

can result in a serious injury or even death. Accidents have occurred on inclined ship's ladders as well as vertical ladders. Training the employees to lower the materials by some hand line or light tackle is the answer. It may require training and retraining to attain consistent compliance.

7. Adequate walkways not provided in the machinery spaces of newly constructed vessels being outfitted, were responsible for a significant number of falls and injuries to workmen. In most cases the walkways were not erected because of anticipated installation of piping systems or equipment. Another reason was that the area was located remote from the immediate work operations and therefore did not pose an imminent accident producing situation.

But men *did* walk in that area, and *did* fall and injure themselves. The answer is to either provide appropriate and safe walking and working surfaces on the various levels of the machinery spaces, or barricade the unused areas. The rails or barricades, of course, should be substantial for the use intended.

Regulations Related to Materials Handling Equipment

The significant number of crane accidents, which have been recorded over the past 6 years, suggests the advisability of extending the cargo gear certification requirements, which presently cover cargo handling equipment, to floating derricks, drydock gantries, and other floating hoists used in shipyards. This would be a step toward standardization of certification of materials handling equipment used for maritime work.

Regulations Related to Personal Protective Equipment

I would like to call your attention to several work practices in this category where, due to lack of appreciation of the hazards present, the requirements of the regulations were not fully or correctly applied.

1. No goggles worn under the welding helmets or shields.

2. Inadequate protective clothing worn by welders and burners against hot slag and radiation.

3. No protective or shaded lens goggles worn by other workers in the proximity of chipping, blasting, or welding operations.

4. No respiratory protection worn by other workers in the proximity of operations requiring such protection.

5. Wearing of respiratory equipment not approved by Bureau of Mines.

6. No respiratory protection worn under welding shields while exposed to heavy smoke and fumes.

7. Wearing of improper filter and chemical cartridge type respirators for the particular exposure.

8. No buoyant life vests or working vests worn in smaller boatyards, while working on small boats, work floats, or near unguarded edges of floating equipment.

Regulations Related to Electrical Hazards

The major need in this category is positive determination by an electrician or technician working on a circuit, of whether the circuit is live or dead. Due to absence of this knowledge, whether through personal error or through the lack of a proper lock-out procedure, several fatalities have occurred. The suggested guide is that strict, positive, lock-out procedures should be enforced by the employer through the electrician or technician.

Several electrocution cases have occurred:

One, when a welder's body was grounded as he contacted the bare electrode in an A.C. welding circuit, while in an extremely sweaty condition, and while pressed against the steel structure in a confined space. Several others occurred through use of ungrounded electrical hand tools.

What was considered a proper ground was either inadequate or was no ground at all.

Several others occurred because the employees using the tools thought the ground arrangement unnecessary.

Although we have highlighted only a few of the existing, unsafe shipyard conditions and practices to which our regulations apply, we hope that these will serve as a guide for developing a keener recognition of their presence in your work operations.

We are convinced that efforts directed to controlling the deficiencies discussed in this paper will be well spent, will better your accident experience, and reduce the toll of life, limb and property being exacted within the shipyards of America.

TANKER SAFETY IN AN ERA OF CHANGE

By JOHN T. KNEPPER

Manager, Employee Relations Division, Marine Transportation Department,
Socony Mobil Oil Company, Inc.

We are living in an era of change that is obvious to all.

The extent and speed with which these changes are taking place, however, is rather more difficult for us to grasp. Some values which have gone unquestioned for generations and centuries are now viewed with skepticism or have been discarded entirely. The accepted practice of yesterday is being questioned today. The sacred cow of today may be the dead duck of tomorrow.

Our own tanker industry has not been exempted from this upheaval. If we have any doubt of it, let's recall that, within the memory of most of us, the average tanker was something under 10,000 deadweight tons with a speed of about 9½ knots. Not long ago a contract was signed for construction of a 167,000 tonner.

Many of us can remember the last of the commercial sailing vessels. Today nuclear propulsion is no longer a novelty and the hover-craft and hydrofoil are rapidly coming up over the horizon. The giant submarine tanker could even be commonplace in the not too distant future.

Changes never come easily in the marine field. With good reason, we are one of the most conservative of industries. While poor planning, bad judgment or corner cutting in the shoreside business can be expensive, it is seldom catastrophic, as it may well be when a ship at sea is involved. The elements seldom give us a chance to make more than one mistake. Change for the sake of change under these circumstances is entirely out of place, where safety may be compromised.

Whether we like it or not, we are being forced to make radical changes in our practices and in our thinking to keep abreast of the times and meet the demands placed upon us by present day conditions—particularly the keen competition in the tanker industry. These changes have brought with them new problems and hazards. How we in Socony Mobil Marine Transportation Department are attempting to solve them is the general subject of my remarks.

Before talking about the "hardware" involved, I'd like to review for a moment some of these changes which have caused us to revise, or at least to reconsider, long standing practices.

The first and most spectacular is the tremendous increase in size of tankers which has taken place in the last 20 years and which, incidentally, shows little sign of having run its course. As the basket gets bigger and the number of eggs in it increases, so the problem of protecting it from harm grows accordingly greater.

Another change which has stimulated thinking on tanker safety is the increasing number and variety of products we are called upon to carry in our ships. The rapid development of the petrochemical industry has brought us into an entirely new field and presented us with safety problems of an entirely different nature. Liquified gases under great extremes of temperature or pressure pose still different problems. While we have not yet become involved in it, we might before long be called upon to provide transportation for LNG, another new area with attendant problems to be solved.

The skyrocketing cost of labor and stiff competition within the industry has made it essential to keep manpower to a minimum wherever possible, and reduce the amount of work to be done by the ship's crews. This is being done by labor saving devices, equipment and materials requiring less maintenance, and automated controls of vital shipboard functions. All these have presented new problems involving safety of life and property.

With a whole new set of problems to be solved, it soon became obvious that merely continuing on in the same old way would not do; simply adding more of the same was not the answer. Fortunately, the climate which induced the changes in the first place produced some of the answers. In other words, we had to learn to "think big" in safety, too.

Let's now look at some of the actual de-

velopments in safety which have directly or indirectly come about because of recent changes in tanker design and operation.

One of the first things coming to mind in this regard is the elimination of the midship house and relocation of all crew quarters to the after part of the ship. While this was originally conceived as a cost reduction measure, it has had a strong secondary value as a safety feature. This strikes very close to home with us, as we have had in recent years, two casualties in the family, which might have been lessened or even avoided with a bridge-aft type of construction. I refer to the SS STANVAC JAPAN where an explosion in the way of the cargo tanks caused heavy loss of life of personnel in the midship house. Second was the SS MOBIL ASTRAL, where a fire and explosion in the loading manifold area did heavy damage to the midship house, with resultant injuries to personnel.

A great deal of work has been done in recent years in the field of fire protection and fire fighting. One of the most noteworthy advances was the revision of the U.S. Coast Guard's fire fighting regulations, which was done in collaboration with industry. Fire protection for petroleum carriers in the past gave evidence of hand-me-downs from cargo ship practices and like most hand-me-downs, it didn't fit too well. The steam smothering system and the straight stream hose nozzle may have been fine on the general cargo ship, but they are of little use on a gasoline fire on board a tanker. The revised regulations have permitted adoption of some of the concepts of smothering and cooling developed by the petroleum industry to shipboard use.

In our own new vessels we have made substantial improvements in fire fighting protection and installations. Steam smothering has been eliminated entirely and water fog and foam systems substituted. The water fog system consists of a separate piping system in the cargo tank hatches, served by its own fire pump. Foam installations vary from ship to ship; some having fixed systems, others portable. Our newest vessels are also fitted with foam monitors.

While we have standardized on 3 per cent foam on our crude and product carriers, we have retained 6 per cent foam on one vessel which is in the chemical trade. It is our

feeling that the greater body and cohesion of the 6 per cent foam makes it more effective on chemical fires and is worth the sacrifice in volume.

The increased size of vessels has brought up a number of other problems requiring solution. An example of these is the length of fire hoses. As you know, the standard length has traditionally been 50 feet, which has always been satisfactory in vessels of moderate size. With ship's beams exceeding 100 feet, it now becomes impossible to reach over the side with one length, and for this reason we have adopted 75 ft. lengths on our large new vessels.

The matter of personnel has required some thought, and departures from principles of long standing have been made. For example, the crew of 95,000 deadweight ton vessel is roughly the same size as that of a 35,000 tonner. With a much larger number of fire stations on the former it is obviously impossible to follow the customary practice of assigning men to each fire station, as there just aren't enough to go around. We therefore adopted the "emergency squad" concept to concentrate men and apparatus at the scene of the fire. This makes a good deal more sense than the "shotgun" approach where manpower and equipment are scattered about the ship, some perhaps being 1,000 feet from the scene of action.

We think we have thoroughly refuted the notion held by some that there is safety in mere numbers of people. In fact, we feel that as a general rule—a few well trained people with good equipment make a most efficient kind of safety unit. We also feel that a well trained man with poor equipment will have fewer accidents than a poorly trained one with good equipment.

It is our firm belief then, that the training of personnel is by far the most important element in our safety program. It is not enough to provide the most modern up-to-date fire fighting gear in the world. We have to teach our ship's people how to use it and use it effectively. This involves more than the usual perfunctory fire and boat drill held once a week in fine weather, it means actually using the equipment on a fire, seeing what it will do.

We have made it a practice to have every man in our fleet attend fire fighting school before joining his vessel, and take a re-

fresher course periodically. For our U. S. fleet, this training is given by the plant fire department at our Beaumont, Texas, refinery. Our foreign flag fleet personnel receive training in schools at which we have been instrumental in establishing in London, Hamburg, Freetown, Bombay, and Karachi. Most of these have been set up with assistance and collaboration from local fire brigades, using their training grounds and equipment and our instructors. The course at the overseas' schools averages two days except for the one in Hamburg which runs for one week. Both officers and unlicensed personnel are expected to take this training.

While there have been and will continue to be accidents so long as we have the human element with us, well trained men with good equipment offer the best route to our goal of the fewest possible accidents, we must provide both good men and safe equipment.

To go into detail regarding the many minor innovations in fire fighting equipment and techniques would take a good deal more time than we have available. I would, however, like to mention some of them, most of which are refinements of existing materials or practices. We are, for instance, adopting some improvements in hose couplings and connectors to permit easier and faster hooking up of hoses. This involves use of 45° swivel connection fire hydrants, and snap couplings between hose and hydrants. Fire extinguishers are being standardized throughout the fleet. Dry chemical of a type compatible with foam is being used in all locations except electrical flats and radio rooms, where CO₂ is employed. All vessels are supplied with a minimum of 8 applicators, and 90 per cent of all hose nozzles are of the all-purpose type. Two and one-half inch hoses are used throughout in our large new vessels, because of the need for volume of water or fog. Plastic foam cans are to be used in place of metal containers to beat the rusting problem which has plagued us all for so long.

I'd like to mention very briefly here a couple of new developments in which we are interested. I believe you'll be hearing a good deal about them in the future, although they are presently in the development stage. I refer first to sub-surface application of foam. Our research and development and safety people in Paulsboro are doing a good deal

of work with this. If and when they succeed in overcoming their remaining problems, it might very well have an application to tankers by permitting foam to be introduced into the cargo tanks directly through the pipelines.

Another interesting development is the use of high expansion foam for inerting and displacing vapors from cargo tanks as well as for fire fighting. While not new, high expansion foam has never received the attention we feel it merits. Our Marketing people have adopted it as the principal means of fire protection in a new 500 ft. automated warehouse, and information developed in this connection has led us to believe that it may possibly have an application as an inerting or gas-freeing medium in cargo tanks.

Before leaving the subject of inerting, I might mention here that we have installed flue gas systems on two of our vessels, but not the most recent group. We do not believe routine gas-freeing or inerting contributes measurably to safety, but rather the contrary. Had the findings of the Court in the S/S MISSION SAN FRANCISCO case been implemented, in our opinion a great many more explosions probably would have resulted in the industry, than have been experienced under practices of long standing.

While we have made some rapid strides in fire fighting and fire protection, we have taken a somewhat more conservative course with regard to new developments in life saving equipment. We refer chiefly here to plastic life boats and inflatable life rafts.

Boats constructed of glass fiber and synthetic resins have been the subject of much controversy. We have used them in a few of our newer vessels, but until such time as fire retardant resins have been further developed and are available, we intend to remain with metal boats. The matter is being followed with interest, however, and we have looked forward to attending the presentation on this subject which was given at another session of this meeting.

As for inflatable life rafts, these undoubtedly would be useful under certain conditions, but they do not, in our estimation, have the all-around utility of a lifeboat. They are, of course, now required by the U. S. Coast Guard, although not by SOLAS.

Among the other developments in the field of life saving equipment, are adoption of the diesel-powered boat where motor or mechanically-operated boats are required. We are replacing all gasoline and hand-propelled boats. To provide better access to boat decks on the bridge-aft vessels, we have provided additional vertical type ladders. Survival kits have been updated and life boats have been provided with radar reflectors to assist search and rescue teams looking for them. Resuscitator/respirator units have been standard equipment on our vessels for some time.

The hazard of collision is of the greatest concern to us, as it is to every tanker operator. The skills required by the present-day tanker mariner with respect to navigation and ship operation have become more critical than ever with the increase in size and complexity of the large tanker. We recognize that a single failure of action or equipment in these vessels could be catastrophic. Collisions and strandings are to be avoided at all costs. To do this requires a high order of seamanship on the part of our personnel and the best equipment available.

We are in the process of installing a second radar set on all our large vessels. All are equipped with Decca Navigators or Loran. Each of the large vessels is being supplied with walkie-talkie sets to be used in docking and undocking. They may also be used for communication between company ships in the near vicinity. We are experimenting with closed-circuit television as an aid to lookout-keeping.

The safety of the ship's crews has also received a great deal of attention in design of new ships. In noting a few of the improvements built into new construction, we might start with gratings and ladders. These are perennial sources of injury to personnel and we have devoted a considerable amount of research to trends on gratings and the location of the ladders themselves. We have made progress in this area, and feel we have come up with some answers that will result in fewer slips and falls.

Tank repairs, particularly those in under

deck areas have become more and more difficult to carry out as the depth in tanks is increased. The old wooden ladder is long gone, and in tanks 60 feet deep a light metal ladder is no longer suitable. We feel we may have a partial solution by ballasting the tank and using an inflatable raft for the men to work from.

In our new vessels, vent intakes have been relocated forward of the stack to avoid flue gases being discharged into quarters. Air winches have been provided for fore peak storerooms. Hydraulically operated cargo valves have been provided in the large vessels and the newest will also have automated cargo control rooms. On these ships, back strain from turning large hand cargo valves will be a thing of the past. We also feel there is less hazard in one man handling a large mooring wire on a good self-tensioning winch than three or four sailors taking a heavy hawser or a wire to a winch drum to heave the vessel alongside.

Another feature which has resulted in increased safety, although not designed with it in mind, is the air conditioning of quarters. This has been particularly effective with regard to the midship house. There are now no open ports or doors by which fumes can enter during loading and ballasting. With air conditioned quarters, doors are of the vapor lock type, and ports are kept closed at all times.

The majority of the features I have spoken about are on our foreign flag fleet principally Panamanian and Liberian flag vessels. We have not built vessels for our U. S. flag fleet for several years. When we do, the new features will, of course, be included in them as well.

All our new vessels are constructed to standards laid down by the classification societies and the British Ministry of Transport, the German SBG or the U. S. Coast Guard, whichever may be higher. We feel we are fortunate in being able to select the best features of each, which is resulting in ships which are, on the whole, unsurpassed in safety anywhere in the world.

COMBUSTIBLE GAS INDICATORS

By RICHARD O. FLEMING, Vice Pres.,

Alfred E. White Co., Brooklyn, N. Y.; National Chairman, Marine Chemists Assn.

For over a year now it has been a federal regulation to have a combustible gas indicator aboard all tank ships and tank barges. This regulation came into being on June 5, 1964, in the code of federal regulations section 35.30-15. Since these regulations are enforced by the United States Coast Guard, I would believe all our vessels now have combustible gas indicators aboard.

This regulation was made for one prime reason, that being safety. It was believed that with a combustible gas indicator aboard, a man would not have to enter a compartment subject to gas accumulation without it first being tested and proved safe. Testing is usually done by the chief mate or captain at times when a Marine Chemist is not available or needed. This situation usually arises when the vessel is at sea or at a remote berth. Often a reach rod needs reconnecting, a leaky cargo line or coil needs banding or a cement box installed to stop a leak.

Since we assume that all vessels have a combustible gas indicator aboard, we should be able to assume that someone aboard knows how to operate the instrument accurately; this is not the case. I have been on at least a dozen vessels this year where I was met by the officer on watch, have told him that I was sent by the shipyard or owner to check the vessel to see if it was gas free, and when I took out my combustible gas indicator he would say, "Say, I have one of those gadgets in my room; the company sent it a few months ago." Next he often would ask if I would show him how it operates after I had completed my inspection. We usually would find a new meter without batteries or a book of instructions. Either the instruction book had not been sent with the meter or had not been referred to by the officer. This is not a criticism of anyone aboard a vessel who has a gas indicator and does not use it. More often than not they are not properly instructed in the use of the meter and thus apprehensive about using it.

The purpose of this demonstration is to better familiarize each one of us with the

proper use, care, and limitations of combustible gas indicators.

Your life or the life of someone else may be dependent on the care with which you handle any combustible gas indicator. The sensing elements are only $3/1,000$'s of an inch in diameter, and the careless dropping of the instrument might very easily bend or distort the fine coils of these sensing elements, and thus, upset the calibration of the instrument. Then too, the meter consists of a needle or pointer on a sensitive pivot. This pivot is mounted on a very small bearing. A severe jar may damage the pivot bearings.

A combustible gas indicator is an instrument for detecting gas-air or vapor-air mixtures in terms of their explosibility, to determine whether the mixture is safe against the possibility of fire or explosion.

Everyone who may have occasion to use a combustible gas indicator must become thoroughly familiar with the operation and limitations of the indicator, and should satisfy himself that the instrument is in proper operating condition.

Before going into details of operation and the interpretation of readings, it seems desirable to get certain definitions clearly in mind. While these definitions are probably well known, their repetition may help to clarify certain points which will be presented later on.

Lower Explosive Limit (L.E.L.)—This is the leanest mixture of gas or vapor in air, where once ignition occurs, the gas or vapor will continue to burn after the source of ignition has been removed.

Upper Explosive Limit (U.E.L.)—This is the richest mixture in which a flame will continue to burn after the source of ignition has been removed.

Explosive Range (Flammability Limits)—The explosive range exists between the L.E.L. and U.E.L.

Flash Point—The flash point of a flammable liquid is the lowest temperature at which it gives off enough vapors to form

a flammable or ignitable mixture with air near the surface of the liquid or within the container used.

Flash points vary with temperature, for example:

Kerosene, a high flash product at room temperature, gives off almost no vapor, hence, an extremely low reading, if any, on a combustible gas indicator. Should you heat the kerosene, more vapors will be liberated, and you might expect a higher reading on the combustible gas indicator, providing the vapor does not condense back to a liquid before it reaches the analyzer cell. This vapor, which is being liberated due to the elevated temperature, may ignite when a source of ignition is present.

Gasoline, a low flash product, at room temperature, will liberate an explosive mixture, which is extremely dangerous. A combustible gas indicator will indicate the concentration of the gasoline vapor present. Gasoline will continue to give off vapors and will not condense back into a liquid until an extremely low temperature is reached. If this were not the case, our automobiles would not run in cold weather.

Fire and Explosion Characteristics

Fire—The combination of vapor, air and heat, results in a fire.

Flash Fire—The combination of an accumulation of vapor with air and heat in an open area will result in a flash fire.

Explosion—The combination of an accumulation of vapor, air and heat in the correct proportions in a confined space, results in an explosion.

Under all of the above, both the air and the heat remain constant, but the change in the fuel-vapor caused the fire or explosion.

Principle of Operation

Catalytic combustion is the burning of a combustible gas or vapor in air on a catalytic filament. A catalyst is a substance which accelerates a chemical reaction (the burning) without entering into the reaction. There are various catalysts. Most manufacturers of combustible gas indicators use a platinum wire filament, primarily because it is a good catalyst, and platinum wire has a high temperature coefficient of resistance. In other words, the resistance of the wire changes

materially at different temperatures, thus, when such a filament is set up in a bridge circuit, it serves as the basic operating principle of a combustible gas indicator.

The name for the Wheatstone bridge circuit comes from its inventor. It was primarily designed for measuring resistance and actually, when used in catalytic type instruments, it is the change in resistance of the active filament, caused by the burning of the gas or vapor sample which causes a current to flow through the meter.

The manufacturers of combustible gas indicators make available several different models. Care should be taken in selecting the correct instrument for specific applications.

Many companies use these instruments for what we refer to as "Go-No Go," or to determine whether a flammable gas or vapor is present. They are not particularly interested in the actual per cent of the gas or vapor present.

Testing steps often overlooked should be emphasized and practiced.

First Step—Test for tightness.—Any time a filament is replaced in the analyzing chamber, or any other work done on the sampling system, the indicator should be tested for tightness before being assembled and put into service.

With a finger held firmly over the inlet of the instrument, squeeze the aspirator bulb and hold a finger firmly over the outlet valve of the bulb. If all connections are tight, the bulb will remain deflated. If the bulb inflates, there is a leak in the system and it should be found and remedied.

Second Step—Sampling—The directions for sampling are on the name plate in full view of the operator. These directions should be followed in proper order.

How to Check the Calibration

The assurance that a combustible gas indicator is in proper working condition, and therefore, will give a reading of a gas and/or vapor air mixture which can be relied upon, is of prime importance in preventing property damage or loss of life.

An instrument which has been damaged or whose filament has been contaminated, may give false readings and thereby lead to

a false sense of security. Therefore, the matter of frequent testing of instruments assumes great importance.

One method of calibration consists of a known mixture of gas in the cylinder which is released into the evacuated bag. A sample of the bag is drawn into the combustible gas indicator. The reading is noted and compared with the correct reading shown on the label attached to the cylinder. Correct readings for all model instruments are shown on the label.

Accessories for Specific Problems

Probes are usually used when testing overhead, so that the hose may be correctly placed in the area to be sampled. A plastic probe is indicated whenever sampling is done in an area where electrical current might be present.

Various lengths of hoses are available for sampling from a distance. Always use the correct hose for the gas being sampled. Consult the manufacturer of the instruments for his suggestions. Incorrect hose may absorb your sample and give an inaccurate reading up to 80 per cent.

A Liquid Trap is placed on the inlet of a gas indicator to keep all liquids out of the instrument. A ball rises with the liquid and sits on a fitting, thus stopping the liquid and/or gas sample before it reaches the instrument. The largest number of repairs required on all instruments has been caused by liquid entering the instrument.

It is important to know where to test in an area or vessel. Some gases or vapors are heavier than air, and will be found at the lowest point in a vessel or confined area. The direct opposite will apply for gases that are lighter than air. In the case of a flammable gas or vapor that is leaking from a vessel or pipe, the same situation exists. In certain instances, any movement of air could be a factor and should be considered. If in doubt, tests should be conducted at various levels.

Interpretation of Readings

The face of the meter must be watched when testing or a serious misinterpretation of the reading can result. An extremely rich mixture can become highly flammable when diluted with air.

Translation of Readings

The same instrument obtaining the same reading could have different meanings, depending upon the gas or vapor being sampled. This is the reason for the occasional need of calibration curves for field reference. When the needle shows explosive when you are at the lower explosive limit of hexane, other gases and vapors will read explosive when, actually, they are below the lower explosive limit. Thus, there is a safety factor built into the instruments. For example, if the meter reads full scale or explosive for hexane, actually, there is only 68 per cent of the lower explosive limit of hydrogen present. Most of the combustibles, commonly encountered in industry, have curves lying to the left of hexane curve, thus giving extra safe readings.

Do's and Don'ts

- 1) Keep your eye on the meter. Remember, you may sample a rich mixture which will cause the needle to go up scale and return to zero without you noticing it. Thus, an unsafe conclusion could be drawn.
- 2) Select the correct sampling hose for your specific application.
- 3) Follow the proper instructions for the care and maintenance of your indicator.
- 4) Always use the shortest length of sampling hose. It will minimize the possibility of vapors condensing in the hose.
- 5) Whenever a reading is obtained, it is always wise to clear the instrument, zero in fresh air, and take a second test to be certain of an accurate reading.
- 6) It is always well to purge the meter by aspirating the bulb in fresh air, even if another sample is not to be taken right away, as this removes any possibility of corrosive gases in the combustion chamber.
- 7) Check the calibration of your instrument to be sure that it is reading correctly.
- 8) Check your battery voltage and/or zero adjustment periodically.
- 9) Check your instrument for tightness.
- 10) *Don't* sample from elevated temperatures into a cold instrument. Condensation may occur and give a false reading. Whenever possible, the instrument should be at the same temperature of the vapor being tested.

11) *Don't* remove the flashback arrester from the instrument. It prevents the explosion which occurs in the combustion chamber from passing back to the mixture being sampled.

12) *Don't* use the indicator for sampling gasoline vapors containing Tetra Ethyl lead, unless the indicator has been approved for this application.

13) *Don't* let your sampling hose or probe reach into a liquid.

14) *Don't* adjust your voltage when sample is in combustion chamber, unless it is below correct setting.

Know how to use it

Always read the instruction book which accompanies each instrument. You will find complete instructions, possible troubles and remedies, and an exploded view of all parts with their stock number.

This then, is a general outline of the types of instruments we use in marine work, the way in which they work, and the basic care necessary to keep them operational. In the very near future, the Davis people will be publishing a similar outline in booklet form which will be available to all who are interested.

ONBOARD TRAINING OF TANKER PERSONNEL

By CAPT. G. A. McLAUGHLIN
Codan Marine, Inc., New York

I would like to outline a training program now in use, by three companies, that has enabled tanker personnel to organize themselves into fire fighting units. They have been able to control and extinguish fires aboard their vessels using the equipment provided for that purpose. This training program has given the seaman confidence in the equipment and the skill needed to attack fires.

In 1946 the management of the Keystone Shipping Company, recognizing the fire potential of modern tank ships, decided to embark on a major revision of fire fighting devices aboard their tankers. They began by eliminating all suicide nozzles, replacing them with all-purpose water fog nozzles and applicators. Air foam making devices, CO-2 hose reels and extra CO-2 portables were added. A detailed plan of the vessel showing equipment and fire station locations, along with maintenance and operations manuals were provided to each ship.

In addition to providing this equipment, all officer personnel were sent to the U.S. Navy Fire Fighting Schools at Philadelphia, Pa. and Treasure Island, California. About 120 officers were trained in this manner over a two-year period. In 1948 and 1949 an independent consultant demonstrated the equipment in port. In 1949 Keystone decided to

go one step further and Onboard Training at Sea was started, again under the direction of an independent consultant.

In 1956 Codan Marine, Inc. was formed to carry on these instructions and to do anti-collision research aboard the Keystone fleet. Fire fighting and safety programs, as well as instruction in anti-collision radar navigation, are provided aboard ships of companies that cannot draw on a large safety department or fire department. To gain the confidence and respect of the seamen all instructors are licensed Masters or, in some cases Chief Engineers.

The instructors must know shipboard routines and blend the program into the vessel's daily operation. The expense of sending men to the U. S. Navy Fire Fighting Schools on a continuing basis quickly becomes prohibitive. It must also be considered that training programs ashore cannot duplicate the surroundings or situations that occur aboard ship. Thus, the onboard training program provides the most economical, most effective and broadest range of coverage. To date, approximately 5,000 seamen have been trained in this program.

In 1961 one or more of these programs were started and continue aboard vessels of the marine divisions of the Amoco Shipping Company, the Hess Oil & Chemical Corp. and

the Trinidad Corporation. Special programs are set up for each vessel of each company with consideration given to that vessel's cargo and trade. Up to date information received from the National Safety Council, the U.S. Coast Guard, the U. S. Navy, the International Association of Fire Chiefs, American Society of Safety Engineers and various equipment manufacturers is invaluable.

Most marine casualties can be attributed to some form of human error. This in turn may stem from lack of training or failure of the ship's officers to clearly define and acquaint personnel with emergency stations, duties, or equipment. After all, these men are not education majors. Every effort is being made to give the men confidence in their equipment. Fire and accident prevention are stressed at all times. These men are seamen and most have had little or no formal or special training in safety, fire prevention or fire fighting. In the past, their only interest was to get the cargo in or out in the shortest possible time, regardless of any and all safety regulations. Regulations and safety procedures were considered a waste of time. Steps had to be taken to convince them that safe operation was a more efficient and economical way of getting things done. Today the men, through the training programs, know how to protect themselves not only in routine ship's duties but in case an emergency should arise.

Each training program, fire fighting and safety and anti-collision radar navigation, is taught by a separate instructor specializing in that particular field. Each company has special requirements and equipment. Generally, in the fire fighting and safety program, the onboard instructor works with the Master by reviewing company and U. S. Coast Guard safety rules and regulations. The officers and crew members also receive these instructions. Meetings with each department to discuss fire and accident prevention in general and in specific work areas are conducted. The men from the deck, engine and stewards departments make suggestions at these meetings and frequently question the safety of certain working procedures.

At these meetings, the operation of all fire fighting, rescue and safety devices is explained and illustrated. In the last three years, training films have become part of

these meetings. The U. S. Coast Guard films "Fire Fighting Aboard Tankers" and "Amver-Search & Rescue" as well as the API film "Chemistry of a Petroleum Fire" and the British film "Fire Below" have been shown to about 3,000 men and their officers. With the turnover in personnel, common in the shipping industry, these men can spread some of their knowledge to other seamen.

In any shipboard safety program the Master of the vessel is the key figure. His cooperation must be year 'round, not just for the voyage when the instructor is aboard. Shipboard safety must continue 24 hours a day, 365 days a year. He must be convinced that safety will aid him in the performance of his duties and further the efficient operation of the vessel. With the advent of more sophisticated products, chemicals and faster turnarounds, the old cry of "We've been doing it this way for 30 years" is seldom heard. Larger, faster ships have created problems unheard of 20 years ago. Faster ships have reduced sea time and larger cargo pumps along with modern shore facilities have decreased port time. It is still up to the Master to see that the ship operates safely and efficiently. His spirit must carry throughout the ship to every man aboard her.

To assist the Master, these companies send the instructor aboard. As soon as possible after boarding the vessel, the instructor meets with the Master to plan a program of vessel inspections, safety equipment inspections and personnel instruction and drills. The safety program is designed to meet that particular ship's trade and her special needs. After the Master has given his approval, a meeting is held with the department heads and the program is discussed with them. The program is drawn up so that there will be no interference with the vessel's operation, daily work or normal routine. It must fit into, not upset normal practices.

Here is the way it is working now. After the program has been set in motion, an inspection of the vessel is made. The cargo operation in progress is observed. All safety defects are noted. All fire fighting and life-saving equipment is checked. A report of any variation of set company standards is made to the Master and department head concerned. All defects are corrected as soon as possible. At the present time, aboard ves-

sels of the Keystone fleet, we have a check list of 35 items that include gangway, safety net, ullage hole flame screens, scupper plugs, bonding cables, pumprooms, pumproom bilge flooding alarms, rescue harnesses, explosion meters, paint lockers, passageways, ladders, engine room, fire room and galley. If the vessel is on a ballast passage the tank cleaning operations are observed and the tank cleaning equipment is checked. A similar check list is being developed for vessels of the Amoco Shipping Company fleet.

As soon as the inspections have been completed and the vessel has left port, the training and refresher sessions for the officers and crew begin. A series of lectures and training films are scheduled for each department. These sessions include all men off duty, attending on their own time. The co-operation has been almost 100 per cent. Most men are willing to attend so that they can learn how to protect themselves. Every effort has been made to add variety to these meetings. Something new, either a film or some up-to-date information, is added to hold interest. Discussions are lengthy before, during and after these meetings. These crews know they have management's interest, so the companies gain through employee teamwork. Men on duty during some sessions attend other meetings so that everyone has the opportunity to participate. During coffee breaks and after meal hours informal discussions are held with both officers and men.

While men are on duty, the fire fighting and safety devices in their work area are explained and demonstrated. On deck the men are taught proper tank testing methods to be used before entering a tank, how to fight various cargo fires, fires in various housing and fires in pumprooms. In the engine room and fire room they are taught how to fight electrical fires, oil spill fires and soot fires with CO₂ portables, portable dry chemicals, hose reels and water fog. Of course, they are instructed not to use water on electrical fires. The members of the steward's department are taught how to attack grease and grease duct fire, as well as any type fire that might occur in quarters, messrooms and passageways.

All personnel are taught how to organize for and how to attack a major cargo fire using the ship's own equipment. They are taught that panic can and will have a deadly effect on any fire fighting operation. The

entire program is designed to keep these people alert to the ever present dangers and potential hazards in their own work area as well as aboard the vessel in general. When an emergency occurs it will affect every man aboard the vessel, no matter where he works or sleeps. One mistake, by one man can bring a tragic end to the voyage. Some men can pass fire fighting and safety devices day after day for years without ever seeing this equipment and without any knowledge of why it is there.

For years it has been a requirement of the U.S. Coast Guard for every U.S. flag vessel to have a weekly fire and boat drill. On many ships, too many in fact, these drills are hurry up affairs conducted in the shortest possible time. These drills have become a dull, deadly routine. No imagination is ever used. At the usual drill two hoses are lead out, put under minimum pressure and that is the drill. At the boat drills the boats are swung out, the men mustered and that is it. There you have 10 or 15 minutes of nothing.

To put some life into these dull affairs we will hold the boat drill first. By breaking the routine this way, some men will go directly to the fire stations and then sheepishly go to the boat stations when they realize their mistake. This alerts them to signals at future drills. At the boat drill, after the boats are returned to their chocks, the emergency lifeboat radio transmitter is demonstrated. Then the releasing mechanism for the new inflatable liferaft is demonstrated.

At the fire drill actual use of the fresh air breathing apparatus and the resuscitator is demonstrated during either a pumproom or tank rescue. A man is brought on deck with the pumproom rescue harness by a man wearing the fresh air breathing apparatus and revived with the resuscitator. The Keystone Shipping Company and Hess Oil & Chemical Corp. are two of the few companies with resuscitators aboard every vessel. This devise is not only invaluable to a man who has been gassed, but has been used numerous times to revive men with heart attacks and other breathing difficulties where oxygen is required. Gas masks, oxygen breathing apparatus, compressed air suits and other special equipment are demonstrated during this period.

After a demonstration of all fire fighting

devices, the officers aboard Keystone and Amaco fleets organize teams to put these devices to practical use. Within the Hess fleet every vessel has its own built-in foam system. This is operated for one minute during the drill using a foam monitor nozzle, a 2½ inch foam portable nozzle and a back up team applying low velocity water fog. Men also use portable CO₂ and dry chemical extinguishers with other portable or CO₂ hose reel nozzles as back-up for extinguishing simulated drip pan fires. Foam and back-up teams attack a manifold or tank fire. These imaginary fires are extinguished promptly. Throughout the year, most of the Masters see that their men are drilled in one or more of these operations at the weekly drill.

To impress the men with the importance of preventive maintenance, the devices used at the drills are seldom tested before hand. If there is a failure, they are asked: "What would you do if this happened to be a real emergency instead of a drill?" As you gentlemen know such a breakdown could result in loss of lives, cargo and ship. A ship is a world of its own with assistance hours away at best. Even in port assistance is slow.

Fire fighting, emergency and safety training takes time. That is the advantage of an on-board training program. You do have a captive audience which welcomes a change in the daily routine. Then too the men can be observed going about their duties, and safety suggestions can be made for everyday jobs. Accident prevention is also an important part of the program.

At times actual drills are filmed by the instructor. Succeeding drills are also filmed using the personnel aboard. When the men see themselves and their shipmates on the screen the reactions are gratifying but not surprising. Just like people ashore, seeing themselves in home movies, they enjoy looking at themselves. They point out mistakes they have made as well as the mistakes others have made. We all learn from our mistakes and so do the officers and seamen. The one who can learn from the mistakes of others is truly wise. Films taken on four or five vessels of the fleet are put together so that they can see what is being done on other ships.

The third phase of Codan Marine's on-

board training programs is anti-collision radar navigation using the Keystone Anti-Collision System. During the 20 years following World War II, there has been a very substantial increase in size and speed of ships and a corresponding increase in collisions. Three tanker companies, Hess, Keystone and Trinidad, recognized this and financed organized anti-collision radar research aboard each of their vessels annually for a total period of 10 years.

A professional instructor in radar navigation went from ship to ship, where he radar navigated with the navigation officers using all techniques, observations and suggestions. The information supplied by hundreds of experienced radar navigators and the instructors has produced and proved the Keystone Anti-Collision System, which is the first such complete and simple system.

The Keystone System is a rapid, routine plotting system as well as a rapid method for calculation of relative motion. It is capable of handling all radar navigation in dense traffic. The system is based on the new mathematical concept that the relative motion triangle is still a triangle even when it is so sharp angled that it resembles a straight line, or so small that it resembles a point. This concept makes it possible to handle all collisions situations by the same simple routine procedure. The navigator can instantly read the relative motion in respect to other ships and landmarks which will result from any course and/or speed changes or maneuvers he intends to make, even without reference to conventional navigational definitions and numerical figures, simply by using the length and direction of line (AD). He can handle traffic with greater ease, safety and efficiency than by the use of any electronic plotting device or costly computer known.

The Keystone System can be used in many other ways. It can be used by a radar-equipped ship when piloting with radio orders a ship which has no radar, for precise bridge-to-bridge communication, for naval strategy, and for three-dimensional navigation, because it defines with the first eight letters of the alphabet (A-H) all relative motion needed in anti-collision navigation and in associated terrestrial navigation. It is ready to be adopted as a complete, uniform anti-collision system. It will eliminate the present prevailing ignorance in radar

navigation and the destructions and deaths by human errors. These errors account for 95 per cent of all collisions.

Navigators are instructed to plot all radar situations when the set is in use. This keeps them alert to any up-coming collision situation in time for evasive action. The instructor brings out or renews a skill that the navigator may have forgotten or is so vague about that it is absolutely useless—plotting for anti-collision with radar. By use of this system in the future many lives, ships, cargoes and hundreds of millions of dollars, which may now be marked for destruction, might be saved. Who can tell the exact amount of money saved by companies with efficient operating, safety and training programs? To date we know of no radar collisions involving vessels using this system.

To achieve maximum effect, all training programs must be arranged so that there is a follow-through by management. The employee must be convinced that management cares about him and his personal safety. This can only be done in the maritime industry by personal contact, education and training. The entire crew of each ship, from the Master on down the line, knows that the management of these four companies is behind them 100 per cent. This knowledge results in safer operation reducing accidents, fires and collisions.

Ship's personnel have been able to organize themselves to prevent, or if prevention has failed, to attack fires that have occurred aboard their ships with the ships' own equipment. Modern ships and their cargoes call for modern safety and fire fighting equipment and up-to-date onboard training.

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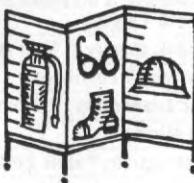
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