meetings, making inspections and keeping records.

The Mission has recorded a respectable safety record in the past, but everyone is always trying to make it better. New suggestions and ideas are welcomed and searched out in the attempt to have an accident-free operation.

REACHING THE MINER WITH SAFETY EDUCATION

By HERBERT A. WENDEL
Chairman, Bureau of Safety, The Anaconda Company, Butte, Mont.

Reaching the miner with safety education is the ultimate goal and main objective of every safety program in the mining industry. If we can get safety education to every worker and it is properly learned, enforced and obeyed, we should eliminate at least 85 per cent of all potential accidents. We should have very few accidents as a result of unsafe behavior. Then we could concentrate most of our future efforts on preventing the type of accidents which are caused by faulty or defective machinery, equipment, tools and materials.

An uninformed or uninitiated person would think that it should be a rather simple process to reach the miner with a safety education. Theoretically he would be right because here we get involved in a matter of semantics. When we say "reaching the miner with safety education" we actually mean that this education must also be accepted and learned by the miner; we intend to mean that safety must be observed and followed at all times. But in order to realize our complete meaning of the phrase, we must overcome or find the solution for a number of problems and obstacles which are all too well known by management and safety personnel.

Probably the greatest deterrents we face in properly reaching the miner with safety education are the far too numerous faulty mental reactions which are usually referred to as unsafe attitudes; these, coupled with superstitious or fatalistic beliefs common in the minds of the type of workers who follow mining as an occupation, complicate our corrective efforts.

A summary of the more common problems we are confronted with in reaching the miner with safety education would include: 1) employee resistance or reluctance to new safety ideas, programs, innovations or devices; 2) long standing, undetected or unobserved unsafe work habits; 3) improper attitudes including fatalistic beliefs and the philosophy that life itself is a gamble; 4) inherent desire to take short-cuts or chances; 5) reluctance to obey orders or safety rules that seem to involve additional work; 6) objection to the use of required personal protective equipment; 7) resistance to safety because it seems to restrict freedom of action; 8) feelings of personal immunity to accident or injury.

Miners and other employees resist safety mainly because they feel that it restricts their actions, seems to cause more work, interferes with their freedom of action or slows them down. This is probably not, in their minds, a disregard for orders or a disrespect for safety. Some men believe they know more about the job than anyone else,

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