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MARINE SESSIONS

A FRESH LOOK AT THE AWO SAFETY PROGRAM

By JOHN KERN

Vice President, Simms Bros. Towing Company, Inc.; Chairman, Safety Committee, American Waterways Operators, Inc.

From its very beginning in 1945, the American Waterways Operators, Inc. has demonstrated a strong interest in crew safety. Evidence of it's first attempts to promote safety appeared in 1955 in the form of an "Accident Prevention Guide," intended to provide the towing industry with a basic program for reducing the frequency and severity of personnel injuries.

Included in the program were several activities which are still very much with us today, such as the sponsorship with the National Safety Council of a barge and towing vessel industry safety contest, inclusion of appropriate safety publicity in the AWO Weekly Letter, and the production and distribution of posters and other safety material.

The Accident Prevention Guide remained as AWO's primary safety tool for the industry until it was succeeded in 1963 by our Basic Safety Program booklet. This new, comprehensive program was well received by the operating companies and today remains as the keystone of AWO's safety efforts.

The principal emphasis in the past has been on the prevention of injury to employees. Certainly, this was an admirable purpose, and the control of such accidents must always be the foremost goal in any organized safety program. But with the passage and introduction of myriad legislation and regulations concerning so many facets of accidental cost, the horizons and challenges have broadened considerably and the prevention of personal injury now becomes only one part of the loss control picture.

Recently, according to an article in a Pacific Coast publication, Rear Admiral William Benkert, chief of the Coast Guard's Office of Marine Environment and Systems, spoke to a group of West Coast pilots and masters on the various new laws and requirements involving environmental matters. He said, "This is a whole new ball game From now on you're going to have to consider environmental impacts as well as the safety of your vessel, its cargo, and its crew. We look for radical changes in the design of vessels carrying inflammable materials, also of vessels carrying any substances that could be damaging to the ecology."

Truly, as Admiral Benkert said, this is a whole new ball game! And instead of being content with applying the term "safety" exclusively to the control of injuries, we must now adopt the concept of loss prevention long practiced by the major insurance companies, loss being defined as any accidental happening or occurence that might result in an unexpected cost to the operator, whether it be in the form of personal injury or damage to equipment or property of others, or loss of cargo, and now, damage to waters and marine life by spillage of oil, chemicals, and other substances.

Exactly what are the laws and regulations that make up the "whole new ball game" referred to by Admiral Bankert?

First, the most widely-known is the Water Quality Improvement Act of 1970, dealing with the pollution of water by oil and other matter from vessels. While not designed primarily to improve the safety of operations, the clean-up requirements and financial responsibility section of this law will certainly act as a deterrent to careless handling of vessels and cargoes.

The law requires (1) the person in charge of a vessel or shore facility to notify the Coast Guard immediately of any spill; (2) the owner or operator of a vessel to clean up any oil spill; and (3) vessel owners must show financial responsibility for oil spills up to the level of $100 per gross ton of a vessel.

If an owner fails to clean up an oil spill the federal government may and will impose a penalty to cover costs of clean-up in an amount up to $100 per gross ton of the vessel involved or $14,000,000, whichever is lesser. Where the spill is the result of willful negligence or misconduct within the knowledge of the owner, the full amount of the cost will be assessed.

Where the owner or operator can prove that a spill was caused by an act of God, an act of war, negligence on the part of the government, or an act or omission of a third party, he will not be held responsible.

The proposed Coast Guard regulations will apply to all vessels carrying oil as cargo and to all vessels engaged in fueling, oily waste disposal, or ballast discharge, and will be applicable to uninspected vessels and foreign vessels operating on the navigable waters of the United States. In addition, these regulations will provide for inspection of oil terminals and shore facilities, issuance of permits, and emergency procedures and equipment, as well as certification of personnel supervising the transfer of oil products.

Sections of the bill dealing with the control of sewage from vessels become progressively effective. Standards for sanitation devices on vessels, issued by the Environmental Protection Agency, will be incorporated into Coast Guard regulations governing the design, construction, installation, and operation of such units. These are expected to be published next January. Starting two years after adoption, all new vessels equipped with a marine toilet must have a holding tank to prevent discharge of wastes; starting five years after promulgation vessels completed or under construction at the time the regulations were issued must cease all sewage discharges into United States waters.

A provision of the proposed regulations which originally would have required double walls and double ends for barges of 100 gross tons or more built, rebuilt, or converted to oil service after December 31, 1972, are being deferred pending the outcome of a joint Maritime Administration/Coast Guard study to determine the economic and environmental impact of double-skin versus single-skin oil barges and the relative risk of pollution involving use of these barges. The study is scheduled for completion December 1, 1973.

Just last week, the Congress passed an amendment to the Water Quality Improvement Act aimed at completely eliminating by the year 1985 the discharge of pollutants into the waterways and imposing for spills of unremovable hazardous substances a penalty of $50,000 maximum per incident for accidental discharge, which penalty escalates after two years to a maximum of $2,000,000.

Another new law signed by the President this year is the Port and Waterways Safety Act, likewise designed primarily to help protect the inland waters from oil and other hazardous polluting substances. This law confers on the Coast Guard broad authority to involve itself in many aspects of safety—to control vessel traffic on inland waters; regulate the handling and storage of cargoes on waterfronts; establish safety requirements for waterfront equipment and buildings, and investigate accidents and other incidents which would affect the safety of environmental quality of ports, harbors, and navigable waters.

The bill also amends the 1936 Tank-Vessel Safety Act to authorize inspection of all watercraft that carry hazardous and polluting liquid cargoes and empowers the government to regulate the design, construction, and operation of such vessels and to include environmental factors as well as safety factors in administering the law.

The Coast Guard has already established vessel traffic control systems in San Francisco harbor and Puget Sound and is considering similar systems for New York, New Orleans, and Houston.

The new Ports and Waterways Safety Act "Gives the Coast Guard a mandate," Admiral Benkert said in his West Coast remarks. "We can tell you when your ship should come in. We can tell you when to leave. We can make you stay at the dock. We can do any damn thing we want to!"

Now, lest we become overly apprehensive about such an apparently strong statement, the admiral added this qualification, ". . . we have only the good intention to use our authority where it is needed. We will administer it judiciously and properly to encourage safety, including the environmental aspect of ship traffic."

There is no question but that over the years the Coast Guard has been the friend of the waterways operators. Its dealings with us have been fair and reasonable. Its officers have dealt with us not with timidity, but with a desire to help. For this the Coast Guard has its critics—those who fail to either understand or appreciate its purpose.

On September 19th the House Committee on Government Operations issued a press release charging that the "Government's enforcement of the nation's oil pollution prevention laws has been 'lackadaisical'," and called upon the Coast Guard to "vigorously enforce the Refuse Act and civil penalty provisions of the 1970 Water Quality Improvement Act."

In reference to the Coast Guard's enforcement practices, Congressman Reuss, spokesman for the Committee, called them "absurd policies, which are contrary to the law," and stated that they "have resulted in a few civil penalty assessments against oil polluters over the last 30 months." The Wisconsin lawmaker added that "the 1970 law mandates that the Coast Guard shall assess a civil penalty for each violation."

An apparent effect of the committee's criticism was a statement made at a recent AWO meeting by a Coast Guard officer that when a spill occurs he expects to assess the maximum penalty of $10,000, based on the size of the business, ability of the business to pay the fine and remain in business, and the gravity of the violation.

Throughout history one of the most common weaknesses in our society has been the inability to clearly communicate. On the waterways, the failure to communicate with each other has been the cause of many collisions between two vessels. In order to help correct this deficiency, Congress passed the much-needed Vessel Bridge-to-Bridge Radiotelephone Act.

The new law requires bridge-to-bridge radiotelephone communications, while navigating, on (1) every power driven vessel of 300 tons or more; (2) every vessel of 100 gross tons or more carrying one or more passengers for hire; (3) every towing vessel of 26 feet or over in length; and (4) every dredge and floating plant engaged in or near a channel or fairway in operations likely to restrict or affect navigation of other vessels.

The new law, which will require mandatory monitoring on channel 156.65 MHz, is expected to be a significant step in the promotion of navigational safety, as it will insure the ability of the individuals in charge of vessels to communicate their current situations and intentions to each other. This positive exchange of vital information should be instrumental in preventing many marine collisions, as well as the near misses—collisions which might have occurred but didn't due to the elements of chance or luck!

It is recognized, of course, that electronic equipment, being as sensitive as it is, can fail. What happens when this occurs in the course of a voyage? Must the vessel tie off to the bank? Under the law, should radio communication capability be lost for one reason or another, the person in charge will not be required to stop the voyage until repairs can be made, but will be allowed to continue, although the loss of such capability must be treated as a factor when under way.

Both the Coast Guard and the Federal Communications Commission have issued regulations, effective January 1, 1973.

The barge and towing industry supported this measure in the interest of safe navigation. And while no system has yet been found to be completely foolproof, the chances are greatly reduced that there will be a failure to communicate, such as occurred between the Chicago bus driver and the little old lady standing at a bus stop on Michigan Avenue. Looking up at the driver, she said, "Does this bus go to da Loop?" "No m'am," he said, looking back at her, "It goes beep! beep!"

Some years ago a panel discussion was held on the merits of licensing or not licensing personnel on uninspected vessels. At that time the infant idea, proposed out of St. Louis, included manning scales, vessel inspection, and a number of other features with which operators would have had difficulty in complying. The author took a position in opposition to the program. Talking in favor of the general idea was a young Coast Guard lieutenant, now turned admiral, W. F. Rea, III.

Who won or lost those many years ago was not decided at the time, but could the answer be reflected in the fact that President Nixon recently signed into law the Pilot House Licensing Bill—a direct offshoot of the St. Louis proposal with most of the objectionable features deleted, at least for the time being.

The new law requires that, in the interest of assuring safe navigation, all towing vessels over 26 feet will be under the control and direction of a pilot licensed by the Coast Guard. It provides, too, that he be licensed for a specific geographic area and may not work more than 12 hours in any consecutive 24-hour period except for an emergency.

Under the law, there will be two types of licenses: an operator's license and a second class operator's license. To obtain the operator's license the pilot must be 21 years of age and have at least three years service on a vessel; for the second class license the pilot must be at least 19 years of age and have at least 18 months service on deck of a towing vessel.

In addition, it is proposed that the applicant for each license must pass an examination covering Rules of the Road in the geographical area for which the license is to be endorsed, practical use of the magnetic compass, use of navigation instruments, emergency signals, practical use of charts, aids to navigation, lifesaving and simple first-aid, fire-fighting equipment and fire prevention, boatmanship, regulations and laws applicable to the operation of a towing vessel, and pollution prevention and control.

The practical manager realizes that operator licensing by itself is no panacea for navigational safety on the inland waterways, just as the licensing of automobile operators has not stopped traffic accidents. But, with the Coast Guard's authority to revoke or suspend an individual's license to pilot a towboat, the new law will have two very important effects: (1) the habitually lax or reckless operator or so-called "cowboy" will be forced to exercise greater caution in order to maintain his livelihood; and (2) no longer will a pilot with a poor accident record be able to go from company to company since, as noted, the Coast Guard will simply be able to remove his license if conditions justify.

Initially, the proposed licensing regulations were developed as a result of a cooperative effort between the Coast Guard and an industry-wide committee organized by the AWO some years ago.

Perhaps the one new law that could give waterways operators unexpected problems is the Occupational Safety and Health Act of 1970. There is no question about the extent of its applicability to shoreside facilities—boat construction and repair, drydocking, longshoring, terminals, etc. But what about the boats themselves?

The regulations state, in essence, that the OSHA standards apply to all employments except "those with respect to which federal agencies other than the Department of Labor exercise statutory authority to prescribe or enforce standards or regulations affecting occupational safety or health." The Coast Guard believes that the comprehensive delegation of statutory authority by Congress over the years reflects a clear intention to invest in the Coast Guard exclusive authority for the safety of inspected vessels and those who sail and work aboard them." With this there can be little dispute, but the question is: Does the Coast Guard or any other such agency currently exercise such statutory authority over non-inspected towing vessels? If not, then who comes into the picture? Is it OSHA? The AWO has been informed that representatives of the Coast Guard and the Department of Labor are working toward the development of an inter-agency agreement designed to insure that there would be no misunderstanding relative to jurisdiction. It is believed that an agreement has been reached in principle, and we are hopeful that the details will be completed in due course and will be made available to the industry in the near future. We are hoping, too, that the industry will be given the opportunity to comment on the regulations or procedures before they are adopted, to the end that a practical, working guide for the waterways will result, and that the Coast Guard will not simply assume carte blanche the responsibility for enforcing on vessels the standards that OSHA has prescribed for other employments.

In most of the measures reviewed herein, the AWO and other industry groups have worked closely with the sponsoring bureaus in an effort to produce situations with which all involved can live. In addition, the AWO has worked for many years for uniform Rules of the Road governing navigation in domestic waters. Such a system would provide a single set of Inland Rules of the Road to replace the several existing sets which now cover navigation on the western rivers, inland waters, and Great Lakes. The Rules of the Road, of course, prescribe passing rules, whistle signals, navigation lights, and other operational procedures which assist the persons in charge of vessels to achieve a safe passage with others.

Other long-standing projects of the AWO concern a cooperative venture with the Coast Guard for the removal or improvement of structural hazards to navigation; working through a Corps of Engineers Liaison Committee in connection with that department's operations; cooperation with the Maritime Administration in their new involvements in the barge and towing industry; and sponsorship of quarterly navigation conferences with representatives of the Coast Guard and Engineers and AWO members, all with definite safety and loss prevention implications.

And, of course, the AWO Safety Committee itself has long been a factor in the promotion of loss control in the waterways industry. Now, with its responsibilities being multiplied with the adoption of so many new laws and regulations which will require certain measures of accident prevention, the activities of this committee, and others having related involvements, will of necessity have to be expanded. In this connection, we have established a working liaison with the Inland Waterways Safety & Health Association, which has long been a leader in waterways safety. We are appointing subcommittees to absorb some of the work load of the main committee, including one to develop statistics which will show that the accident record on the waterways compares favorably with other modes of surface transportation. For example, National Transportation Safety Board figures covering the injury loss rates for surface freight transportation for the five-year period 1964 through 1968 show railroad injuries per billion ton-miles—20.0, highway injuries—130.7, and marine injuries—2.82. Speaking at the 10th annual conference of the National Council of Physical Distribution Management in Chicago, Braxton B. Carr, President of the AWO, said, "Water transportation of certain so-called hazardous commodities is demonstrably the safest method of moving them, safest from the standpoint of water pollution, air pollution, safety of personnel handling the transportation and, finally, from the public standpoint, inasmuch as water transportation is generally isolated from heavy concentrations of population."

What will be the over-all effect on the waterways industry from all of the new laws and regulations which we have discussed? Of course, the increase in the work load of the personnel involved is obvious. No longer will the safety man be concerned primarily with the prevention of injuries, but he will be faced with the responsibility of devising sophisticated procedures for preventing and removing oil and chemical spills, major and minor; providing and maintaining holding tanks and arranging discharge facilities for sewage and other refuse; developing procedures to assure that radio equipment is operable at all times; maintaining records on the qualifications of wheelhouse personnel; keeping equipment in a condition that will comply with the standards of OSHA; being certain employees use protective equipment that will be required under the various laws; not to mention the continuation of the all-important procedures of the past to prevent injury to personnel.

Not only will the work load increase on all concerned, but the price of water transportation is going to go up because of an increase in insurance costs, an increase in costs of certain vessels to meet new pollution control standards, an increase in personnel training costs, and an increase in the number of supervisory employees needed to carry out the mandate of the new laws and regulations.

In his comments in Chicago, Mr. Carr noted that some of these requirements are "so restrictive, so burdensome for compliance, and so interpreted for enforcement that they actually raise the specter of curtailing certain commodity movements by water, drastically raising the price of transporting others, and even *prohibiting* the movement of some." And discussing a Senate committee report on a provision to assess a penalty for the spillage of hazardous substances, he stated that "the intent of the committee was to set the penalty so high for spillage of such commodities that water carriers would not take the risk, and therefore the movement would not be made by water transport."

Perhaps the overall situation with which we are faced today is best described by the Southern States Industrial Council in a letter to prospective members: "We have a serious problem of regulatory overkill in OSHA, EEOC, and other agencies, yet pressures increase for more government intrusion into the operation of every business firm." The letter further states, "These anti-business pressures from self-proclaimed reformers will continue regardless of the outcome of the November elections."

We cannot be blind to the rules and legislations of our "brand new ball game" or the regulatory overskills with which we are faced will surely tear us up! To be sure, they are *going to constitute* one heck of a challenge for the future. But the waterways industry has faced challenges before and met them admirably, just as we *will meet these new challenges*, particularly from the standpoint of loss control. The AWO is well aware of the situation, and will make every effort to keep from being torn up as we take a "Fresh Look at the AWO Safety Program!"

THE TWO YEAR NATIONAL RIVER ACADEMY PROGRAM

By Captain PIERRE R. BECKER
Superintendent, The National River Academy of the United States of America, Helena, Ark.

The purpose of this paper is to show, through the history and development as well as through present trends and needs, the necessity of producing an alternative and practical solution to meet the manpower needs of the inland waterways industry. The only way in which the challenge can be effectively met is by reducing interest risk and optimizing training results through the application of modern techniques, effective administration, unique training aids, and use of institutional training.

Traditionally, the inland waterways transportation industry has depended upon on-the-job training to fulfill qualified personnel requirements.

Skill, experience, and a feel of the river are required to pilot a tow of barges, most of them longer than the greatest ocean liners, through the inland waters. Education of this kind could save both the shipper and the carrier substantial costs involved in damage suits and insurance rates. Safety is a matter of continuing and vital concern to the barge and towing industry. Intensive in-company training and safety programs are recognized as giving crews an opportunity to improve their skills in accident prevention and safety.

The U.S. Coast Guard and other responsible agencies have been formulating and updating regulatory controls for many years to safeguard the movements of oil and the so-called dangerous cargoes. Continued efforts to improve these standards will improve the safety of operations for the shippers and the carriers, as well as the public.

It is a logical coroellary to the foregoing statements that the development of the inland waterways industry will be largely dependent on the competence of its personnel. As navigable waters become congested with a large array of vessels, as the types of loads become more heterogeneous, and as the quantities shipped by water increase, the commercial waterways industry must advance in regard to technology and trained personnel as well as fostering an increased awareness of our ecology and environment by emphasis on pollution training.

The National River Academy will put real worth in plans to continue the progress of river navigation which is directly related to the economic development of our inland waterways. The Academy, in addition to providing a much needed professional education program, has the potential to become the focal point of technological advancement for the inland waterways industry.

The Academy is presently coordinating with industry executives in achieving ultimate objectives with respect to the safety of personnel, transfer of liquid cargoes and liquefied flammable gases, chemicals, and the so-called dangerous cargoes.

As aforementioned, safety is a matter of vital concern to the barge and towing industry. In a recent study of towing vessel operations and casualties undertaken by the Coast Guard, it was discovered that while the number of towing vessels increased by 20 per cent in a ten-year period, the number of casualties increased 120 per cent. If a major crisis is to be avoided in the industry, prompt and aggressive action must be taken.

The development of a total environment simulator is a substantial advancement in providing a labor force which will be prepared to cope with the advancing automation and industrial demand within this rapidly expanding transportation network. What better way can prospective masters, pilots, and operators be afforded an opportunity for planned, periodic, professional development, in order that they may stay abreast of growing technology and gain practical experience while learning new techniques of operation? The proper use of simulation equipment in a classroom environment is the best way to meet these needs. The investment in the new technology will not pay off unless personnel are trained not only in equipment operation, but also in effective utilization of that equipment.

At this point I would like to touch on the future manpower availability the Academy plans and, finally, the two-year cadet/pilot program.

Prior to the Towing Vessel Operator Licensing Act for uninspected towing vessels, inland waterway owners and operators had been free to engage such personnel whose employment experience and familiarity with particular river systems was sufficiently adequate to assure reliable operations. However, the new Act requires various combinations of experience prior to sitting for an operator's license. These combinations basically require three years total service, of which one year must be served on deck of any towing vessel. This indicates an imminent shortage of qualified manpower to sit for an original license as operator of uninspected towing vessels upon full implementation of the Act.

In line with satisfying the industry's needs and to elevate the safety record, the Academy plans to meet this challenge by developing and implementing four additional programs aside from the existing programs. They are:

1. *Firefighting, River Safety, and Pollution Training Course.* Oceangoing firefighting procedures are not applicable to the river. Pollution training is comparatively new and lacks the availability of a formal training guide slanted toward river men. In the case of river safety, the accidents experienced in this field are unique, vary tremendously, and reflect high insurance premiums.

The inland waterways industry is in dire need of a manual which will serve as a basic reference for all ratings presently serving on board towboats and barges. This manual will be developed by the Academy and will include firefighting procedures aboard towboats and barges, identifying a recommended course of action with respect to wind and navigation, and the use of the various equipment on board. The characteristics and limitations of each piece of equipment will be included.

Also included will be appropriate information concerning the history, nature, characteristics, and prevention of pollution, in addition to methods and techniques of cleaning up minor spills.

River safety, in the latter part of the manual, will identify the history of accidents, analysis of towing casualties which result from fire and pollution, and personnel casualties.

We also plan to conduct a formal, one-week training program for all personnel operating on the Mississippi River and its tributaries at our firefighting school specifically designed for inland river personnel.

2. *Radar Training Course.* The recent towboat licensing legislation requires the licensing of operators on uninspected vessels. This means that any persons satisfying the requirements may sit for an operator's license and qualify for possible employment as an operator of uninspected vessels.

Radar is not a part of the examination nor is it a requirement. The use and interpretation of radar, however, is essential in operating major and minor tows during limited visibility and from dusk to dawn. Familiarity with radar is considered mandatory to enhance safe towboat handling on the rivers. The Maritime Administration's "Radar Handbook" is not applicable for use by towboat personnel, nor is there any similar book applicable for the inland waterways industry on the market. Therefore, a definite need exists for a one-week radar familiarization course conducted at the Academy for persons qualifying for an operator's license, and for a manual outlining an introduction to radar, interpretation, use limitations, adjustments, and safety procedures with application to river operations only.

3. *Deckhand Training Program.* Deckhands consist of approximately 50 per cent of the major line towboat crews, which amount to approximately 20,000 billets. No previous experience or qualifications are required to serve in this capacity. The attrition rate has been tremendous and is reflected in insurance claims.

The new licensing legislation for uninspected vessels will make it essential for prospective operators to have at least one to three years service on deck, depending upon the level or experience. It is foreseen that future licensed operators will obviously come from the ranks of deckhands, thereby necessitating lower attrition rates. A standard formalized training program, supplemented with a standard training manual for the deckhand occupation, is considered essential to meet the future manpower needs. The Academy plans a three-week deckhand/tankerman course of instruction that will cover all objectives in developing the essential skills required.

The manual and formal training program will be a tremendous asset to the industry in standardizing procedures, enhancing safety, and enabling deckhands to progress to a level short of operator.

4. *Operator Training Program.* The Pilot House Licensing Act, signed into law by President Nixon on July 7, 1972, requires uninspected towing vessels to be under the direction of a person licensed by the USCG. Since this is a new licensing requirement and includes some 12,000 operators (USCG estimate), it is foreseen that this program is essential in training future operators as well as developing a training manual for this position.

The Academy's present plans include the development of an operator's manual identifying the duties and responsibilities of an operator in addition to towboat handling, casualty reviews of accidents, rules of the road, operation and use of pilot house instruments and accessories, use of charts, aids to navigation, and other essential information not covered in the previous three courses and manuals.

In order to provide this industry with competent personnel qualified in all aspects as previously discussed, the National River Academy's two-year cadet/pilot program is designed to provide a small but effective manpower input and to accommodate the training of future pilots through a combination of practical and technical training with on-board experience supplemented with institutional training.

Today, we have commenced the two-year cadet/pilot program. This program has been on the drawing boards since 1969 and has received detailed consideration towards it's implementation. The inland waterway industry, a unique and ever expanding industry, plans to be in the forefront in the training and development of future personnel through the National River Academy of the United States of America. The Academy offers a highly specialized and unique program for young men seeking a career with this industry, ashore and afloat. The word unique is used because management is not concerned with the obtainment of a Bachelor of Science degree, a license as third mate or third engineer, or a commission in the U.S. Naval or Coast Guard Reserve.

Students are offered a two-year cadet/pilot program that will provide them with professional knowledge and skills, river science, and a well rounded program of general education in preparing our prospective pilots for effective and competent leadership.

The Academy accepts up to 20 students every six months. Final satisfaction for admission rests with the Admissions Board, which carefully reviews all information contained in the applicant's file. The primary factor bearing on selection reflects his aptitude for the skills involved and a sincere desire to make a career in the river industry. In addition, he must be a high school graduate or equivalent, a citizen of the United States, and must have passed his 17th birthday by the date of registration but must not have reached his 27th birthday. He may be married, but non-married are preferred. With regard to physical requirements, he is required to undertake a physical examination and comply with the USCG vision requirements for an original license.

The course of study is divided into two month periods. Cadet/pilots will alternate every two months for the purpose of receiving institutional training at the Academy and on-board experience aboard a main line towboat. For instance, the program is designed to train a cadet to become a deckhand by covering the following subjects: River History, River Seamanship, River Safety, Towboat

Hygiene, First-Aid, Human Relations, and Physical Education. Upon completion of this first phase of study, he then reports aboard a towboat and serves as a deckhand for a two-month period. Subsequently, at the commencement of the fifth month, he receives basic indoctrination in engineering, covering such subjects as engineering safety, basic marine engineering, technical math, basic electricity, engineering graphics, machinery repair, refrigeration/air conditioning, and physical education. He then reports aboard the towboat for another two months and works under the chief engineer and fulfills a river project designed to further his engineering background.

At the commencement of the second year period, he commences pilot training and again alternates every two months between the Academy and a river towboat. While aboard the towboat he will serve as an apprentice pilot in addition to accomplishing river project assignments.

Each phase of training at the Academy includes field trips in addition to presentations by representatives from commercial companies and government agencies such as wire and rope companies, deck hardware companies, USCG, National Transportation Safety Board, Hartford Insurance Group, lock master, towboat companies, Corps of Engineers, and a visit to a lock and dam and the Waterway's Experiment Station, Vicksburg, Mississippi.

In addition, in order to insure a closer relationship between the student cadet and his parents, we have scheduled the weekend of December 2 and 3, 1972, as a "Father and Son Weekend" at the Academy. The "Parent's Weekend" is scheduled for August 18, 1973. These particular weekends are scheduled a couple of weeks prior to their reporting on board a river towboat.

The cadet/pilots undergoing training today were screened in depth. Our experience in having screened some 25 applicants for the present session has indicated to us that the individuals are highly motivated, have a deep respect for the river occupation, and look forward to upgrading themselves to mainline towboats and ultimately management positions. One outstanding trend indicated to us in interviewing and screening the present applicants reflected a conservative attitude. They look forward to disciplinary measures, are adverse to the use of narcotics, and are highly motivated to engage in a profession that has an uphill climb for employment. Another interesting note is that one student has a Bachelor of Science degree in Geography, another is a licensed commercial aircraft pilot formerly with one of the airlines, two others have two or three years of college, and the remainder are highly motivated for a river occupation, since their close relatives are engaged in the same industry.

In conclusion, the occupational outlook for cadet/pilots is unlimited. This program, coupled with our upgrading and planned future programs, expresses management's confidence in the future of the professional riverman employed in this industry. Management is initiating every effort to make the National River Academy the best of it's kind ever undertaken and to assure that skilled rivermen who come through the program will take their places in a strong, growing industry.

INLAND MOVEMENT OF LASH AND SEABEE BARGES

By B. M. ALDRIDGE
Safety Director, Dixie Carriers, Inc., Harvey, La.
R. L. FOX
Manager, Safety & Security, New Orleans, La.

The following is a summary of commentary that accompanied a slide presentation on the topic:—Ed.)

B. M. ALDRIDGE:

Bargeship's and Shipbarge's are new modes of water transportation more commonly known as LASH and SEABEE vessels.

When we were first asked to make this presentation we began to review our casualty files and talk with our operations people. We found that the movement of the barge part of these vessels on our inland waterways by tug and towboat has been a relatively safe operation. While there are several other problem areas including regulatory agencies, customs declarations, and cargo loss exposure (which are being solved by industry committees), we have had very few problems from a safety standpoint.

Dixie Carriers move most of these types of barges in the Gulf Intracostal Waterway both to the east and west of New Orleans, and Ingram Barge Line makes most of the movements in the Mississippi River System to the north of New Orleans. Dixie's accident experience in connection with the movement of these barges consists of two minor personnel injuries and one minor collision damage. Ingram's experience has been even better, as they have had no casualties with the LASH and SEABEE barges. Also, Dixie's casualties resulted from personnel error rather than from the design or operation of the barge or its equipment.

We have gotten together some slides which will give you a brief exterior look at the operation of the LASH/SEABEE ships and barges and will show you how the barges are made up into tows and moved on the inland waters of the Gulf Coast and the Mississippi River System.

R. L. FOX:

The *Acadia Forest* was the first of a class of new ships designed to carry inland barges across oceans. This ship and several other LASH vessels have recently been joined by two SEABEE ships, an independently conceived but similar concept. One other SEABEE is due to join Lykes Fleet by the end of the year.

These systems are turning inland ports into sea ports on the inland waters of the United States, in addition to penetrating deep into the heartland of Europe.

The present barge ship construction schedule calls for 27 vessels by 1974. Additionally, it has been predicted that a minimum of 20 more orders for LASH vessels will be placed on both sides of the Atlantic in the near future.

The main battery of these barge ships is their lighters, of which the SEABEE is in many respects twice as large as the LASH. Although a LASH barge can carry six 20-foot or three 40-foot containers, the SEABEE barge has been designed with specific compatibility to containerization and can handle ten 30-foot containers in addition to 16 40-foot containers atop the barges on the mother ship's upper deck only.

LASH barges are versatile with regard to various cargoes. The heart of the SEABEE is its 2,000 ton elevator, as is the 500 ton crane, of LASH. The SEABEE's elevator can handle two fully loaded barges at a time between the water and the three horizontal barge decks. Storage of the barges is accomplished by one of two transporters. One of the major differences of the LASH ships is the crane which lifts the barge from the water, moves it horizontally, and lowers it into specially constructed cells.

LASH and SEABEE barges are positioned by a switch-boat. The LASH crane lowers a lifting beam to the barge and mates with four lifting posts. In both systems the sequential operation is monitored by permissive circuitry through lights. Special attention has been given to maximize safety and minimize total breakdown.

At the end of 1971, 1,000 LASH barges were completed. Additional barges will be ordered for the eight LASH vessels recently contracted.

Standardization came naturally with regard to outside dimensions. However, interior dimensions of LASH barges differ, especially with the inclusion of double skin in second generation barges.

The process of embarging or loading the LASH barge aboard the vessel was specified as one every 15 minutes. Ideally, this can be accomplished, but various conditions and circumstances occasionally extend this to one every 25 minutes. The time required for the barge to arrive at its inland destination after separation from the vessel varies. This is not necessarily proportionate to the miles covered. Such delays are primarily caused by the necessity to transit locks.

On the intracoastal waterways, single column tows are most prevalent, while on the Mississippi System ship barges are combined with major tows of conventional barges and are normally towed outboard of the main tow. One of the river arts is "facing up" or in a layman's term lashing all barges with the towboat into a single, near rigid unit by virtue of wire and ratchets. Wire and ratchet sets are carried aboard the towboat in sufficient quantity to provide the necessary rigging for the maximum number of tows and are generally 7/8 inch or 1 inch wire. The kevels or cleats on the walkways do not necessarily match, and present further problems when making up lash barges. Two SEABEE barges equal one jumbo barge in size, and fit into integrated tows as an equivalent of one jumbo barge.

Large mainline tows are driven by towboats in the 7,500 horsepower and above range, powered by three engines with a crew of up to 14. It is not unusual for such a towboat to push 50 barges, which may represent as much as 70,000 tons of cargo. Since the width of tows varies from 240-300 feet, sounding gear is generally provided on the bows of the forward port and starboard barges. The wire rigging that is used to secure the barges to the towboat in a rigid manner is generally 1 1/8 inch wire. Forward constant tension winches are remotely controlled from the wheelhouse and are used to take up the slack as necessary. As the volume of ship barges increases on the Intracoastal Waterway or similar narrow waters, it is foreseen that a combination bow piece and steering system such as the "Steermaster" might literally lead the way. Unlike a conventional bowthruster, it is capable of performing effectively at speeds as great as 13 knots. At present, the steermaster is used on some tows to the maximum extent, leaving the towboats rudders in a midship position, enabling safer passage with superior control. In this case the rub rails on the bridge abutments were formerly made of wood. Due to the need for constant replacement of the wood pieces, steel rails were substituted, creating a dangerous situation when carrying flammable products because of the possibility of sparking.

The creators of LASH have designed a self-propelled 14-knot ship. This crane equipped feeder vessel is capable of carrying 22 LASH barges. A Mini-LASH ship, if you will.

Speaking of Minis, shown here are two mini-ships of Greek registry with an eight man crew which have quietly invaded inland waters of the United States carrying bulk, neo-bulk, containerized, and general cargo. North of Baton Rouge, the draft limitations prevent the mini-ship from fully utilizing its cubic capacity, a disadvantage not shared by shallower ship barges.

Unlike containerization, which began by utilizing existing or modified equipment and vessels, the principal elements of the barge ship concept came into existence with completely new and specially constructed hardware. As we have seen, the ship can and does utilize only a harbor and a few tugs, while the lighters load at conventional wharves. However, we understand also that the construction of elaborate specialized terminals geared to the logistical support of LASH and SEABEE barges and ship is forthcoming.

You have noted I am sure, that this presentation touched only briefly on safety in that it referred to the use of sounding gear, remote controlled winches, and the steermaster, all of which are useful pieces of equipment in the prevention of property-damaging accidents. As was mentioned in the beginning, we are not aware of any serious personnel injuries which resulted from the towing of LASH or SEABEE barges.

There have been some things, however, which have been troublesome and caused some concern. One of these was the winches mounted on the LASH barges. Allegedly, they were fabricated in Japan, and the combination of parts which did not mesh, plus the use of galvanized cable which was adversly affected by salt water, caused the winches to lock at times, and they were difficult if not impossible to release. The deck hand, finding one of these locked and being unable to release it by hitting it with a cheater bar, sledge hammer, or what have you, would invariably cut the cable. This caused problems for the tower, in that he had to carry extra rigging, and for the operator, in that every 30-45 days or whenever the barge reached New Orleans he had to replace cables. This condition is currently being rectified by going to a different winch.

One other problem is, of course, the size of the LASH barge as compared with the common size barge of 150 × 50 or 175 × 50. There is no combination of either LASH or SEABEE barges which will fit uniformly into a regular tow. You understand, of course, that the smaller barge was designed with the waterways of Europe in mind, and apparently not considering the United States waterways. Consequently, often times the smaller barges will be strung along the sides, and there is the chance that they will get wiped off in a narrow channel or on a sand bar. Fortunately however, as with personnel injuries, we are not aware of any serious problems to date.

PORTABLE INSTRUMENTS FOR ATMOSPHERIC TESTING

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Primarily due to the Occupational Safety and Health Act of 1970, industry in general has become more aware of the need to test atmospheres for hazardous materials. The maritime industry has always been concerned about what is in the atmosphere of enclosed spaces. There has been an increasing awareness in the last few years as many new materials have been developed which are being transported by water.

The shipping industry is greatly concerned, and justly so, about the condition of the spaces which hold these cargoes before, during and after shipment. Is the area free of contaminants and clean prior to loading cargo? Is there loss of cargo out of, or entrance of contaminant into the space during shipment? What is the condition of the atmosphere after the cargo has been unloaded? Is the space "safe for men" and "safe for work?"

The use of instruments to test the atmosphere in the space can help determine the answers to these questions. Since there are many enclosed spaces in any given vessel, most of the instrumentation used is of a portable nature so that it can be moved from one area to another. In this context, portable instruments are those which require no external source of power and/or are battery-operated.

Included in OSHA as ways of assessing the hazards under this program are the standards and practices published by recognized organizations in this country such as the American National Standards Institute (ANSI), the American Society for Testing Materials (ASTM), and The National Fire Protection Association (NFPA). Standards of these organizations are referred to in OSHA as consensus standards. NFPA has published several which pertain to the maritime industry and most refer, in some way, to the testing of spaces for various hazards.

We shall mention various types of portable instruments that are available to check enclosed areas for some of the hazards that may be present. It is impossible to discuss in detail each of these instruments but there will be mention of what the general types will and, just as importantly, will not do.

Three major areas are covered in this discussion of instrumentation for testing enclosed spaces. The first has to do with oxygen content; the second, with flammability potential; and the third (but no less important), with checking of the atmosphere from a health hazard standpoint. This third category includes testing for toxic gases, dusts and fibers.

Oxygen Indicators

Important to assessment of the potential hazards of enclosed spaces is the knowledge of oxygen content. The section of OSHA that deals with open-surface tanks specifically states that personnel shall not enter such tanks without respiratory protection if the atmosphere contains less than 19.5 per cent oxygen. Of specific interest to the maritime industry is NFPA Standard 306 which concerns the "control of gas hazards on vessels to be repaired." Section 105 specifically requires the oxygen content of compartments or spaces shall have a minimum oxygen content of 18.0 per cent by volume.

These two specific references to oxygen-content of an atmosphere are concerned with the health and safety of individuals. In addition to this most-important reason, it is vital to know the oxygen-content of an atmosphere in testing that area for combustibles. If the oxygen-content of that atmosphere is less than 10 per cent by volume, it may not be possible to obtain a true reading of a combustible gas which may be present in that atmosphere. It must be remembered that hot wire combustible-gas instruments are dependent on oxygen in the atmosphere for burning of molecules on the filament.

Previous requirements of the above-referenced standards were only that the oxygen concentration should be above 16 per cent. Much of the testing of the atmosphere for oxygen-content was done through the use of a flame safety lamp in which the flame went out if the concentration fell below approximately 16.5 per cent by volume. This method of measurement is not sufficiently accurate for the current requirements of OSHA or Standard 306. It is almost impossible to differentiate, for example, between 19.0 and 19.5 per cent. Also, since the flame goes out at approximately 16.5 per cent, the lamp is of no value in assessing an atmosphere for combustibility if the oxygen-content is below this value.

Currently, the greatest majority of oxygen indicators on the market are based on the electrolytic or galvanic principle. In such sensors, two different electrodes are immersed in an electrolytic or galvanic solution. This solution may be in the form of a liquid or more like a paste. Oxygen-content in the sample causes a flow of electrons between the two electrodes and this current-flow can be made proportional to the oxygen concentration in the atmosphere. These sensors can be incorporated into individual instruments with the sensor mounted on the end of an extension cable. This permits the sensor to be lowered into the atmosphere being tested, and an instantaneous reading obtained for oxygen-content of that atmosphere.

Combustible Gas Indicators

The second major area is that of combustible gas detection. First, a review of the definitions of the major terms used in this area. The definitions used are those contained in NFPA Manual 325-M, which has to do with the properties of flammable gases and liquids.

The first term is *lower explosive limit*, abbreviated LEL. It is defined as the lowest mixture of a combustible gas or vapor in air that will burn or explode when ignited. This percentage varies widely among different compounds. For example, the LEL of pentane is 1.4 per cent by volume, while that of methane is 5.3 per cent by volume.

The second term is *upper explosive limit* which is defined as the highest or greatest mixture of a combustible gas or vapor in air which will explode or burn when ignited. This percentage also varies from one compound to another: using the same two examples mentioned, the UEL of pentane is approximately 7.5 per cent, while that of methane is 14.0 per cent. As for mixtures of gas and air, there are three specific regions: *lean*—the area from fresh air to lower explosive limit; *explosive*—the area from lower explosive limit to upper explosive limit; *rich*—the area from upper explosive limit to pure gas. When discussing instruments for testing atmospheres for combustible gases, we must have the capability to test across the full spectrum of gas/air mixtures.

Another term important in the area of combustible gas testing is *flash point*, defined as: that temperature at which sufficient vapors are given off on the surface of a liquid to form a flammable mixture with air. This is an important factor to know about the materials that are, or have been, stored in a given space. If the temperature is below the flash point of a given combustible, a test will show little if any concentration of that gas in the atmosphere. A change in conditions which increases the temperature would certainly show different results when that atmosphere was tested. The hazard of these compounds has been further classified by labeling as *flammable liquids* those whose flash point is below 100°F. and as *combustible liquids* those whose flash point is at or above 100°F.

In testing atmospheres for potential combustible gas hazards, two separate means of measurement are used. With the first, known as catalytic combustion, molecules of combustibles which may be present in the atmosphere are burned with the oxygen from the air. This burning takes place on a coil of platinum wire which is generally referred to as a hot wire filament. This filament is made one arm of an electrical circuit, called a Wheatstone bridge, and in its simplest form the filament is the only variable. The burning of the molecules of gas on the filament increases its temperature and electrical resistance which in turn, by proper circuit design, become a measure of the combustible present in the atmosphere tested. This method can be used to measure only air/gas mixtures where the combustible gas concentration is below the lower explosive limit. The meter readout is most often expressed as *per cent LEL.* That is, the indication is an expression of what per cent of the way is the atmosphere from fresh air to the lower limit of flammability.

Where it is expected that the sampled atmosphere will be in or above the explosive range, the second form of measurement is required. Instead of burning the combustible molecules of the filament as described previously for the hot wire principle, a different type of filament is used and the concentration is determined by the amount of heat that is taken away from the filament. This is generally known as *thermal conductivity* and is a measure of the ability of a specific gas to absorb heat. The thermal conductivity filament is placed in a Wheatstone bridge circuit and the degree of electrical unbalance caused by the cooling effect on the filament becomes the measure of the concentration of gas present.

There are instruments on the market which combine the hot wire and thermal conductivity principles in the same instrument. Indeed, this type of measuring device has been used on a number of petroleum tankers. The instrument has a dual-scale meter in which one scale reads from 0-100 per cent LEL and the second indicates from 0-100 per cent by volume gas. A selector switch changes from one measuring circuit to the other. The 0-100 per cent LEL circuit is primarily used for testing areas outside the storage tank for possible cargo leakage into those areas. It also can be used for testing tanks after the cargo has been removed and the areas cleaned and purged to make sure that the atmosphere is not hazardous prior to repair work being done on the ship.

The thermal conductivity portion of the instrument is useful to measure the tank atmospheres above the cargo to make sure that the atmosphere is well above the upper explosive limit. This type of test is performed to make sure that air, or more importantly the oxygen in the air, is not entering the tank and diluting this rich mixture into the flammable range. The thermal conductivity portion of the instrument is also used when unloading cargo to check the empty space above the material to again insure that the makeup air is not diluting the atmosphere into the combustible or flammable range.

Many of the tanks on cargo vessels are 75 feet or more in depth. Sampling from these spaces, particularly when the sample line must be lowered almost to the bottom of the tank, requires a great many squeezes of an aspirator bulb in order to bring the sample from the inlet end of the line to the instrument. One variation of this dual-scale instrument has been supplied with a built-in, battery-operated pump which draws the sample from the inlet to the instrument. The batteries which operate this version of the instrument are nickel-cadmium rechargeable type. They will supply a number of hours of operation, but do require a source of 115 volt A.C. power for recharging the batteries.

A third variation, or model, of these hot wire combustible gas instruments is a dual-filament, dual-range indicator. In this instance we place two hot wire filaments in the Wheatstone bridge measuring circuit. One of the filaments, called the detector, is in the sample stream just as we have discussed previously. The second filament, called the compensator, is located in an opposite arm of the measuring circuit and is placed in a sealed chamber. Such an arrangement gives us a greater degree of sensitivity and a higher degree of accuracy. One measuring range of this instrument covers from fresh air to the lower explosive limit (0-100 per cent LEL); the second circuit is 10 times as sensitive, measuring from 0-10 per cent of the lower explosive limit (0-10 per cent LEL). The higher range is used for standard flammability tests.

The second or more sensitive range is very useful for locating and checking areas where there is a very small leak. This low range is also useful for estimating the toxicity of some compounds which are also flammable. Manufacturers of this version of a combustible gas indicator supply response curves for both ranges. These response curves correlate the meter reading of the instrument to actual concentration of other combustible gases. Do not use the curves of one manufacturer to interpret meter readings from the instrument of another manufacturer. These curves are related to the response of a manufacturer's device to the calibration gas used in his plant.

Portable combustible gas alarms have been designed which can be used to test an area prior to entry, then taken into a tank or vault to monitor the air in which work is being done. Operating on rechargeable batteries, this type of indicator incorporates both audible and visible alarm signals to warn of a build-up of combustible gases. A full charge on the battery pack provides up to 10 hours of operation.

Since the measurement of both combustible gas and oxygen in enclosed areas is of vital concern prior to entry and while personnel are working in the spaces, there have been developed combination instruments which will give simultaneous readings of both. Most of these instruments incorporate rechargeable battery-operated circuits and have a built-in pump to draw the sampled atmosphere to the instrument. The battery capacity in these instruments will provide approximately eight hours sampling time. The nickel-cadium battery pack can be recharged overnight from a 115 volt A.C. source of power.

Calibration

All of the devices discussed previously require periodic calibration to make sure that they are responding properly. In the case of the oxygen instruments, uncontaminated fresh air provides a source of calibration gas in that it contains a constant 20.9 per cent by volume oxygen. The user should always make such a check prior to the testing of an enclosed space.

There are several ways in which the combustible gas units can be tested. Where a large number of instruments are involved, the user can obtain pressurized cylinders filled with a known concentration of the combustible gas in the air. Where only a small number of instruments are being used, small aerosol cans filled with a known concentration of combustible gas in air can be provided by the manufacturer. With these aerosol cans the manufacturers supply calibration curves which relate the concentration of the gas in the can to a meter reading. Only the calibration kit recommended by the manufacturer of a given instrument should be used to make this check.

Toxic Gas Detection

The Occupational Safety and Health Act is concerned about the condition of the atmospheres to which people are exposed during their normal working day. Under Paragraph 1910.93 of Subpart G are listed the maximum concentrations of air contaminants to which the average person may be exposed for an eight-hour period without suffering ill effects. These values are known as threshold limit values (abbreviated TLV) and are a time-weighted average value. They are established by a committee of the American Conference of Governmental Industrial Hygienists. They are reviewed annually, revised as necessary, and printed shortly after the annual American Industrial Hygiene Association meeting, usually held in May. The table lists the compounds alphabetically and the values are given in two separate columns. The first column is primarily concerned with those compounds which are either gases or vapors and is given in parts per million (ppm). The second column is primarily for compounds which are found in particulate form and which are collected on a weight basis with the values being given in terms of milligrams per cubic meter (mg/m^3).

When OSHA was implemented, the concern was about hazardous industries, with primary consideration being given to those with the highest accident rates. The five selected for initial target effort included roofing and sheet metal, meat and meat products, lumber and wood products, miscellaneous transportation equipment, and longshoring. It was labeled the target industries program (TIP). During the first six months of the program, however, the department of Labor found that over 60 per cent of the complaints were not industry-oriented but stressed the individual health hazard.

In January of 1972 Assistant Secretary Guenther announced the Target Health Hazard Program (THHP). Under this program concern was to be concentrated on certain hazardous compounds. The selection of these compounds was based on a priority rating index which included such things as prevalence of the compound, number of people exposed, degree of hazard, etc. The first selected were carbon monoxide, asbestos, cotton, dust, silica, lead, with others being added as the criteria developed.

The most widely used method of testing atmosphere for gaseous contaminants has employed chemically-filled detector tubes with an individual aspirator bulb tester. While this type of tube is generally referred to as a colorimetric, the greatest majority do not depend on a degree of color change as a measure of gas, but on a length of stain discoloration. These tubes are designed to be a guide in checking a given atmosphere for potential contaminants. They are *not,* and never have been, intended to be used as a precise measuring device. The generally accepted accuracy of these detector tubes is ±25 per cent. While this sounds like a very wide degree of variation, it is not as bad as one would believe when it is realized that the measurements are related to the threshold limit values and that these values are time-weighted averages related to an eight-hour exposure. They certainly can be used to determine if a given gas is present in the atmosphere, and will indicate trends as to whether the concentrations are increasing or decreasing.

Industry has developed detector tubes which will measure in excess of 140 different compounds. As a result, it is rather impractical to have a separate sampling device for each compound. Consequently, the industry has designed multipurpose or universal-type testing devices in which all of the various detector tubes of a given manufacturer can be used with his pump. Some of these pumps have a single orifice so that the flow rate is the same for all tubes and only the volume is varied. Other versions provide different orifices so that the optimum sampling rate and volume can be used for each type of reaction.

Many of the detector tubes used with these multipurpose pumps are specific for one compound and it is only necessary to break the tips, insert into the pump and draw the prescribed sample through the tube. The concentration of the gas can then be determined by comparing with a scale or calibration chart which may be printed on the tube, supplied as a separate sheet or mounted in the cover of the tube package. For many compounds there is no direct reaction which will give a stain length or color change. In these instances it is quite often possible to break down the compound of interest and measure one of its component chemicals. This is particularly true in the halogenated hydrocarbon compounds such as trichloroethylene and perchloroethylene. The halogen (such as chlorine, fluorine, or bromine) can be separated either by chemical reaction or by heat (pyrolysis). The amount of the halogen present can then be related to the original amount of the total compound.

For some other compounds (chromic acid and lead are examples), there is no economical impregnated chemical formulation which will detect these compounds. It is possible, however, to draw a sample through a piece of filter paper and then put a wet chemical on the spot which will change color in the presence of the compound of interest. The concentration can then be determined by comparing the chemical reaction with a calibration color chart.

Many times it is desirable to sample from a remote location, such as a cargo tank, prior to entry. For such applications the detector tube should, wherever possible, be placed on the remote or far end of the sampling line. In this manner, fresh sample is drawn through the tube as soon as the pump starts the sample moving through the system.

Manufacturers of these multipurpose or universal-type pumps supply data sheets on which are listed all of the compounds that can be measured with that manufacturer's device. In addition, information will usually be included on the range of the various tubes, general information on interferences, and ordering information. With each of the packages of tubes there will be included data concerning life of the tubes, an indication as

to the manufacturer's lot number, and instructions as to the use of that tube.

We have mentioned the Target Health Hazard Program. The number one priority compound on this list is carbon monoxide. The detector tube method of measuring carbon monoxide is listed as the second choice for measuring the amounts of this compound in air. The primary method of measurement is listed as a rechargeable battery-operated detector in which carbon monoxide-content is determined by a catalytic reaction. The built-in pump draws the sample through a dryer to remove atmospheric moisture and then into a cell where carbon monoxide is catalytically oxidized to carbon dioxide. This action liberates heat. The amount of heat is sensed by a thermistor which is made one leg of a Wheatstone bridge circuit, and it (the heat) unbalances the electrical circuit in proportion to the amount of carbon monoxide present in the sample.

Accessory alarm and/or recording devices can be used in conjunction with this indicator. It is designed primarily for operation in the area of the threshold limit value of 50 ppm, and for this application a full charge of the batteries will permit sampling for approximately eight hours. When sampling higher concentrations the system must be periodically purged in order to remove any trapped products of the catalytic action.

Dust Collection And Measurement

There are two different areas of interest to be concerned about when assessing an atmosphere for dust. The first is concerned with the total amount of dust that may be present, while the second pertains to that amount which can directly affect the health of the individuals in that atmosphere. The concern for total dust usually evolves when the constituents of that dust are unknown and a total sample must be collected for analysis. It is also important when assessing the atmosphere for other than health hazards. Where the concern is primarily one of health, the interst lies primarily in the dust which is retained in the human body as a result of breathing and is usually referred to as the respirable fraction of the dust.

For many years, the tried and true device for collecting dust has been the midget impinger. In this device a pump, which may be hand-operated or battery-driven, draws a sample through a measured amount of liquid. This sample, with the dust contained in it, bubbles through the liquid, and the dust particles are trapped within the liquid. At the end of the test the liquid must be either microscopically or chemically analyzed in order to determine the type and size of particles. This is a rather tedious operation and requires a relatively high degree of skill to make such analyses. An electrostatic precipitator is particularly adapted to atmospheres where the dust particles are metallic. Here again, it is necessary to microscopically examine or chemically analyze the sample in order to determine the dust which is present in the atmosphere.

The Occupational Safety and Health Act, the Federal Coal Mine Health and Safety Act and other similar pieces of legislation are primarily aimed at the health and safety of individuals. Consequently, the concern for dust is primarily in the area of respirable sizes. The human respiratory system will retain particles smaller than 10 microns and larger than one-third micron. The percentage retention in these areas is generally represented by the pulmonary deposition curve. The device developed to collect samples follows the AEC penetration curve. This sampler makes use of a cyclone separator in which a fixed sample is spun at a known rate. This action causes particles larger than 10 microns to be thrown off and dropped into a collection trap.

Particles between one-third and 10 microns are retained in the sample stream and collected on a filter disc. The disc, which has been weighed prior to the test, is then reweighed and the difference represents the dust present in the sample. Where the identity of the dust is known prior to the test, such as is true in coal mining, there is no need for chemical identification, and the total respirable dust collected can then be related to the volume of sample and compared with the established threshold limit value for that particular dust. A wide variety of dust can be sampled in this manner since the cyclone sampler, in general, follows the characteristics of the human respiratory system.

In instances where the hazard may be fibrous in nature, such as asbestos, the cyclone principle is not adaptable and it is necessary to take a sample of the total atmosphere. At the end of the collection period the sample media is made translucent through the use of a given solution, and a portion placed under a microscope so that the fibers can be counted and sized, with the hazard being related to the length and number of fibers per cubic centimeter of air.

The dust hazards of cotton, silica, lead and other materials will be assessed through the use of similar personal sampling systems.

A relatively new area of atmospheric sampling has been developed for the identification of compounds which may fall into the same general chemical family. The various types of hydrocarbons are probably one of the best examples in this area. The detector tubes discussed previously do not have the capability to distinguish between compounds in the same chemical family. Sampling systems have been developed which take advantage of the ability of charcoal to absorb the hydrocarbons. The system consists of a rechargeable battery-operated pump and a holder in which one of the charcoal tubes can be placed. A measured volume of sample is drawn through the tube over a measured period of time, after which the tube is sealed and shipped to a laboratory. At the laboratory, when combined with the proper chemical, the hydrocarbons can be desorbed and passed through a gas chromatograph to give an indication of the types and quantities of hydrocarbons present in the sample.

This discussion has presented very briefly a number of different types of instruments which are available to assess possible hazards in the atmospheres in our workplace. It has covered combustible gas detection and measurement, determination of oxygen content for both life-support and combustible measurements. Also discussed have been various types of indicators and detectors for toxic gases and dusts. Further details on efficiency and application should be obtained from the various manufacturers of these types of equipment.

SAFETY AND SILICOSIS

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Industry is being forced to evaluate occupational safety and safety hazards more than anytime in history. Because of the apparent lack of published information pertaining to the incidence of silicosis and in view of the alarming increase of industrial injury in the field of sandblasting, in particular silicosis, a discussion of the problem and presentation of this paper is indicated.

Silicosis is not new but for some reason has not been recognized or taken as a serious industrial hazard. Actually, silicosis has been recognized as an important industrial disease since the time of Hippocrates, who wrote in 460 B.C. about the "difficult breathing of metal miners".[1] Agricola wrote that mining is a "perilous occupation to pursue, because the miners were sometimes killed by pestilential air which they breathe. Sometimes their lungs rot away."[1]

A clear definition of the word silicosis, as taken from the World Book Encyclopedia is: "a disease of the lungs that is caused by breathing in dust that contains silica. Granite cutters, road builders, glassmakers, blasters, and workers in the abrasive and grinding industries are especially in danger of getting this disease."

If a person regularly inhales dust for a year or more, the dust may begin to lodge in the lung and irritate the lung tissues. The lung may become inflamed and tiny swellings may begin to develop all over the lung. In the midst of each swelling, or nodule, there is a speck of silica dust. This silica dust has a bad chemical effect upon the body. Silicosis usually causes short breath, coughing, and pains in the chest. As time goes on, the body becomes weaker and the person may not be able to work. He may finally get tuberculosis. Silicosis has caused the death of many workers every year.[2]

Pneumoconioses

Silicosis is a disease that is classified under the harmful or major pneumoconioses. To understand the pathogenesis of this disease we need to discuss pneumoconiosis, a Greek word meaning "dust retained in the lung." All our lives we inhale dust with each and every breath.[3] In general, city air contains over twice as much dust as country air, and the working atmosphere in many industries contains even more tremendous amounts of dust. Most dusts are innocuous, but a few h. ve varying capabilities to produce pulmonary disease. Dust is air in which are suspended various particles of material of about 150 microns in diameter or less. As a general rule, all particles of dust five microns or greater settle out of the air in the nasopharynx, upper respiratory passes, or lower respiratory passes, depending on their size (descending lower in the air-way with decrease in size). These particles, if they are insoluble, are cleared from the respiratory tract by the action of the cilia and mucus-secreting epithelial cells and coughing. They are then either expectorated or swallowed. Particles below five microns in size reach the alveoli, where they are engulfed by the phagocytic cells that either conduct them to the respiratory mucosa to be expectorated or carry them to the pulmonary lymphatics and tracheobronchial lymph nodes where they are deposited.

The storage of insoluble dust in the lung during life is in direct proportion to the concentration and duration of dust inhaled and in inverse proportion to the size of the particle. Excessive deposition of dust in the lungs results from prolonged inhalation of high concentration of particles that are less than ten microns in diameter. In the face of this excessive deposition, the self-cleaning mechanism becomes overloaded and the dust is deposited in the pulmonary lumphatics, perivascular and peribronchial sheaths, and in lymphoid foci. Thus does a pneumoconiosis develop.

The type which develops depends on the nature of the particle, and the presence or absence of pulmonary disability depends on the reaction of the lung tissue to the presence of these particles. Inert dust, such as carbon that we breathe, does not produce a tissue reaction (e.g., inflammation) and does not produce shadows on the chest roentgenogram because of its low density. It does stain the lung black and hence explains the postmortem findings of the black lung of the perennial city-dweller versus the pink lung of the country-dweller, infant, or young child.

There are other inert dusts that are inhaled as by-products of various industrial processes that produce symmetrical scattered nodules on the roentgenogram because of their density, but no disability because there is no inflammatory reaction to their presence. Silica dioxide in sand produces an intense fibrosis tissue reaction of a rather specific type that results in severe crippling pulmonary disease.[4]

Silica Dust

Silica is the name given to silicon dioxide, the most abundant material in the earth's crust and the most widely distributed. About 60 per cent of the earth's crust is silica. In the form of quartz, it makes up the largest part of sand. It is necessary material in the formation of most crystalline rocks. Silica occurs in both crystalline form and amorphous form, which means without a definite structure. It will not dissolve in water or in any material acid except hydroflouric acid. Crystalline silica forms the common mineral, quartz.[2]

Through studies conducted between 1914 and 1935 by the U. S. Public Health Service, U.S. Bureau of Mines, and other research workers,[5] it has been established that the critical factor for the development of silicosis is the inhalation, over an eight-hour day, of silica dust containing more than five million particles, ten microns or less in diameter, of free silica per cubic foot of air. It seems apparent that the time it takes to develop clinical silicosis depends on the concentration of the free silica particles, duration of exposure, individual susceptibility, and size of the particle, the smallest or even ultramicroscopic sizes producing a more immediate reaction.

Sandblasting is the process of projecting a stream of sand by means of compressed air or steam against a surface. It is used to produce on clean metal a surface suitable for subsequent treatment by coatings, and for removing paint from and otherwise cleaning large surfaces such as ships.

After variable, usually prolonged, inhalation of silica dust, the lung tissue reacts to the phagocytized silica particles by the development of concentric whorls of dense hyaline collagen fibers forming rather uniform fibrous nodules throughout the lung parenchyma and tracheobronchial nodes. When these nodules reach 2-4 mm in diameter they become radiologically visible and are usually associated with some pulmonary disability. With continued exposure, and frequently after cessation of exposure, the nodules may increase in size and finally coalesce to form large fibrotic conglomerations and massive fibrosis. These fibrous lesions produce severe pulmonary disability as a result of distortion and compression of the alveoli, with emphysema, atrophy, disappearance of the interalveolar septa, and loss of the pulmonary capillary bed. The disease may be complicated by the development of tuberculosis, aseptic necrosis of large nodules, secondary bacterial pneumonias, pheumothorax, respiratory insuffiency, and cor pulmonale, any or all of which contribute to or cause death.[4]

Case Report

The first bonafide case of silicosis in the state of Louisiana, as reported to the State Board of Health, Occupational Health and Safety Section, occured in 1960.

A 28 year old male was admitted to Charity Hospital of Louisiana at New Orleans March 22, 1960. He was apparently perfectly well until six months prior to admission, when he developed progressive exertional dyspnea, non-productive cough, night sweats, fever, and 15-pound weight loss. At the time of admission he stated that his dyspnea was of such a nature that he had to rest after walking one block or climbing one flight of stairs. He denied hemoptysis, chest pain, orthopnea, paroxysmal dyspnea, abdominal swelling, and ankle edema. Complete review of systems did not elicit any difficulties in any other organ system. Past history was non-contributory to the present illness. For the past five years he had been working as a sand blaster and metal worker in a local shipyard. He stated that he wore a mask when working. A detailed description of the nature of this work was not obtained at the time of admission. For the first three weeks this patient was febrile, spiking daily temperatures of 101, 102, and 103°F. On the tenth hospital day he was transferred to the Tuberculosis Service and placed on isonicotinic acid hydrazide and para-aminosalicylic acid. This was continued until his death. Later in the course of his illness, streptomycin was added.

On August 8, 1960, the patient had a thoractomy and biopsy of the lingula segment of the left lung. Histological sections showed fibrosis of the pleura, and scattered fibrous thickening of the aveolar septa. One section showed a granulomatous inflammation with giant cells and clefts. This lesion was thought to represent lipid granuloma. This patient's immediate post-operative course was uncomplicated. His entire hospital course was marked by a paucity of complaints. He ate well, and was up and walked around the ward with other patients, complaining of dyspnea only when walking fast. He did well until November 24, 1960, when he began to complain of pain in his stomach, nausea and vomiting, and progressive dyspnea. He expired on November 30, 1960.

A survey was conducted by an Industrial Hygiene Engineer as an on-the-spot investigation of the working environment in the ship-building plant where the patient had been employed. Dust samples were collected in and around the building. These samples are obtained in a Mine Safety Appliance Midget Impinger using distilled water and a suction rate of 0.1 cubic foot per minute through the impinger bottle. The impinger is a small box that is carried over your shoulder. In the box is a small bottle of distilled water through which the air is sucked by manual operation of the handle. The particles in the air drop out in this solution. The solution is then placed in a Dunn Dust Counting Cell that looks much like a hemocytometer, and under 100 magnification in the light microscope the total number of particles under ten microns in size are counted. Knowing the suction rate of the impinger, which is 0.1 cubic foot per minute, and the total time over which the sample was collected, one knows the total number of cubic feet of air that was sampled. The particle count is then expressed as a million particles of dust per cubic foot of air sampled (mppcf).

This patient was exposed both inside and immediately outside the blasting building to from 20-30 mppcf of silica dust less than ten microns in diameter, which is five to six times the maximum allowable concentration as established by the American Conference of Governmental Industrial Hygienists. His length of employment before death was only six years, and his lungs showed extensive fibrosis of a type seldom seen in any other condition. The question might be raised that the sandblaster always wore a hood and that the concentration of silica under it was 0.1 mpcf, much below the allowable limit. We need only remember that these men rotated their jobs, and that most of the time two of them worked in lethal environments of silica dust without respirators. Furthermore, silica dust counts were not made in the immediate environment of the blasting after the machine was turned off. It is quite possible that the count remained high for a considerable period of time after the machine was turned off, and that the operator removed his helmet while staying in this area. It should also be stressed that smaller, more lethal particles, one micron or less, may remain suspended for longer periods of time, and may not even produce visible smoke plumes because of their low density.[4]

Silicosis and Sandblasting

I have attempted to pinpoint this as a case of silicosis arising out of the sandblasting occupation. Since the reporting of this first case, there have been many cases reported. Hunter states that "silicosis is found amongst sandblasters in various parts of the world, and the same features—a short period of employment and rapid course of the disease—characterized all the cases. The average length of employment of sandblasters before death was at one time about ten years, as compared with forty years in the other silicosis-producing industries".[7]

He further mentions that in cases of silicosis where the exposure to dust had been intense and the course of the disease relatively rapid, the individual silicotic nodules become so crowded together that practically no lung tissue is seen. Drinker and Hatch, quoting from the literature, mentioned that cases of silicosis have been described developing after only eight months' exposure, and some fatal cases after only one and one-half years' exposure.[8, 4]

One large insurance underwriter company in New Orleans, Louisiana reported the following on September 22, 1972:

"The potential losses due to silicosis claims and judgments being awarded by our judicial system certainly merit the attention of both employers and insurance companies."

"Presently, in our office we are handling 12 silicosis claims. The largest amount demanded so far has been $750,000. Judgments and settlements have been awarded in the range of $175,000. These settlements and/or judgments, of course, are based on the man's expected work life capacity remaining, and obviously the older men will receive less than the younger men."

"I would estimate the average age of these men to be in their forties, with seven to ten years sandblasting exposure. These men generally are transitory workers and will work for a number of companies. When the lawsuit is filed, all of the companies back to the first date of this man's sandblasting career are named in the suits."

"The courts have not at this time rendered any definitive judgment as to how far back these men may claim against insurors of the companies they worked for. I personally have claims dating back to 1957 and 1958. We are awaiting a current decision as to whether or not the courts will allow such claimants to proceed back to inception or assess the damages against the last employer where the man was exposed to silica."

"The companies that we insure are fully aware of the potential danger and have taken measures to institute the very latest equipment, such as air vent hoods, filtered and cooled air, and the use of low free-silica abrasives. They have also instituted regular x-ray checkups prior to hiring a man, simply because they may at a later date be faced with a lawsuit, wherein the man was exposed for many years previously without using proper protective equipment."

"From the underwriters' point of view and the uncertainty of what the courts will or will not allow, underwriting such risks obviously is a calculated guess. If the trend in silicosis continues, rates will have to rise dramatically in view of the large judgments being awarded."

"We are hopeful that the courts will take into consideration the number of days, months or weeks these men worked and assess only that prorated portion against each employer and their insuror which would be equitable.[9]"

Low Free-Silica Abrasive

Industry has been searching for a safer blasting abrasive containing less silica. Several factors have to be considered, such as percentage of free crystalline silica; dust particle fall out; availability; hardness, size, and shape; and cost.

One abrasive that meets these considerations and requirements is the processed residue of burned coal. When coal has been burned, all the combustible portions are consumed. The residue, in the form of molten slag, is discharged into water. The water immediately quenches the molten slag and gives it an extreme hardness with a rating of seven on the MOH scale. The slag is air washed, dried, crushed, and sized. Once this process is completed and ready for use as a blasting abrasive, it contains less than one per cent free crystaline silica, which classifies it as a low free-silica blasting abrasive.[10]

Also to be considered is the dust level. It is reported that dust levels encountered with this type abrasive are greatly reduced, therefore the hazardous condition is further reduced by limiting the area of fall out.

We want to point out that the same safety procedures and equipment should be used with this abrasive. You will not solve all of the safety problems involved with blasting, but the hazards will be greatly reduced when using a low free silica abrasive.

Conclusion

Silicosis does exist and the potential losses due to the disease is alarming. It is obvious that a more detailed study must be made to protect workers who are subjected to dangerous dust levels and toxic silica dust particles. It is also obvious more medical research is needed to determine when a worker has silicosis to the degree that would classify him totally and permanently disabled to perform work of any type.

In the book, *Disease Of The Chest*, we find that silicosis may progress to an extensive degree before producing any symptom, and no sign other than evidence recorded on roentgenograms of the chest. Mild to moderate degrees of silicosis are quite compatible with good health, unimpaired working capacity, and long life, if tuberculosis does not supervene.[1]

A sincere effort by those charged with safety, an honest look by industry, fair and just decisions by the judicial system, and continued research by the medical field will determine the future course of this and other industrial disease.

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MARINE CASUALTIES: PRACTICAL ASPECTS OF MARINE BOARDS OF INVESTIGATION

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First, I would like to *inform* you of the more practical aspects—regulatory, technical, and investigative—of the Coast Guard's Commercial Vessel Safety Program. Second, I would like to impress upon you the extremely urgent, very real need for continued advances in all areas of maritime safety.

The Coast Guard's Commercial Vessel Safety Program is a viable and, of necessity, changing one. Though some may think that regulations and methods of administration of regulations pertaining to marine safety remain fairly static, we in the safety business can no more afford to remain static than can our counterparts in the business of commercial shipping. As recent technological advances in a variety of industries have increased the need for vast quantities of bulk chemicals and other hazardous materials, shippers are meeting that need through water transportation.

Accompanying this growth in the amount of shipping is a corresponding increase in the potential for disaster. Public awareness of the potential which exists for a marine casualty of catastrophic proportions and the recent occurrence of several serious casualties both at sea and on inland waters are factors stimulating changes in our programs. One incident, though not catastrophic in proportion, should illustrate the need for continued awareness and continued change.

The weekend of August 14, 1971, a cruise of 11 people in a pleasure boat ended fatally for seven of them as their cabin cruiser collided with a 1000-foot tow being pushed up the Ohio River. Though it was dark, the visibility was good; the cabin cruiser and its party were returning from a picnic along the river. The owner's 11-year-old son was operating the boat up until 5-10 minutes before the incident. Shortly after ten o'clock the master of the tow boat sighted the lights of the small boat at a distance he estimated at approximately one-third of a mile. Though the master felt that the headings of the two crafts would allow them to pass safely, when their distance had decreased to two hundred feet the cabin cruiser appeared to veer sharply, crossing the head of the tow. Impact occurred moments later as the boat struck one of the lead barges and was driven underneath the tow. It disintegrated under water.

The boat owner was an average American, a family man, who worked for a living and who had always had an interest in boats. Some 18 years earlier he owned a small 15-foot outboard boat for two summer seasons; about 10 years ago he owned a 17-foot outboard which he ran on weekends for a season. Last year he bought this 21-foot inboard cabin cruiser which, up until the incident that caused his death and that of his friends and part of his family, he had operated on the busy Ohio River for several hours on sunny weekends. He had never undergone any course of instruction nor had he enrolled in any of the many safety courses available to the public through the Coast Guard Auxiliary and the U.S. Power Squadrons.

A cursory reading of the newspaper items which followed the incident indicated several obvious lessons, the major one being that ownership or a certificate of title to a boat does not automatically by some mysterious process convey the know-how and experience to safely operate a boat, especially on busy waterways at night.

The other important lesson to be learned from this casualty concerns the regulations-making process. You see, the Marine Board of Investigation convened to study the disaster recommended that tows be required to carry a flashing amber warning light at their head. It is interesting to note that experiments with such a light had been conducted by the Coast Guard since 1969 and the response from industry and the public was favorable. Yet it took three years for regulations requiring such a light to get on the books. The lesson? We must continually make ourselves aware of safety needs and work hard to meet them.

At sea the need for change in safety programs is equally urgent as the world's 60,000 merchant ships sink at the rate of one per day. The amount of tonnage shipped has nearly doubled in three years; American ports now handle more than one million vessels a year. The booming demand for oil has accelerated the rate of shipping, and larger and faster tankers have both eased the energy shortage and increased the hazard of major ecological damage. By 1975 there will be more than 500 "supertankers" of more than 160,000 DW tons and we must now take steps to insure that these giants operate safely.

Two acts have been passed in Congress recently which authorized the Coast Guard to take some definitive action to promote marine safety. The Port and Waterways Act of 1972 provides the Coast Guard authority to establish, operate and maintain a vessel traffic system for ports and harbors and other waters subject to congested vessel traffic. The target date for the institution of mandatory systems varies from port to port; however, there are *several such systems now functioning* on a voluntary basis.

The Bridge-to-Bridge Radiotelephone Act requires many commercial vessels to be equipped with a communications capability which will allow masters and pilots to exchange navigational information in passing situations. Successful programs of this type in the Delaware Bay and River Systems have proved its advantages; with nationwide usage beginning the first of the year (1973) it is hoped that collisions on our navigable waters will be greatly reduced.

At the present time the Coast Guard is preparing regulations concerning the licensing of operators of uninspected towboats. Public hearings on the proposed regulations were held in September; the rules are now being rewritten in light of the comments received around the country. The Coast Guard is also, as required by law, conducting an extensive study to determine if there is a need for licensed engineers on uninspected towboats.

You can see, then, that from the regulatory standpoint our Commercial Vessel Safety Program is moving ahead along many fronts. Our technical and investigative programs are advancing also, and I would like, at this time, to explain to you how the Coast Guard's relatively new computerized marine information system works and how it is being utilized in Marine Boards of Investigation. This system was established in July 1971 as a staff component under the direction of Rear Admiral W. F. Rea, Chief of the Office of Merchant Marine Safety.

The function and objectives of this staff are:

a. To maintain and administer a program for the analysis of casualties involving commercial vessels.

b. To prepare and submit information of broad interest to the Marine industry.

c. Develop, maintain and administer a program for the implementation of an integrated management information system for the Commercial Vessel Safety Program.

d. Establish liaison with other government agencies and private associations for the purpose of information exchange.

The staff is still in the development stage and has not approached its potential, but there are useful functions which it can perform. They have produced several useful reports concerning suspected structural defects in vessels of certain classes. To date the bulk of the output has been for Coast Guard consumption. As we gain experience with the system, and as it develops, it is hoped that more of the output can be used to good advantage by the industry and other government agencies.

Here, then, is a tool developed from advances in computer technology. Let's see how this technological improvement is now being used in Coast Guard investigative activities.

Information derived from the system was

used by the Office of Merchant Marine Safety in the marine casualty involving the loss of the S/S *Texaco Oklahoma* on 27 March 1971. This vessel, an oceangoing tanker, while on a voyage from the Gulf Coast to Boston, Massachusetts, with a cargo of black oil, encountered extremely heavy weather off Cape Hatteras and subsequently broke in two. The forward section which contained the navigation bridge drifted away and sank. The stern section remained afloat for about 27 hours. During this time the crew attempted to use the portable emergency lifeboat radio transmitter to communicate their plight. They also attempted to attract attention by means of visual and whistle signals. The sinking stern section was abandoned by the remaining crew using the 15-person inflatable liferaft and two makeshift rafts comprised of empty oil drums. Ten hours after the stern section sank 11 crewmen were rescued by another ship, and 32 hours after abandoning the stern section another two men were rescued by another ship of the same company. Total loss of life was 31 of the 44 crew members.

In addition to the Marine Board of Investigation, which was immediately convened by the Commandant to investigate and report on the loss of the vessel and part of its crew, the Chief of the Office of Merchant Marine Safety directed the marine information and analysis staff to identify ships of similar design so that they could be examined as soon as possible by a Coast Guard inspector. The inspectors were to look for faults in the vessel's structure which might be common to all vessels of the class and which in any way could be related to the casualty. The information system was to search the records looking for anything which could be casualty-related.

Fourteen vessels were identified as sister vessels although several were built in different shipyards and four were of a modified design. The inspections and searches of files and records were unproductive with regard to finding a common fault in the ships which could be considered as a possible contributory factor to the casualty. However, the effort produced some beneficial effects in that other problem areas of a broader nature were identified, and lots of useful information was at hand. It was clear that this information should be passed along to field inspection offices. A team was organized headed by an experienced inspector, and the information obtained was condensed to a practical size and presented in seminar form to inspectors in those eight ports which handle inspections of large seagoing tankships. The field-response to the program was so enthusiastic that the project will be repeated next year.

The *Texaco Oklahoma* incident occurred in March of 1971, and Marine Board findings, the Commandant of the Coast Guard's action on the findings and recommendations, and the National Transportation Safety Board's action have been completed. The report of the casualty has been published and made available to the public.

Another casualty to a tankship which resulted in the loss of the vessel with loss of all persons on board provides us with yet another example of the growing use of the present technology to aid investigations. I am speaking now of the S/S *V. A. Fogg*, a 572-foot, oceangoing, jumbo-ized T-2 tanker which exploded and sank in 100 feet of water about 36 miles south of Galveston, Texas on 1 February 1972. All of the 39 persons known to have been on board at the time of the incident are dead or are missing and presumed dead.

Since the report of the Marine Board of Investigation is still under review (by the Commandant or the National Transportation Safety Board) it would be inappropriate for me to comment upon the conclusions and recommendations contained in the report; however, some of the factual aspects will be commented on, mainly to give you an idea of some of the problems faced by a Board of Investigation that is charged with the task of finding out what happened, when, how and why it happened, and what persons, if any, caused or contributed to the casualty by an act or omission.

The *V. A. Fogg* had left Freeport, Texas on the day before and was to proceed to sea, to wash and gas-free her cargo tanks in preparation for her next cargo. This was to be methanol, kerosene, and heating oil. Her previous cargo was benzene and, except for

19,000 barrels of xylene in her No. 8 and 9 center tanks, she was empty. The vessel was expected to return to the Galveston bar 12 hours or so after her departure from Freeport, but in any event the master was expected to notify the operators of his expected time of arrival by radio-telephone. The tankwashing and gasfreeing was to be done by the ship's crew assisted by five shore-based laborers who were to wipe the tanks dry.

At about 1600 on the day the vessel left Freeport a NASA pilot on a test flight saw a high mushroom-shaped black cloud of smoke in the Gulf of Mexico about 50 miles south of the Galveston VORTAC. No one could explain the cloud, but a Coast Guard air search plane was sent to investigate. The pilot was unable to determine the source of smoke that evening, and a search of the area the following morning was negative.

The *Fogg* was reported overdue at 1430 on 2 February and searches continued for the next 10 days until the wreckage of a vessel was found in 100 feet of water with parts of its radar antenna above water, about 36 miles south of Galveston. The vessel was identified as the *Fogg* by divers.

First reports on the condition of the vessel by Coast Guard divers indicated to the board of investigation members that this was to be more than a case of "several sailors trying to find out what happened to other sailors." Additional hard hat divers were authorized by the commandant. Video and photographic equipment was used by divers employed by the Coast Guard and by the team hired by the vessel's owners. In all, some 13 hours of video tape and photographic film were produced by these groups. Numerous "still" photographs were also produced.

In addition to viewing the film several times, the board held three formal public sessions during which testimony of former crewmen was taken, information from many sources was obtained, and over 112 exhibits were gathered. The work of the board was further complicated by lack of survivors or any witness who saw or heard the actual explosion.

It is too early to assess what lessons are to be learned from this casualty or what effect it will have on our safety program through changes in regulations or laws. It seems reasonable to assume that we will learn a great deal from this casualty due, in part, to the underwater films taken.

The point I want to emphasize is that our Vessel Safety Programs are growing and advancing in the investigative aspect as we utilize technology in the form of the marine information system and films.

You may have noticed that I use the words "change," "advance" and "growth," a great deal; and I have done it deliberately because I want to stress that it is essential that we *continue* to change, grow, and advance if we are to meet the new maritime safety needs. There have been arguments that the Coast Guard's regulations react to, rather than anticipate, problems in the now complex multifaceted maritime industry, and occasionally these arguments are persuasive. Bridge-to-Bridge Radiotelephone Communications had been cited as an important navigational safety tool since the *Andrea Doria-Stockholm* collision in 1956. Now, 16 years later, we are getting the regulations on the books. There were lives lost during those 16 years which no doubt might have been saved had the vessels involved been able to transmit their intentions over a bridge-to-bridge system. I have already talked about seven people killed in the collision of the barge and cabin cruiser. While their deaths may not have directly resulted in the new regulations for towboat lights, the fatalities must have been a stimulating factor.

Needless to say, I am not here to point an accusatory finger at anybody, nor do I feel that any one party is particularly worthy of blame. The public regulation-making process is necessarily long and sometimes arduous. That is the price we pay for giving everyone a chance to be heard.

I do urge, however, that we become more aware of the great need for change and growth in our safety programs. For every casualty in which a life is lost or the ecology is damaged there are dozens of "near misses." The casualties make the headlines and prompt the action; the "near misses" go unreported and unnoticed. We must no longer wait for accidents to happen to show us where the need for action is. Let us begin now to *anticipate* rather than *react* to maritime tragedy.

THE REGULATORY ADMINISTRATOR, A PARTNER IN SAFETY

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Various recent Licensing Bills, intended to guarantee the proficiency of towing vessel operators, were introduced in the 88th, 89th, 90th and 91st Congresses. These pieces of legislation understandably brought forth many witnesses attesting both to their desirability or alleged deleterious influence on the towing industry.

For example, a House Subcommittee heard testimony from the Coast Guard that during the fiscal years 1962 thru 1964 there were 1,490 towing vessel casualties reported. The overwhelming majority of these casualties involved groundings and/or collisions mainly attributed to personnel error, or more specifically a fault of the person in charge. The next four years, from 1965 thru 1968, saw little change in the type or cause of casualties involving towing vessels. The only significant difference to be considered was an annual increase in the reported incidents.

Inherent in any consideration of opposition to legislation, which is designed to increase the authority of the federal government over a sector of private enterprise, is the ingrained repugnance of any further "Big Brotherism." Aside from this natural opposition was the relevant consideration, to be weighed by Congress, of the ratio of the reported casualties to the total number of vessels in operation. For example, the 1965 thru 1968 four-year total of 2,593 reported casualties originated from an average yearly operation of 5,500 vessels. Without recourse to a precise analysis of a year-by-year comparison, which could adjust for the same vessel's involvement in multiple incidents, it can be argued that one reportable marine casualty occurred for approximately each nine towing vessels in operation during the period.

A fair presentation of these statistics must consider that this one in nine mean ratio is greatly influenced by a disproportionate number of casualties occurring in a relatively small geographic area in the large seaports. Furthermore, it is an undisputed fact that in many cases the same person has been involved in multiple incidents. Unfortunately it is these congested water lanes that a few towboat operators have been permitted to wantonly display their lack of proficiency or competency. It is indeed sad that they enjoy so much notoriety although they represent such a small percentage compared to the towing vessel operators plying these same waters safely. This minority is a detriment to the general public and to the overwhelming number of unlicensed masters presently operating towing vessels. Notwithstanding this disproportionate influence, the unalterable fact remains that in the four-year period considered the Coast Guard has knowledge of 109 fatalities and property damage in excess of 50 million dollars. Support for the appropriateness of these ominous statistics was provided by the National Safety Transportation Board before both House and Senate Committees with specific examples of tragic marine casualties examined by the Board in depth.

The Board singled out its special study of "Towing Vessel Safety And Accident Preventatives" for particular consideration. They also cited two major collisions involving large oceangoing vessels and towing vessels with barges in tow, which occurred less than 13 months apart in the same geographic area. These tow collisions, along with their attendant conflagrations, accounted for the loss of 21 and 25 lives, respectively. In both cases negligence of the unlicensed operators of the towing vessels involved were considered to be the principal cause of the casualties.

The National Transportation Safety Board reiterated its strong support of the Towing Vessel Licensing Bill to the Senate Committee on Commerce on 1 May 1972. At that time the Board cited numerous incidents of towing vessel founderings and recent casualties that occurred on the Ohio River, in addition to again describing the two casualties examined above. The Board concluded, in effect, that the reports and the described casualties substantiated the need for legislation which would provide for placing the operation of towing vessels in the hands of qualified personnel. This conclusion convincingly buttressed the position of the Department of Transportation and Coast Guard that operator licensing would offer a substantial contribution to marine safety.

A New Tool for the "Administrator"—On 7 July 1972 the President signed into law Public Law 92-339, more commonly known as the "Towing Vessel Licensing Act." Section 4427 of the Revised Statutes of the United States (46 USC 405) as amended, in part, to provide that "An uninspected towing vessel in order to assure safe navigation shall, while underway, be under the actual direction and control of a person licensed by the Secretary to operate in the particular geographic area and by type of vessel under regulations prescribed by him. A person so licensed may not work a vessel while underway or perform other duties in excess of a total of 12 hours in any consecutive 24 hour period except in case of emergency." With this legislation the United States Coast Guard, in its role as the concerned "administrator," can now ensure that all operators of towing vessels will exercise a responsible concern for the safety of life and property if they wish to remain licensed. This tool will provide some measure of solace to the competent and proficient operators that their reputations and safety will not suffer at the hands of a few disreputable operators.

Jurisdictional History—How does all this affect the role of the Coast Guard as the administrator? Does it, in fact, aid that agency in carrying out the mission of safety of life and property at sea? Yes, it does provide the wherewithal to minimize negligent operation. That part of the Amendment which requires that an uninspected towing vessel shall be under the control of a person licensed by the Secretary now makes operators amenable to action under Section 4450 of the Revised Statutes (46 USC 239). Specifically, Title 46, United States Code, Section 239, provides the Coast Guard with authority to take action against a license issued by that Agency for any act cited therein. In layman's language this means that action can be taken to suspend or revoke a license issued by the Coast Guard for any acts of incompetence, negligence, or misconduct.

Supplementing the broad and vague powers of the statutes are the detailed regulations contained in Part 137 of Title 46, Code of Federal Regulations. For example, these regulations offer concise and meaningful definitions for the prohibited acts specified in the Statutes.

Misconduct is defined, in part, as a human behavior which violates some formal, duly established rule, such as the common law and the general maritime law. However, in the absence of these established rules, "misconduct" is also defined as human behavior which a reasonable person would consider to constitute a failure to conform to the state of conduct which is required in the light of all the existing facts and circumstances.

Negligence is defined as the commission of an act which a reasonably prudent person of the same station under the same circumstances would not commit. Likewise the failure to perform an act which a reasonably prudent person of the same station, under the same circumstances, would not fail to perform is also negligence.

Incompetence is defined, as one would expect, as the inability on the part of a person to perform required duties either due to professional deficiencies, physical disability, mental incompetence, or any combination of these.

We now see that the "administrator" in question, the Coast Guard, possesses a measure of control over the personal actions of incompetent operators. For after all, it is the competent majority who is threatened the most by the few bad apples. Understandably this control and authority can only be exercised in actions resulting from incidents whereby the licensed towing vessel operator is in fact serving under the authority of his license. The action considered herein cannot be taken against the person himself but can be directed only to Coast Guard issued licenses. With this limitation, any disciplinary sanction ordered against the license becomes remedial in nature vice punitive, arguments to the contrary notwithstanding.

The legality and effectiveness of the remedial objectives of these sanctions have been repeatedly attacked in the courts. The Coast Guard has consistently and successfully held that the language of Revised Statute 4450 (46 USC 239) clearly supports this position by providing for the referral of criminal evidence to the Department of Justice. Therefore, this distinct separation manifestly recognizes the penal versus remedial conflict.

Application of Jurisdiction—The mechanics for accomplishing this remedial process were developed within the guidelines set forth in the Administrative Procedures Act, Title 5, United States Code, Sections 1001 to 1011. The Act provides for an administrative law judge, formerly known as examiner, who is a civil service appointee and as such is a direct representative of the Commandant of the United States Coast Guard. He serves as an impartial trier of facts and functions in the same manner as a magistrate or minor judge. Armed with his power of sanctions, directed solely at the Coast Guard issued license or document, he presides within rules much the same as those found in federal courts. Admittedly they are a relaxed version where the administrative law judge can weigh the charges of the "administrator" and provide an objective decision consistent with the Coast Guard's responsibility of safeguarding life and property at sea. The administrative law judge and the established appeal procedures provide an effective check and balance to any arbitrary action by the "administrator." Combine these long established procedures with the authority of the Towing Vessel Licensing Bill and the "administrator" now has the clearly defined means of taking action against the license of the undeserving. It is self-evident that this so-called undeserving will represent a very small minority of the towing industry.

In the five-year period immediately preceding the passage of the Licensing Bill in question, one Coast Guard Marine Inspection Office initiated investigations which clearly demonstrated the need for the "administrator" to initiate charges against 67 persons who at that time were outside its authority. Included in this total were, naturally, multiple offenders. Although it is impossible to infer that an impartial administrative law judge would have instituted sanctions against the licenses of all 67 individuals, it is rational to assume that remedial action would have been taken in sufficient proportions to aid in the mission of the concerned "administrator."

SHIP STRUCTURE
(Introduction)

By RADM W. F. REA, III,
Chief, Office of Merchant Marine Safety, U.S. Coast Guard, Washington, D.C.

The Ship Structure Committee is an interagency advisory committee composed of the Coast Guard, the Naval Ships Systems Command, the Maritime Administration, the Military Sealift Command, and the American Bureau of Shipping, which conducts a research program directed toward advancing the technology of ship design and construction for the ultimate purpose of increasing the safe operation of American ships.

As Chief of the Office of Merchant Marine Safety, U. S. Coast Guard, it is my privilege to serve as chairman of the Ship Structure Committee and I consider it particularly appropriate to be able to present the attached Ship Structure Committee Report to the Marine Section of the National Safety Congress. The National Safety Council is concerned with the facts of accident occurrence and with establishing causes and practical means of preventing accidents. This report clearly demonstrates that the Coast Guard and the Ship Structure Committee share this concern.

Research under the Ship Structure Committee involves all phases of the design, analysis, materials, and fabrication of ship hull structures. Reports of recent Ship Structure Committee projects as well as previous Ship Structure Committee Reports may be obtained from the National Technical Information Service, Springfield, Virginia.

The Ship Structure Committee conducts a research program directed toward furthering the interests of its members and of the maritime community in general in increasing the safety and efficiency of ships' structures. By closely coordinating the research activities of its members and by basing the program on the best technical advice available, the Ship Structure Committee strives for effective and useful research results. I would welcome your comments on any phase of the Ship Structure Committee program.

A LIMITED SURVEY OF SHIP STRUCTURAL DAMAGE*

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*Under Department of the Navy Naval Ship Engineering Center Contract No. N00024-70-C-5214

Introduction

The goal of Project SR-189, "Ship Structure Reliability Analysis," is to conduct a survey of ship structural failures as related to types, frequency, and location in order to develop meaningful trends and to assess the possibility of eliminating or minimizing these failures and so improve structural reliability. This report, covering one year's effort, presents the data collected during the survey, together with conclusions and recommendations.

Briefly, the plan was to:

1. Survey data sources to determine the amount and kinds of data available.
2. Develop a data collection format compatible with the information available at each source.
3. Collect available data from each source.
4. Analyze the data collected.
5. Report the results.

The ships represented in the data base are U. S. built subsidized dry cargo ships and a few MSC tankers. Modern ship designs differ from their World War II predecessors in many respects, and modern ship steels gained broad acceptance in the mid-1950's; accordingly, only seagoing ships built after 1955 are included in this study.

Sources of Casualty Data

Ship structural casualty data were obtained from the files of the U. S. Coast Guard (USCG), the Maritime Administration (MARAD), and the Military Sealift Command (MSC). This information comprises the data base from which analyses were made of structural damage. American Bureau of Shipping (ABS), U. S. Salvage Association, and Salvage Association of London reports were often a part of the files of the aforementioned agencies and provided a major portion of the detailed information.

A few comments are in order regarding the kinds of information derived from each source:

A marine casualty must be reported to the Coast Guard whenever it results in damage to property in excess of $1,500, material damage affecting the seaworthiness or efficiency of the vessel, stranding or grounding, loss of life, or injury with incapacitation in excess of 72 hours (46 CFR 97.01-1). In addition, a Report of Structural Damage, Collision Damage, or Fire Damage (Form CG-2752) is submitted in cases of: (1) Class I structural failure—a failure which has weakened the main hull girder so that the vessel is lost or is in a dangerous condition; (2) Class II structural failure—a failure which does not endanger the vessel but involves the main hull structure at a location which experience has indicated is a potential source of dangerous failure; (3) Collision or grounding with damage in excess of $1,500; (4) Fire or explosion with damage in excess of $1,500. Casualties which have been reported to the Coast Guard, but for which a Form 2752 has not been completed, were not included in this study.

MARAD files contain data on U. S. ships participating in the subsidy program. Records for subsidized voyages during the period 1966 through most of 1969 were available. Most of the earlier records have been destroyed, but some data were obtained on specific structural casualties occurring during the period 1961 through 1965 from other sources at MARAD. It is worthy of mention that some ships go in and out of subsidy, thus information on structural casualties occurring during out-of-subsidy operation may not be included in the files. The majority of the relevant data contained in MARAD files are in the form of investigative reports from one or more of the following organizations: U. S. Salvage Association, ABS, and Salvage Association of London.

Files of the MSC contain information on ships of their fleet from date of construction. The most useful sources of data found in these files were ABS survey reports.

Casualty Data Collection

At the outset of the project a tentative listing of information requirements was derived. After visiting the various potential data sources and perusing representative case files, a revised format was developed for use in the actual data collection effort.

In addition to a case number, the desired information is divided into ten basic categories: ship data, information source, circumstances, cause, disposition, extent, type of failure, type of structure, location, remarks. Each basic category is then divided into subcategories with coded designations for each item and sub-item so as to permit the use of automatic data processing equipment. The entire data format as shown can be reduced to a single card for basic ship data and another card for the details of the specific structural failure. Thus for a given ship for which there are ten individual structural casualty cases, there would be eleven data cards.

Cost of repair is not included on the data form. For most of the cases investigated in this study, cost information was not available.

Scope of Structural Casualty Data

The survey of structural casualty records resulted in a data base of 824 cases from 146 ships over the 15 years considered. It is difficult to determine the total number of U. S. flag ships operated during that period. However, for comparison purposes, in mid-1969 there were 244 subsidized merchant ships of over 1,000 gross tons in an operating status in the U. S. Flag Fleet. In addition, MSC was operating 23 ships built after 1955.

The following discussion of the frequency-of-occurrence of a particular type of damage does not include cost. Frequency alone is not necessarily a measure of the severity of damage.

Various types of collision damage comprise the largest portion of the total cases—67 per cent. Heavy weather causes, resulting in forefoot, forecastle and weather deck or other miscellaneous damage, are the next largest general category—11 per cent of the total. Cases for which the cause of structural damage was undetermined amounted to a little over 10 per cent, and the remaining 12 per cent fell into eight other categories: grounding, struck object in water, ice, wastage, fire, launching or dry docking, loading or discharging cargo, and miscellaneous.

Collisions with piers, quays and other fixed mooring structures comprise 203 cases, or 25 per cent of the total. Townsend and Hamrin found a similar trend for 100 ships surveyed over a period of a year (*Marine Engineering Log*, "Ship Damage," p.51, Vol. LXVIII, No. 11, October 1963). Collisions with locks comprised a little less than 10 per cent of the total data base. Ships of some designs did not have any reported damage from this cause, suggesting that trade route considerations are a major factor.

Structural damage sustained through collisions with other vessels alongside also constitutes one of the major categories of casualties. Tugs assisting ships during mooring maneuvers, lighters, crane barges, and landing craft of various types were frequently parties in such collisions. A number of the reported casualties happened in Southeast Asia, where cargo ships were unloading directly into landing craft and lighters.

Structural casualties of undetermined cause comprise 10.4 per cent of the data. These casualties were all minor and generally were revealed in the course of routine surveys.

Thirty-seven groundings (4.5 per cent of the data) were reported. Of these, 31 involved deformation and buckling of various underwater portions of the ships, with only six cases of holing or fracturing of bottom plating. In 23 cases, of which four involved bow bulbs, only shell plating damage occurred. Five more cases involved internal structural members as well as shell plating, and nine additional cases included damage to bilge keels, plating, and internals. About one-third of the damaged areas were located in the forebody, about one-half around the midbody, and the remainder aft.

Three other categories of structural casualties warrant brief mention in this summary. Damage caused by striking objects in the water for the most part was confined to ships' bottoms (nine out of 14 cases), indicating that the vessels either struck an unchartered object or actually grounded. Most of these cases involved deformation and buckling of the shell, or the shell and internal structural members.

Structural damage caused by ice was revealed during the survey. The total number of cases was small (seven), but since all occurred on tankers this may be of special interest relative to Arctic ship design. It is worth mentioning here that, with one exception, damage attributed to ice was fairly extensive, involving numerous plates on the sides or bow and, in one case, buckling of the main deck, internal bulkheads, and fracturing of framing and shell.

With four exceptions, the structural damage which occurred during loading and discharging operations is of only incidental interest. Four cases were found where structural damage resulted from filling tanks under pressure; three occurred on tankers and the fourth on a cargo ship. In one instance the problem was traced to a vent ball-check valve which was plugged with rust; whether the remainder resulted from inadequate vent size or carelessness is not known.

The statistical center of damage is forward of amidships, and generally the damage occurs in the outboard portions of the hull. It also appears that certain types of structure are more susceptible to damage. Here 58 per cent of the occurrences were in the shell and stiffeners and 19 per cent in the framing. The preponderance of casualties (79 per cent) resulted in deformation.

Structural Casualty Problem Areas

Analysis of the structural casualty data revealed three areas which warrant detailed discussion: collision damage, slamming damage, and forecastle and weather deck damage. While these areas are not intended to be all-inclusive, they are presented to indicate the value of the program in identifying and localizing problems. Some need added research while others need to be brought to the attention of designers for refinement of design details.

Some 13 specific ship design classes (designated "A" through "N") have been selected for a more detailed investigation of these three problem areas. Ships of each of these classes have sustained damage attributed to one or more of the problem areas.

Collision Damage. Of the 13 cargo ship designs selected for detailed analysis, ten were selected for collision damage analysis. Ships of these ten designs were involved in almost 80 per cent of the casualties related to collisions with piers, vessels alongside, and locks.

Three specific factors were investigated: longitudinal extent and location of damage; vertical extent and location of damage; and type of damage. The following paragraphs cover analyses of each of these factors.

Using the survey data and basic information for the respective ship designs, plots were derived of the longitudinal extent and location of collision damage. Collisions with piers, vessels alongside, and locks were treated separately in order to ascertain whether characteristic differences existed between these types of damage. Comparisons of individual ship results by cause did not show any marked differences, so they were combined.

The longitudinal and vertical damage distributions from collision' with piers and locks are markedly similar, whereas collisions with vessels alongside result in distributions with different characteristics. Pier and quay collisions tend to cause somewhat greater damage at the waterline than do collisions with locks. Lock collisions tend to produce more damage just below the sheer strake, which is probably related to accidents occurring when ships are on the low-water side of the lock.

The Ship Structure Reliability Data Sheet lists seven types of failures: fracture, buckling, deformation, cracks, bending, failure of weld, and wastage. As a practical matter, a given case may involve more than one of these categories in conjunction with one or more structural members. Analysis of the failure type data for the ten cargo ship designs involved summarizing the occurrences of each type of failure, taking into account the practical aspects of the problem mentioned above.

The vast majority of the cases, regardless of cause, consisted of deformation of just the shell plating or the shell plating and internal structural members. Indeed, out of 363 cases there were only 26 cases involving deformation and buckling of internal structural members and only eight involving fractured structures. Of the eight fracture cases, only three involved shell plating, less than one per cent of the total.

The relative occurrence of collision damage with piers in U. S. and foreign ports was investigated. Thirty nine per cent of the collisions with piers occurred in U. S. ports and 61 per cent in foreign ports. While a much higher percentage of these collisions with piers occurred in foreign ports, one must be careful not to make improper assumptions about ship handling or pier construction. For instance, it was not possible to determine the relative number of ports of call between the U. S. and foreign countries. Cost information for collision damage was not obtained during the survey.

Heavy Weather Slamming Damage. The total number of occurrences of bottom slamming damage amounted to 48. All occurred on dry cargo ship designs. Since the number of casualties found during the survey was limited by the availability of records from each source of data, the number of casualties shown does not necessarily represent all of the occurrences of slamming damage for the ship designs listed.

The longitudinal extent and location of slamming damage is shown as a function of ship length. In general, this type of structural damage is centered at approximately 20 per cent of the length from the bow and extends as far forward as five per cent of the length from the bow and as far aft as 35 per cent.

The most prevalent type of failure was deformation of hull plating, in particular the flat keel and A-strakes, port and starboard. A smaller number of cases involved additional damage to other strakes, floors, and internal structural members. Further details will be discussed in the treatment of individual designs.

All 11 ships of Design A encountered slamming damage at one time or another; a total of 14 cases were reported. They encountered the reported damage while operating in the North Atlantic between 1963 and 1966. Eight of the 11 ships suffered damage between the months of November and March, one in August, and for the remaining two casualties no dates were given. Four of the casualties involved the flat keel and A-strakes, port and starboard, one additional case involved the keel plate, A-strakes and floors; the remaining nine cases involved damage to combinations of the flat keel, floors, and shell extending out to the C-strake.

The body plan of Design A indicates generally U-shaped forebody sections typical of many U. S. cargo ship designs. Although details were not available, it was ascertained that all ships in this class sustained damage of the type described above during their first year of operation. After recognizing this slamming damage problem, additional longitudinals were added on all ships of this class. No further casualties were experienced.

Six of the eight ships of Design B have incurred 11 cases of slamming damage. Six cases of damage resulted from operations in the North Atlantic during the winter months. Three of the casualties occurred in the South Atlantic during July and August (winter), one occurred in the Indian Ocean in March, and the date of one casualty was not given. Eight cases involved the flat keel and A-strakes, port and starboard, two involved the flat keel alone, and in one case just the A-strake. In 10 cases the hull plating was deformed, and one case involved minor cracking of the keel plate.

Five of the eight ships of Design C suffered seven slamming damage casualties. Six of the casualties occurred in the Atlantic, and one in the Pacific. Five occurred during winter months, and two in the summer and fall months. The location and extent of the slamming damage on ships of this design is interesting in that it generally occurred a little farther forward than was the case with all but one of the remaining designs. The center of damage is approximately 16 per cent of the length from the bow and is generally confined to the area between 10 per cent and 20 per cent of the length.

All but one of the casualties to ships of Design C involved the flat keel and A-strakes, port and starboard; the remaining case involved damage to the flat keel. All cases resulted in deformation of the plating. Some structural modifications have been made to ships in this class but details of these modifications and their relative success in reducing slamming damage were not found.

Design D comprises four cargo ships, three of which incurred slamming damage. Three of the casualties occurred in the North Atlantic, two in the winter and one in April; the fourth casualty occurred in the Pacific during the winter. The location and extent of this damage is also interesting since damage was confined generally to the forward 10-20 per cent of the length and consisted primarily of deformation of the flat keel and A-strakes, port and starboard. No information was obtained regarding structural modification to these ships.

Designs E, F, G, and H are similar and incurred slamming damage on from 30-50 per cent of the ships in each class. The slamming damage to Designs E and F occurred during the winter in the Atlantic, and to Designs G and H during the winter in the Pacific and Mediterranean, respectively. Six of the seven casualties involved typical deformation of the flat keel and A-strakes, port and starboard, as well as internals; the seventh, on Design G, resulted in a fracture of the E-strake just above the inner bottom.

Designs I, J, and K incurred heavy weather slamming damage on less than one-third of the ships per class. Five of the six casualties occurred during winter months in either the Pacific or Atlantic. Three of the casualties for Design I involved deformation of plates in one or more strakes, both , port and starboard. The two casualties to Designs J and K involved deformation of the flat keel and A-strake.

Designs A through D are classes for which reasonable proof has been obtained of susceptibility to damage from slamming. For each of these designs, all or most of the ships have suffered slamming damage at one time or another. Most probably, if more complete records were available additional cases would be added to those already revealed in this survey.

The remaining eight designs, E through K, apparently fall into two additional categories relative to structural resistance to slamming damage. These categories are: (1) those designs having sustained slamming damage but not to the extent that they can reasonably be considered as being structurally deficient (Designs E, F, G, and H); (2) those designs having sustained slamming damage under extenuating circumstances where structural sufficiency is difficult to evaluate (Designs I, J, and K). Further monitoring of structural casualty data should provide a greater insight into the relationship between structural sufficiency and susceptibility to damage from slamming.

Precise details as to the circumstances under which the casualties occurred are lacking. Other than the fact that the majority of the cases occurred during winter months on various trade routes, little additional data could be found. Ship speeds, loading conditions, and other environmental details at the time of the casualties were, in most instances, either unreported or stated in very qualitative terms, such as "mountainous seas."

None of the slamming casualties resulted in catastrophic or "unable to proceed" damage. Indeed, most of the cases were minor to the extent that some of the ships were not taken out of service specifically to repair that damage. Some cost data were obtained in the instance of slamming damage to ships. The average cost of repairs was found to be $27,700, with a spread from $4,800 to $68,700.

Heavy Weather Damage, Forecastle and Weather Deck. The next most prevalent form of heavy weather casualty uncovered during the survey was damage to structural components on the weather deck. Out of 23 cases, 17 occurred in the area of the forecastle, and the remainder at locations farther aft. Most involved damage to bulwarks, and some to decks and structural internal members as well.

All of the designs are cargo ships, with the exception of Design M, which is a tanker.

Four of the six ships of Design J had at least seven casualties, six occurring on the forecastle and one involving bulwarks farther aft. The types of structural failures symptomatic of this design are: (1) forecastle deck torn or deformed; (2) bulwark and bulwark brackets and stiffeners fractured, buckled, and deformed; (3) internal beams, longitudinals, and frames deformed or fractured. Most of this damage occurred within the forward 20 to 30 feet of the forecastle.

Three of the five ships of Design K sustained a total of five casualties in the forecastle area. For the most part, the damage occurred in an area between six feet and 35 feet aft of the forecastle head. Bulwark brackets and knees, as well as deck plating, deck beams, and girders, were deformed or fractured.

Design M is a tanker which has had five structural casualties in the area of the forecastle. Three of the cases involved only fracturing of bulwark brackets. One case, however, included deformation and fracture of the bulwarks, deck plating, and internal structural members. In this instance, the bulwarks were set out and the deck plating was set up, indicating that for this casualty the damage resulted from moving water trapped on the forecastle. The remaining case involved fractured and deformed hull plates in the vicinity of the hawse pipe, both port and starboard.

Design A also sustained weather deck damage which is of interest. Three of the 11 ships in this class had a total of four casualties. One casualty involved damage to the forecastle and appears to be an isolated instance. The other three casualties, however, involved damage to bulwarks much farther aft, by hatch numbers three, five, and six. In one instance, 60 feet of bulwark was torn away and missing; in another, 30 feet of bulwark was seriously distorted, along with the fracturing of a number of bulwark brackets. Since side bulwark damage occurred relatively infrequently and since one-half of the occurrences were on ships of this design, it is suspected that the bulwark arrangement on Design A is marginally adequate at best.

Interpretation of Structural Casualty Data

In the limited survey of ship casualties covered by this report it is not possible to extract all of the meaningful information which may be contained in the accumulated data. Yet there have evolved a number of trends which give some insight into what may be learned by more exhaustive analysis of these data or from more extensive surveys of this type. Additionally, the limited analyses which have been made can be interpreted to indicate a logical path to follow in future research, development, and design projects aimed at improved ship structures.

First it is important to remember that a ship casualty involves both a cause and an effect—and the two are not always separable. Furthermore, both cause and effect may each comprise a number of factors related to the environment, operational techniques, economics, and chance, as well as to the many complex elements which enter into the design of a modern merchant ship. Any interpretation of ship casualty data which has as its goal the improvement of one aspect of ship design, such as ship structures, must necessarily take into consideration all of the factors involved.

A cogent example of this cause and effect relationship is found in analyzing structural damage resulting from collisions. A collision may be caused by environmental disturbances over which no control can be exercised, such as high wind or unexpectedly strong current. It can be caused by improper ship handling by the crew, by pilots and dockmasters, or by the crews of vessels alongside. The cause may also be laid to the designer and builder who provide inadequate maneuvering control, or to malfunctioning of critical equipment.

The effect of a collision, as far as this study is concerned, is damage to the structure of the ship. The pertinent question is, then, whether the ship structural designer can do anything to ameliorate the damage resulting from collisions. The survey data can be interpreted to show that, to some extent, he can. From the contours of damage location probability obtained in this study it is possible to make some observations related to the cause and the effect of the collisions which produced these results.

Collisions with both fixed and mobile structures caused damage most frequently in the region of the load waterline. Collisions with fixed structures also incurred a fair amount of damage just below the sheer strake; both the waterline and above-waterline damage concentrations centered primarily at one-third of the length and secondarily at two-thirds of the length from the stern. These concentrations of damage location could indicate that collisions with fixed structures occurred most often when the ships were moving forward and that contact was made in the region of maximum hull curvature. Damage from collisions with vessels alongside centered in about the same region of the waterline forward, but the after damage centered at about 80 per cent of the length from the stem. Also, damage from mobile structures occurred with greater frequency aft than forward, indicating that either the damaged ship was moving astern or that the other party to the collision was the culprit. It might be mentioned that this after damage center is a favored region for pushing with tugs when moving away from a pier.

The foregoing discussion related primarily to a surmise of causative factors in collisions as indicated by the survey data. On the other hand, these damage location probability contours could be interpreted as evidence of a failure of the ship structure to withstand collisions with fixed and mobile structures. Both sets of contours have a marked similarity in this respect in that the damage occurred most frequently at the weakest points of the hull structure.

A conventional hull girder is designed with major strength members along the upper and lower extremities, i.e., the main deck and sheer strake and the double bottom and bilge strake. Midship shell plating is designed heavier to resist bending. The fore and aft peak tanks, with their heavy internal structures, provide a great deal of strength to the forward and after five per cent of the length. If this total strength pattern is superimposed on the damage location probability contours, it can be seen that the probability of sustaining damage is inversely proportional to the strength of a conventional hull design.

Whether it is economical to attempt to design a ship structure to resist or ameliorate damage from collisions is somewhat questionable. However, the data obtained in this survey would indicate that if such an attempt is made it would logically include installation of stringers along the shell at the waterline and web frames in the regions of one-third and three-quarters of the length from the bow.

Although design to reduce collision damage may be open to question, there appears to be no doubt that structural design to reduce heavy weather damage is mandatory. This applies both to slamming damage and damage to the forecastle and weather deck. The basic cause of heavy weather casualties is obviously the environment. The operator has some control over both cause and effect; he can reroute the ship to avoid heavy weather and he can slow down to lessen the chance of sustaining damage. However, both of these control measures have an economic connotation in that they involve the loss of time and a corresponding reduction of revenue. Thus, it devolves upon the designer to provide a vehicle which offers maximum protection against heavy weather damage.

The likelihood of slamming and of taking green water over the forecastle and weather deck is also related to the hull form and the configuration of the above-water body of the ship. Weather deck damage can also be avoided to some extent by the erection of protective barriers. If it is assumed that everything possible has been done to minimize the hydraulic impacts, it then is necessary to provide a structure to withstand the loadings which may be imposed.

The survey data alone do not reveal much information on what can be done structurally as a palliative for slamming damage. However, they do show a spread of from 10 per cent to 30 per cent of the length over which the damage extended, and that damage was generally confined to the flat keel, A-strakes, and floors in this region. This shows the limit of the area over which structural strength might be increased. Furthermore, if details were available on the modifications made to Design A it would be possible to point to one structural arrangement which apparently provided satisfactory resistance to slamming damage on one class of ships.

From the meager data available on forecastle deck damage, only tentative conclusions can be drawn as to what structural modifications might be warranted. Apparently, conventional bulwark structures are adequate to withstand the hydraulic impact incurred as the bow pitches downward. The major damage seems to have been incurred after green water engulfed the forecastle on a down-pitch; as the bow lifted, the upward acceleration of the mass of entrained liquid developed forces which deformed the forecastle deck and lowered the bulwarks outboard.

Apparently the deck drainage afforded by line-handling openings in the bulwark is inadequate to cope with this problem. One interpretation might be to eliminate the bulwark and provide a considerable amount of camber to the forecastle deck. If the bulwark is required as a spray shield in less severe weather, it might be replaced by rows of spray-deflecting slats which would permit more rapid drainage of the forecastle. The same approach might be considered in areas of the main deck abaft the forecastle to provide protection for deck cargo, particularly in the case of container ships.

The instance where a tanker incurred damage to plating and structure around its hawse pipe prompts a precautionary note relative to structural design in the bow region. A rigid element such as this can create a hard spot which restricts flexing of the structure in response to heavy weather impacts. This can result in localized damage in the area where the rigid element is attached. Excessive stiffening of the forefoot or the forecastle deck could have a similarly undesirable effect.

Conclusions and Recommendations

It has been shown, even from the limited quantity of casualty data obtained, that significant trends of structural failure are evident. From the data evaluated in this survey it has been possible to draw a few conclusions as to damage related to heavy weather at sea and the relative susceptibility of various ship structures to damage from collisions with fixed and mobile structures.

Although these trends are significant, they have not yet been sufficiently validated to recommend and justify specific structural modifications. It is believed, however, that a more thorough examination of the casualties which produced these trends would be of value. Particularly in cases of slamming damage, and to a lesser extent cases involving damage to the forecastle and weather deck, it would be possible to attain a better understanding by further examination of the environmental conditions and of the hull form and above-water configuration in the bow area of each ship involved.

In cases of collision casualties, it appeared that the damage centered in the weaker regions of the hull structure. But these damage concentrations were also logically related to operational factors associated with ship handling in restricted waters. The understanding of cause and effect in collision casualties could be markedly improved by adding more tanker collision casualty data to the data base. The longitudinal framing of tankers appears to be inherently more resistive to damage of this type and thus, if structural changes can indeed reduce the extent of collision damage, this would become apparent in analyses of such an expanded collection of data. Such additional data on tanker casualties are available in the files of the U. S. Salvage Association.

Any statistical summary of a mass of data has both advantages and limitations. The statistical approach can aid in pointing out areas of damage attributable to specific causes and the physical extent of such damage. The greater the mass of data the more is the authority with which the finger can be pointed at areas of deficiency; thus there is a strong tendency to perpetuate any data collection and analysis program. However, in this particular case, it is believed that continuation is warranted. At present it is evident that the data collection and analysis program has yielded information of specific value as related to certain types of structural damage. With the assimilation of additional data it will be possible to learn more about these specific types of damage and to isolate other types of damage which occur frequently in various classes of ships.

The data form derived as a part of this study is generally adequate to record the maximum amount of information available from known sources of casualty data. Although the form provides for numerous entries related to the extent of damage, the applicable information is seldom provided in casualty reports. One addition to the form is suggested which would make the data more meaningful in this regard—the cost of repairs. Cost would be used not as an economic index but as an analytical weighting factor as a means to assess the extent of damage.

It is also concluded that, while statistical analyses of the accumulated data are valuable and should be continued, the ultimate worth of studying casualties is highly dependent upon an engineering evaluation of all casualty situations. From a design viewpoint it is essential that cause and effect be isolated and categorized so as to determine what aspects are design functions and what aspects are outside the realm of the designer. In this sense the designer's realm includes such elements as propulsion and maneuvering control, hull configuration and arrangements, as well as the hull structure itself. These design elements are all interrelated in the performance of a ship and must be treated together when examining how total performance can be improved both technically and economically. Thus, casualty data analyses should be undertaken by competent engineers who are aware of all design elements and who have a reasonable understanding of the many complexities of ship operation. When examining casualty data they should have access to pertinent design details of the ships involved, including hull lines and machinery arrangements, as well as structural plans.

A final recommendation on the continued collecting and analysis of ship casualty data is that the process be expanded to include all data available for the last fifteen years, and that the process then be kept current as new casualties occur. In this way a solid base of fundamental data will be in hand against which new data can be compared. It then may be possible to spot deficiencies in specific ship designs in time to recommend corrective action while those ships have useful life remaining. Furthermore, over an extended period, it will be possible to evaluate the success or failure of specific modifications. This eventually will provide a powerful tool for improving the economic performance of ships of the U. S. merchant fleet.

A REVIEW OF SHIPBOARD RADAR PLOTTING AND ITS SAFETY APPLICATIONS.

By JACK PANSMITH
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Today various systems and types of equipment are installed on board vessels to assist in avoiding collisions. When the number of vessels and the gross tonnage figures are compared with the number of collisions for the years 1900 and 1968, it is obvious that the safety systems and equipment have reduced the collision rate considerably. In 1900, Lloyd's Register listed 28,890 vessels greater than 100 GT and a total gross tonnage of 29 million tons. In 1968, Lloyd's listed 47,444 vessels and a total gross tonnage of 200 million tons. At the same time, the Liverpool Underwriters recorded greater than 2,000 collisions in 1900 between vessels of over 500 tons, and some 1,600 collisions in 1968.

One of the primary anticollision systems is the Rules of the Road. Certainly this system has contributed in reducing the number of collisions. However, there are certain weaknesses in the rules which have become more chronic as conditions have changed in marine commerce. They do not adequately cover situations which involve more than two vessels. Such situations commonly occur in today's congested harbors and rivers. The need for the seaman to interpret the meaning, as determined by the courts, of such phraseology as risk of collision, moderate speed, immediate danger, and proper lookout, add to his difficulties in safely navigating his vessel in restricted waters. The provisions for whistle signals are inadequate in that they do not always provide a positive and reliable means for vessels to determine the position and intentions of other vessels in their vicinity. The Safety Board has commented on this problem before in its reports on the *Union Faith-Warren J. Doucet* collision and the *Arizona Standard-Oregon Standard* collision. Also, these problems have been recognized internationally and proposed changes currently are being prepared for consideration before the Intergovernmental Maritime Consultative Organization in 1972.

Within the past 30 years, radar has been the most significant anticollision tool developed for shipboard use. It has been effective. However, it has not been infallible, and collisions involving radar equipped vessels have continued to occur. Some of these collisions at times are referred to as "radar assisted" collisions. The Safety Board in its "Study of Collisions of Radar-Equipped Merchant Ships and Preventive Recommendations," thoroughly analyzed this problem and concluded that a lack of understanding of relative motion, failure to plot, failure or inability properly to interpret or evaluate radar-produced data, failure to maintain a constant radar watch, and immoderate speed were the most frequently encountered causal factors. These factors indicate the need for better training and, perhaps of greater significance, the need to recognize the human limitations of the mariner. This latter point was recognized in the Safety Board's report on the *Arizona Standard-Oregon Standard* collision. Today the watch officer is burdened with greater and greater decision-making responsibilities, and normally has less time in which to collect and evaluate data and then make his decision.

Within the past few years, considerable time and resources have been expended in developing what are commonly referred to as "collision avoidance systems." These systems display excellent potential for solving the watch officer's basic problem. They can collect and evaluate pertinent information accurately and rapidly, and provide the data necessary for a watch officer to make correct and timely decisions to ensure the safe navigation of his vessel. The sophistication of these systems varies from a basic mechanical plotting device to a full-blown system which has a large computer capable of performing other shipboard tasks besides navigation and collision avoidance. However, the primary components of most of these systems are a radar to provide the raw target data inputs, a computer for analyzing and processing the data, and some type of display to present the desired outputs to the watch officer.

Currently, a number of systems are being developed and tested.

Most of the systems (all that incorporate a computer) provide for automatic tracking of targets. The number of targets which can be tracked varies from seven to more than 60. Many of the systems are capable of tracking and displaying 30 to 40 targets. Most of the systems require manual acquisition of targets. At least one system uses automatic acquisition. The advantage of automatic acquisition is that it relieves the radar operator of the need to make a preliminary threat assessment of every target on his radarscope to determine which targets he desires to have tracked. When there are large numbers of targets on the scope, automatic acquisition prevents the possibility of a threatening target being overlooked by the operator. On the other hand there are some potential disadvantages of automatic acquisition. One is the determination of which targets to select. Since there is a limit to the total number of targets which can be tracked and displayed, some target selection criteria must be established. Selection might be on the basis of targets closest to own ship, those with the fastest closing rate, only approaching vessels, or those on a collision or near-collision course. There may well be differences of opinion as to what the criteria should be for target selection. Also, target discrimination may be difficult. One does not want an object on the shore, a fixed object in the water, or any other nonvessel target to be tracked and displayed as a vessel target. Another possible disadvantage is that in high density traffic, the display may become too cluttered.

Most of the systems provide a separate bright display. Some display the targets with vectors attached which indicate target course and speed. One, which provides a separate printout of target data, indicates target identification next to each target but displays course and speed vectors only upon request. Most provide numerical target data, either automatically or upon request. Some provide the target data on the main display, whereas others have a separate teletype readout. The usual target data provided are range, bearing, course, speed, time of CPA (closest point of approach) and distance to CPA.

Two of the systems use a danger area concept in lieu of CPA data. Their displays show an elliptical shape at the end of the target's projected trackline, which defines the danger of collision area. The size of the danger area is determined by the accuracy of the radar, the accuracy of the computer in computing target course and speed and the minimum passing distance selected by the operator. With the danger area concept, an operator may select any course which does not cross a target's danger area to avoid collision. The operator may place the cursor on any proposed new course to verify whether such a course will avoid all target danger areas.

Those systems which provide CPA data also have trial maneuver capabilities. These capabilities allow an operator to select a new course and/or speed, to insert them into the system, and to obtain a speeded-up picture which will show the effect of the proposed maneuver relative to all the targets.

One of the problems of most of these systems is to obtain an accurate and reasonable own ship's speed input. Some use shaft r.p.m.'s or pit log reading, neither of which is extremely accurate. A Doppler system will determine own ship's speed accurately; however, it is very costly.

Numerous types of visual and audible alarms are included in the various systems, most of which provide both audio and visual intrusion alarms. Depending upon the particular system, the intrusion criteria may be selected by the operator by the use of range rings, distance or time to CPA, or a target's danger area. Some systems have alarms which are activated when there is a prediction of a collision or when a new target appears on the scope. One system has an alarm to indicate a target changing course and to warn of an approaching navigational hazard.

Most of the systems provide both a true and a relative motion display, the choice resting with the operator. The usual choice of modes is either head up or north up; however, some have only a course up mode. Some displays are replicas of the radar PPI scope; others are elongated, which provides greater coverage ahead and less astern and to either side; off centering is a common feature; some systems display land, and one system also displays shoals and obstructions.

The variety of systems and features which currently are or shortly will be operational and under evaluation on board ships indicates a need for determination of some basic criteria or specifications.

The following is a suggested list of minimum criteria for a shipboard radar collision avoidance system:

1. Effective bridge-to-bridge voice radio communication.
2. A competent, well trained watch officer at the conn.
3. A reliable radar.
4. A visual display or representation which will clearly and unambiguously present the following information: the positions of targets and navigational hazards derived from radar; the true course, speed, range, bearing, distance at CPA, and time of CPA of targets; and projected positions of own vessel and other vessels, or an indication of a proper disengagement maneuver, or indicate forbidden regions of maneuver relative to other vessels.
5. Manual or automatic target acquisition, or both.
6. Automatic audio and visual alarms to identify threatening targets or dangerous situations.
7. Reliable target identification.
8. Variable controls for setting up the threat criteria.
9. Trial maneuver evaluation.
10. A variety of selectable range scales.
11. Capability of all weather operation.
12. Capability of being mastered quickly and easily by qualified watch officers.

These suggested criteria are basically self explanatory. However, emphasis should be placed on the need for an unambiguous presentation of the data needed by the watch officer to make rational decisions. Also, the requirement that the system must be easily understood and quickly mastered by the watch officer is very important. The system must be comprehensive enough to provide more useful collision avoidance data than are provided by radar alone, but it should not become so sophisticated that the average watch officer has difficulty in properly using it.

Another consideration is the cost. Those systems which include a computer usually cost between $40,000 and $100,000. Such an expenditure is not economically feasible for all sizes and ages of vessels. As a result, the overall effectiveness in preventing collisions is reduced in a busy harbor or port where many of the vessels do not have a shipboard system installed.*

Since the Andrea Doria disaster, many papers and articles have been written on the problems of collisions at sea and the failure of shipboard radar to materially reduce these collisions. In countless cases of radar-equipped ships involved in collisions, the findings show that the watch officers *failed to plot* the information derived from radar and "... that a major cause of these collisions *was a lack of understanding of relative motion.*"

Radar gives the bearing and distance off of objects shown on the radar screen at the instant of observation. It does not give a history of past events. A single inspection of the radar screen at any one instant cannot be used by itself to analyze a situation. It is necessary to make a plot of the movements or non-movements of the data derived from the scope at timed intervals. This plot must be depicted in a manner that will present a visual picture which can be rapidly and clearly

*The foregoing material is from National Transportation Safety Board, Washington, D.C., Report No. NTSB-MSS-72-1 entitled "Special Study of Collisions within the Navigable Waters of the United States Consideration of Alternative Preventive Measures."

interpreted. For anticollision purposes, the plot must: (1) show which contacts may become problems; and (2) serve as a basis of a solution for appropriate evasive action.

Since the advent of radar for shipboard use, the "relative motion" plotting technique has been the accepted method taught by all U. S. authorities—Bowditch, Dutton, H.O. Maneuvering Board Manual, H.O. Radar Plotting Manual, Marad's Radar Manual, and others. That it is confusing, ambiguous, and subject to misinterpretation is shown by the fact that a True Plot is usually employed to explain the relative motion plot.

Over the past 25 years, many officers and radar experts have proposed various methods to make it more understandable.

Relative motion radar plotting techniques require the observer to form a mental picture in his mind's eye of the *past* and *developing* situation to determine evasive action to prevent a collision. Unless you are a "Dunninger" mindreader, this is practically impossible.

As an illustration, contacts that move from dead ahead, or almost so, toward your position at the center of the relative motion plot, *can* mean: (1) a ship is heading directly toward you; or (2) a ship is going away from you, or (3) a ship or object is stopped or motionless.

If a contact is going astern from the center of the plot, it *may* mean the ship is going in a forward direction not astern.

A motionless pip means a ship is moving on a parallel course at the same speed as your ship.

Also, two scales usually are necessary, one to determine speed and the other for distance; often they are confused.

How can an officer be expected to mentally interpret these situations correctly and take appropriate evasive action, particularly if any ship on the plot changes course or speed?

We must conclude: the relative motion radar plotting technique is ambiguous, confusing, visually undecipherable, time consuming, archaic, and obsolete and has been a causal factor in many collisions. "Passive knowledge without active awareness" (Sir Robert Watson-Watt).

The True Track plot creates a chart of a part of the earth's surface and a *measure* of that part of the earth. The true plot gives the actual distance and direction of movement to one selected scale.

If either own-ship or contacts change course and/or speed since the previous observation, the actual positions will be indicated on the true plot at the instant of the next observation. It provides continuous tracking of all ships in real time. With the new True Track method, the plot of the situation is constructed in seconds. It utilizes the essential information readily available from *any* marine radar regardless of make or age—that is: the TRUE BEARING AND RANGE OF AN OBJECT, AT THE INSTANT OF OBSERVATION.

A true plot will tend to reduce blunders, even among radar observers with relatively high skills, in interpreting relative motion plots and prevent erroneous interpretations between relative and true courses.

Should any of the radar contacts change course or speed, the true plot will provide a direct indication of such without the need for interpretation or analysis associated with the relative motion plot.

The continuing installation of high cost true presentation radars aboard merchant ships, either as a second radar in addition to a relative presentation radar or as a single radar with optional relative presentation, is indicative of the desirability of a true plot on the navigation bridge.

Even with a relative motion presentation radar, true bearing and range is readily available. Since the true plot provides the true vectors of the radar contacts directly, without need for interpretation, personnel not skilled in the relative motion of the radar will be able to analyze the situation.

The generation of a true plot within the combat information center of warships, while primarily for certain tactical purposes as opposed to collision avoidance, is without doubt helpful in preventing collisions, particularly when the individual warships in close proximity are steaming on different courses and speeds.

Finally, the navigational or true plot has been made practical to construct rapidly and

accurately, and provides the ship's officer with a usable and understandable means of utilizing the vital information he receives from the radar. Hopefully, there should be a reduction in ship collisions due to failure to plot. A number of shipping companies have installed this plotter aboard their ships, and reports of its efficiency have been very gratifying. Models of the Plotter for CIC (Combat Information Center) and aircraft use are also available.

THE CARRIAGE OF DRY BULK CARGOES, INCLUDING THE UNUSUAL HAZARDS OF ORE CONCENTRATES

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On January 14, 1972 the following marine casualty appeared in The Journal of Commerce: "The 13,616 ton Liberian ore carrier *Banaluna*, last heard from while in latitude 19° 24′ N. longitude 127° 24′ E. last November, has officially been posted as missing by the Committee of Lloyd's in London. The vessel disappeared while on voyage from Tolosa, in the Philippines, to Kokura, with magnetite iron concentrate."

Please make note of the cargo transported on this vessel—magnetite iron concentrate. This is one of numerous casualties reported involving vessels transporting ore concentrates.

Many ore concentrates and similar materials which in a static condition appear to be reasonably solid take on some of the characteristics of a liquid after motion incurred by rolling, pitching, and pounding, or vibration induced by engines. Materials which act in this way may be referred to as "thixotropic commodities" or as possessing "thixotropic properties." Undoubtedly, most casualties reported result from the free surface effect caused by such thixotropic change, or actual water migration to the surface of the concentrate.

Before continuing our discussion on the specific hazards which may be caused by the unusual properties of some ore concentrates, let us consider for a moment other bulk materials which are transported in huge quantities.

The title of this report speaks to dry bulk cargoes, which broad category rightly includes bulk grains, pulses, and seeds. Problems relating to ocean transport of bulk grain are primarily associated with loss of stability as the result of surface grain shift. Transport of bulk grain is regulated by the Coast Guard for U. S. flag vessels in CG-266, Part 144 and internationally by Chapter VI of the 1960 SOLAS Convention for safety of life at sea. The international regulations are presently under revision at IMCO, after completion of a three year evaluation period during which many full cargoes of grain have been loaded under the so-called "1969 Equivalent" to Chapter VI of the SOLAS Convention. It will suffice to point out here that, through application of concepts provided for by the 1969 equivalents, fitting of center line shifting boards and feeders may in many cases no longer be required. It is anticipated that the 1969 equivalents will evolve from the experimental stage to actual regulation in 1973. Other bulk cargoes such as agricultural pellets and meals, cement, coal, and coke (including ore concentrates) should be stowed and transported in accord with recommendations contained in the IMCO Code of Safe Practice for Bulk Cargoes.

Our emphasis here is specifically directed to the rather unusual problems which may result during the transport of ore concentrates and arise from the unique physical characteristics of some of these concentrates.

An ore concentrate is a partially refined or purified metal or, more correctly, an intermediate stage between the metallic ore and a refined metal. Ore concentrates transported in great volume are: chrome, copper, iron, lead, manganese, nickel, zinc, and others.

As the result of extensive experience gained in Canada in the production and exportation of various metal ore concentrates over a number of years, and through worldwide knowledge gained within the last 15 or 20 years as the result of increased ocean transport of ore concentrates, the IMCO Sub-Committee on the Carriage of Bulk Cargoes first produced a guide, or code, for dry bulk materials including concentrates, in 1966. Much of the credit for completion of the IMCO code must be given to the United States Panel on Bulk Cargoes, which was responsible for a great deal of the input to the Code through the U. S. representatives to the IMCO Sub-Committee.

Recently, there have been significant sharp increases in the transport of ore concentrates, partially due to new air pollution legislation in several states and also, more importantly, as the result of developing mines in new areas and new markets for the products thereof. In addition, the new U. S. vessel construction program, as envisioned by the Maritime Administration and others, provides for a fleet of U. S. flag bulk carriers, designed and built for this specific purpose, for the first time in the history of our merchant vessel fleet. Obviously, these U. S. owned and operated bulk carriers will be transporting ore concentrates and similar materials in ever increasing quantity and frequency. The need for education regarding hazards involved in transport of such potentially dangerous materials, and the cautions which should be observed, cannot be overemphasized.

Problems which may result through the transport of bulk cargoes, specifically ore concentrates, include the following:

1. Spontaneous Heating. Copper concentrates with a high sulfide content, originating on the West Coast of South America and elsewhere, have at times been extremely troublesome through the property of autogeneous heating. In recent years, the fire record of cargoes of high sulfide concentrates has improved, largely through the control of moisture content. This problem, after being lost or buried for several years at IMCO, has recently been reintroduced for consideration of the Sub-Committee on the Carriage of Dangerous Goods.

2. Improper Weight Distribution. This may result from excessive concentration of weight in 'tween deck locations, or overstressing of inner bottoms caused by excessively high peaks in unusually heavy material.

3. Improper Stability. The low center of gravity of an extremely heavy material may cause excessive GM, or metacentric height, resulting in violent and rapid roll periods, a potential cargo shift, and possible structural damage to the vessel and equipment.

4. Reduction of Stability. This may result from a transverse shift of cargo surface in cases of "dry" cargoes similar to grain or transverse shift of "wet" cargoes which become fluid. The latter is, of course, the "thixotropic" property and is evidenced in seemingly dry ores or concentrates which may become fluid or partially fluid when shaken or vibrated.

At this point, it is in order to look at some definitions:

Concentrate is that material obtained when a natural ore has undergone some form of purification by physical separation of undesirable ingredients. Other materials having similar physical properties are included.

Thixotropy is the property or phenomenon exhibited by some substances of becoming fluid, or undergoing an alteration in viscosity, by shaking or stirring. The change is reversible. The word is derived from the Greek word "thixis," meaning touch, and "trope," which means turning.

Angle of Repose is the angle between a horizontal plane and the cone slope obtained when bulk cargo is freely dropped onto this plane.

Moisture Content is that portion of a sample consisting of water, ice, or other liquid, expressed as a percentage of the total weight of that sample.

Flow Moisture Point is the moisture content at which a flow state develops.

Transportable Moisture Limit is the maximum moisture content of a concentrate deemed safe for carriage by sea in general cargo vessels which are not specially equipped, strengthened, or constructed to restrain concentrates which may become fluid. It is 90 per cent of the flow moisture point.

The IMCO Code of Safe Practice for Bulk Cargoes is divided into ten sections:

Section 1. Definitions, including those previously given.

Section 2. General precautions, including: (1) requirements of the 1960 SOLAS Convention for stability data to be provided all cargo vessels, specifically in regard to contemplated voyages with bulk cargoes; (2) reference to bulk-loaded vessels with relatively large metacentric height or GM which will result in violent motion (however, such a vessel is more able to resist a heavy list through the shifting of such heavy cargo); (3) the importance of proper weight distribution to avoid excessive local overstressing; (4) guidelines for use of the master when adequate information regarding his vessel is not available; (5) other general safety precautions to be taken when loading any bulk cargo, required by the ordinary good practices of seamen.

Section 3. Covers bulk cargoes including ore and similar cargoes having an angle of repose greater than 35°.

Section 4. Covers bulk cargoes including ore and similar cargoes having an angle of repose equal to or less than 35°. Many cargoes in this category are likely to shift more readily, due to the lesser angle of repose, and therefore require more trimming and leveling than materials with an angle of repose above 35°.

Section 5. This section is exclusively dedicated to the hazards involved with the transport of concentrates and similar materials, particularly the hazard previously referred to resulting from the thixotropic nature of some concentrates with excessive moisture content and a resultant moisture or water migration. This hazard may be found in finely divided materials, such as concentrates which are shipped in a damp state. These concentrates may appear to be completely dry when loaded, but may contain sufficient moisture as to become fluid through the motions and vibrations the material is subjected to during an ocean voyage. The surface of such ore concentrates may, in a short time, be completely covered with free water or be in a partially viscous fluid state. As the vessel rolls, and particularly in cases where there is a list to one side from such causes as wind heel or improper distribution of liquids, the partially fluid concentrate may flow or slide higher up the shell plating with each successive roll. The vessel will rapidly reach a dangerous condition of list with little prospect of overcoming such a serious situation at this stage.

It is impossible for us to fully comprehend the dilemma of the shipmaster who suddenly realizes that his vessel may capsize with the next roll. The casualty reports indicate that this has occurred much too frequently.

Section 6. Contains precautions to be taken when loading concentrates and similar materials on general cargo vessels, particularly in regard to ascertaining that concentrates with an excessive moisture content are not transported.

Precautions must be taken throughout the voyage to prevent liquids entering compartments in which concentrates are transported, including water which may be used to cool a concentrate shipment subject to spontaneous heating.

Ore concentrates having a moisture content in excess of the transportable moisture limit may be transported in general cargo vessels specially equipped and strengthened for this purpose or in specially constructed bulk cargo vessels with internal structural bulkheads located to sufficiently restrain concentrates which have undergone moisture migration. Such vessels must be approved by their government for transport of concentrates with moisture content in excess of the transportable moisture limit.

Recent casualties experienced by vessels loaded with ore concentrates having moisture content exceeding the transportable moisture limit have confirmed our opinion that wooden shifting board bulkheads cannot withstand the tremendous pressures caused by the shift of concentrates which have undergone thixotropic separation. .

Less than one year ago a Panamanian vessel, the *M/V Hermosa*, loaded with 15,000 tons of mineral concentrate at San Fernando, Philippines, developed a list and diverted to a port of refuge to replace and tighten shifting boards. After an initial loss of 17 days, the cargo again shifted and the vessel returned to another port of refuge with a heavy list, collapsed shifting boards, and free water over the cargo surface in two hatches. It was necessary to discharge the entire cargo, install twin longitudinal steel bulkheads in four holds, and bag a portion of the remaining cargo in the other two holds before the voyage could be resumed.

Section 7. Sampling procedures for determination of transportable moisture limit are contained in Section 7, which speaks to "representative samples" which should be taken from the production process at reasonable intervals. and where cargo has been wetted during transit or prior to loading in the vessel. In such cases, representative samples should be taken from approximately one out of every five truckloads, or the equivalent, at the surface and at half-depths. Obtaining a true representative sample from a huge stockpile containing thousands of tons of an extremely dense material can be most difficult, and this section of the Code may not be completely adequate in the present form.

A laboratory certificate stating the actual moisture content at the time of loading, and the transportable moisture limit, should then be given to the master and/or the appropriate authority.

Section 8. Test procedures in determining moisture content, flow moisture point, and transportable moisture limit, including a sample check which may be done on board the vessel, are described.

Section 9. Includes specific details regarding recommended test procedures, such as apparatus to be used, standards of tests, temperature and humidity conditions, and the procedures in detail.

In 1968, as the result of discrepancies revealed in tests of the same concentrate samples reported by different laboratories, the Code was enlarged by including a narrative description of the Flow Moisture Point Test, with photographs.

Section 10. The 1972 edition of the IMCO Code contains new stowage factor conversion tables from English units to metric units, and vice versa. The IMCO Code also contains two Appendices: Appendix A lists bulk cargoes other than concentrates; Appendix B lists ore concentrates and similar materials. These lists include data such as approximate angle of repose, stowage factor, and description of material. The data furnished should be recognized as basic information only, and complete current details on the actual cargo to be loaded should be made available to masters of vessels and others concerned.

The problems concerning transport of ore concentrates and precautions to be taken in regard to such ventures are deserving of far more attention from all parties involved, including shippers and carriers, underwriters, organizations or individuals concerned with safety, and governments than has been accorded in the past.

If our efforts contribute in some small way to the safety of vessels, lives, and cargoes, they will have been more than well worthwhile.

SAFETY IN POLLUTION CONTROL

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Safety in merchant marine pollution control is coming of age. The installation of pollution equipment has commenced, and new safety considerations by management, ships' officers, and crew are needed. Fortunately, only cqmmon sense safety rules are called for when servicing the equipment.

Shipboard pollution control is a most complex problem. It is new, it has not been totally researched, demons'rated, hardware installed, or best results achieved. Let us look at the overall problem, sqme safety rules, and possible training and research.

The Water Quality Improvement Act of 1970 centered attention on pollution control in the merchant marine by expanding the scope of past laws such as the Corps of Engineers Harbor and Refuse Act of 1899, pollution control statutes recently established by many states, the Canadian government, and even IMCO.

The major enforcement efforts are directed at the control of human waste, oil spills, and the direct overboard discharge of of oily waste.

The capital cost of pollution control equipment, its maintenance and operating cost, the potential enforcement of penalties possibly leading to fines for non-compliance, and the possibility of closing certain waterways and harbors to non-complying merchant ships is a new concern of ship operators.

It is estimated that the capital cost for the control of human, sanitary, and galley wastes for domestic ships on the Great Lakes may total $30,000,000.

EPA Standards of Performance

On June 23, 1972 EPA annqunced final regulations establishing performance requirements for marine sanitation devices pursuant to the Water Quality Improvement Act of 1970. As finally promulgated, the standards, on their effective date, would prohibit all discharges of sewage from vessels. However, in order to provide incentives for existing vessels to install treatment devices prior to the effective date of the standards, they provide that equipment installed in an existing vessel within three years after promulgation of the implementing Coast Guard regulations may be used as long as it operates properly.

Equipment installed in existing vessels during the fourth or fifth year after the effective date of the Coast Guard regulations may be used until the end of the eighth year following the established date. "Existing vessel" is defined under the Act as a vessel of which manufacture has commenced prior to the promulgation of the Coast Guard regulations.

In order to qualify for the foregoing partial exemptions, the equipment installed must provide level of treatment which will eliminate visible floating solids and reduce the fecal coliform count of the effluent to 1,000 per 100 milileter sample.

Under existing law, states which now enforce no discharge requirements may continue such control under the effective date of the standards three and five years from enforcing date of the Coast Guard regulations. It should be noted, however, that the 1972 Federal Water Pollution Control Act Amendments could accelerate the preemption date for vessels which install treatment devices meeting the standard referenced above to the date of promulgation of the Coast Guard regulations.

There appears to be considerable amount of support for the argument that the enabling provisions of the Water Quality Improvement Act of 1970 did not envisage establishment of a total discharge prohibition and that such a total prohibition is beyond EPA's scope of authority. Litigation is likely in this regard.

Judicial Interpretations

Judicial interpretation of the law and the levels of control is slow. The Lake Carriers' Association vs MacMullan et al in Michigan courts is the lead case which must be settled soon in the interest of public welfare.

The several states on the Great Lakes, for example, have different pollution control laws. The Canadian government has pollution control legislation, and the most recent agreement between the United States and the Canadian government covers control of human waste and added another, garbage. A number of laws are also on the books for control of oil spills and oily waste pollution.

A major endeavor is underw y by the Lake Carriers' Association on the Great Lakes to obtain uniform pollution control regulations so that the intent of legislation can be implemented. The action by Lake Carriers' has moved through the District Court at Detroit to the U. S. Supreme Court where the case was remanded back to the Michigan state courts on the basis that it is a matter of public concern to have the case adjudicated at the earliest possible time.

The Lake Carriers' case will resume January 15 in the Circuit Court at St. Ignace, Michigan unless a request directed to the governor to have the case transferred to the state Supreme Court is approved so that time-consuming handling of the case through intermediate courts may be eliminated.

The implementation of pollution laws relating to the Great Lakes must necessarily be on an international basis, with agreement with Canada essential. Recognition if this fact is an inherent part of the Lake Carriers' Association litigation, and it also recognizes the expectation that such an agreement will be executed by opening of the 1973 season. A single enforcement standard for all vessels plying the Great Lakes is one of the goals sought by the agreement.

The State of Michigan adopted legislation for the enforcement of a no overboard discharge pollution control act. The act has only been enforced on one occasion. The St. Ignace court handling the Lake Carriers' litigation reinstated an injunction prohibiting the State of Michigan from enforcing the law until the present court action has been heard and decision rendered.

Waste Water Treatment Devices

A type of control must be selected soon after legislative actions are completed. Many units are now being researched and demonstrated. The better systems are expected to be approved and purchased for use on ships.

The main principles of most waste water treatment units concern whether or not sewage may be treated and effluent allowed to go overboard, incinerated, recycled, or held in holding tanks for discharge at approved pump out locations.

The Need for Safety

The control units are designed for simplicity but create the need for safety education. The most automated and technically safe unit may expect breakdowns and leaks. Repairs will be required to put the unit back in service. The lay up of equipment on the Great Lakes creates a special cleanup problem.

A new industry to service control devices is in the making, but until it is established the major burden falls upon the ship's personnel.

Here are some rules which should be observed by personell to avoid exposure to virus, pathogenic, and disease causing bacteria:

1. Impervious gloves of rubber or polyethylene to prevent infection should be worn when cleaning pumps, handling waste water screening sludge, or other infectious material. Glove protection is most important when the hands are chapped, burned, or the skin broken from a wound.
2. Rubber coveralls are recommended in the case of a spill or cleanup.
3. The safety rule of all good bacteriologists, "to never place hands above collar level while at work," applies when working on sanitary equipment.
4. After work and before eating, the hands

should be washed thoroughly with plenty of soap and hot water. Antiseptics are not necessary, although safe practice solutions for the hands are 1:1,000 bichloride of mercury solution, 1 1/4 ounces of lysol per gallon of water, 1,000 ppm chlorine solution and phisohex soap.

5. The finger nails should be kept short and clean.

6. Smoking should not be permitted when working in the sanitary control room, as contaminated ends of cigarettes or cigars may introduce infectious material into the mouth.

7. Spills on sanitary room deck which may occur when a tank overflows or when a leak occurs should be cleaned up with soap and water. The deck should be swabbed with a Clorox disinfectant.

8. Rubber foot gear cover may be used to prevent trailings from the sanitary room to the hallways, galley, and crew habitation quarters.

9. Sanitary rooms where waste treatment equipment is located should be supplied with a wash basin so that an immediate wash up is possible when working with spills and repairs.

10. A first-aid box should be immediately available to provide attention and sealing of all cuts or open wounds.

11. A locker with sufficient space to adequately hold safety equipment, rubber gloves, rubber apron, shoe protection, and special clothing should be at hand.

12. Ventilation should be adequate to clear away all odors to the atmosphere.

13. The funnels of all incinerators should be of adequate area and height, insuring good draft under all weather conditions. Waste burners should be sufficiently isolated to prevent the possibility of serving as a source of ignition for any gas-air mixtures.

14. Very important is that oil not be permitted to join with an explosive mixture, such as hypochlorite, which may create a most serious damaging explosion.

15. The storing of any chemical associated with the apparatus should be positive.

16. A tank should be flushed clean and ventilated before entering for repair or lay up inspection.

Safety in Body Inoculation Protection

A medical safety program will provide extra protection for personnel. Fortunately, typhoid and paratyphoid fevers are rarely encountered today, but inoculations against these diseases may be desired.

Tetanus toxide inoculations are highly desirable for personnel assigned to waste water treatment.

Safety Training Programs

Safety training programs may be desired to indoctrinate shipboard personnel to use these systems to perform effectively the function for which they are intended. Personnel must understand the mechanics of the treatment process. They must be familiar with the inspection routine to assure that the plant is operating satisfactorily. Instruction manuals must be provided to clearly describe the treatment process. The functions of each component, recommended inspection routines, ranges of temperature, pressure, voltage, current, rpm, and recommended maintenance testing and cleaning schedules must be explained.

Training may be required in systems approved for shipboard use, routine maintenance, starting and stopping procedures, and safety practices. Operating personnel must be trained for safely accomplishing repairs at sea.

Suppliers of sewage handling, retention, and treatment facilities have the responsibility of ensuring that ample stocks of spare parts are available aboard ship.

EPA research design considerations recommend that shipboard apparatus be operable with usual shipboard knowledge. They recommend that control units should operate automatically—a button provided to start and stop, an electrical panel to control the flow, treatment, and disposition of finished effluent.

Enforcement authorities may have a difficult task unless marine personnel ashore and afloat are knowledgeable in how the job should be done and do the job to the best of their ability.

Research Projects

A number of pollution control projects are underway by government agencies and private industrial suppliers.

The Environmental Protection Agency has research projects on a government vessel, a private vessel, a small craft, and a ski lodge, all of which research concepts are partially adaptable from one to the other. In addition, the U. S. Navy, U. S. Coast Guard, and U. S. Corps of Engineers have been expending funds to un s o accomplish control.

Twenty-five separate companies are listed in Cliffs-MARAD report, indicating research and demonstration equipment available to the merchant marine. The Cleveland-Cliffs-Maritime Administration contract, completed August 17, 1972, provided for a two part program to research a total shipboard pollution control program. It covers many areas, including all oily waste, sanitary waste, other liquid waste such as ballast, cargo hold clean up, and boiler blow down. Solid waste, gas emissions, hazardous substances, and thermal pollution are also included.

The research and development programs contemplate the need for a ship to operate as a self-contained entity both in and out of waterways and harbors.

Environmental Protection Agency

The Environmental Protection Agency awarded a contract to the Cleveland-Cliffs Iron Company to research and demonstrate in 1972 a flow-through unit to include not only human waste but sanitary and galley waste as well.

Cliffs subcontracted the research to Thiokol where similar contracts by the U. S. Navy and U. S. Coast Guard, plus EPA, totaled approximately one million dollars in research endeavors to develop a shipboard unit.

The main thrust in the Cleveland-Cliffs-EPA contract included: (1) meet the EPA flow through effluent standards; (2) operate at a low daily budget; (3) operate automatically so that ship's crew attention is minimal; (4) provide equipment at a moderate capital cost. The unit is meeting EPA flow-through effluent standards. The cost of operating the unit is about three dollars per day. It is operating automatically, and the servicing of the equipment is accomplished by the day engineer. The production costs are at acceptable budget levels.

Duluth—Superior Harbor Survey

A most interesting total harbor pollution study endeavor has been undertaken by the Upper Great Lakes Basin Commission for the port of Duluth-Superior at the western end of Lake Superior.

The areas of pollution suggested for research are concerned with the following: control of ship's polluted dunnage; handling of sanitary and galley waste; control of oily waste; control of debris and washings of cargo holds as ships prepare for grain; control of oily water from ballast as a result of pressing fuel tanks while travelling in light load.

Summary

Safety in pollution control must be a partner of our environmental plan if there is to be a good end result. The plans of government agencies, ship owners, and marine equipment manufacturers and judicial actions will need the safe work practices of our crews if we are to zero in on a solution to this complex problem.

The joint effort must continue at "Full Ahead" in 1973.

STARTING FROM SCRATCH IN LONGSHORING SAFETY

By ELIZABETH WHITAKER TEZZA
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When I went to work for Palmetto Stevedoring Company, Inc. in October 1967 I was supposed to come in the office a few hours a week to sign checks or "something." Now if this sounds a trifle odd, it was. But there is a simple explanation. My father was a founder of the company and the chairman of the Board of Directors, and I am an only child. Need I say more? There are advantages in being the boss' son or daughter, but there are also very definite disadvantages. You are regarded with suspicion by the other employees, some of whom resent you, some of whom are afraid of you, and some of whom feel that the best way to promotion or a larger salary is to get on your good side. There is also the fact that Father does not tolerate any mistakes by you—in fact, things that are forgiven others are not forgiven you. At least that was the way my father thought.

So I sat at a desk and I signed checks and I wandered around poking into things here and there and trying not to step on any toes while I was trying to learn how the whole thing worked. As time went by I started noticing the size of the checks that we were sending our workmen's compensation carrier. That was a *lot* of money. Mercenary motives are somewhat suspect, but if they lead to the corrections of some faults and hazards, they are not all that bad a starting place. That was my starting place. In finding out why the large premiums, I also found out that they came directly from our accident rate. People working for us were getting hurt regularly and seriously. This was not to be tolerated. Certainly not to be tolerated by a person brought up in the tradition of preventive medicine by a mother who was a registered nurse. Not to be tolerated by a person taught by the Girl Scouts and teaching Girl Scouts that you think of safety and training in connection with every activity. Not to a person trained by the American Red Cross to teach water safety and emphasize prevention in life saving and first-aid courses. This doesn't sound like a very technical background with which to approach the very specialized type of safety that waterfront activities demand but, if you consider that attitude and motivation are the nucleus of any safety program, it is at least a starting place. It was where I started, and believe me, it was starting from scratch.

Need I say that I met a certain amount of resistance in my self appointed task. I work for two companies, a shipping company and a stevedoring company, and although we were supposed to be one big happy family, we were the kind of family rampant with sibling rivalry, especially between the dock siblings and the office siblings. I'll hazard a guess that this is not an unusual situation, for it takes two distinctly different types of people for these different type jobs.

I found that stevedores, ours at least, are highly capable, very knowledgable, extremely independent, and definitely resentful of interference by "desk jockies." Unfortunately, the individual in the office who was in charge of insurance statistics, accident reports, etc., could not relate to these men, and they in turn could not relate to him. There was no neutral territory to meet on. The office man was prone to give orders and the dock was prone to ignore them. Not a happy circumstance.

Also, dealings with our insurance carrier were at a sorry pass. Both office and dock had problems with the insurance company, and the insurance company had problems with us. This put pressure on the man in the office, who in turn pressured the men on the docks, who for their part were resentful of interference. The common expression of the day (deleting the profanity) was, "We've been doing it this way for twenty years." Does that have a familiar sound?

Being a see-it-for-myself sort of person, I decided to see just exactly what was going on out there. Just imagine for a moment what the result of that was. I met very definite resistance from my Father, who wasn't sure he approved of women in business anyway and who was positive he didn't approve of women on the docks. There was a quieter form of resistance on the docks, where men don't expect to see females, and there was a sideways form of resistance from the "office man" that came in the form of one particular repeated sentence every time I tried to make a suggestion—"It's no need to bother, you can't get any cooperation out of those men." But being a stupid, stubborn woman, I persisted. I just didn't tell Daddy where I was going. And I managed to convince our stevedore superintendent that I was on their side, and he in turn gave me cooperation in learning what it was all about. And the men outside began to get used to me and began to realize also that I wasn't out to find fault or run back to the office with a list of their offenses and failings.

Now as to our safety program at the time. We did have one but it was not working. They had been having safety meetings, and safety policies had been set up, but no one was paying much attention to them. We were talking safety and writing safety, but our accident ratio was still bad. Our progress began in 1969.

In 1969 our insurance carrier informed us that they would not renew. This was the blessing in disguise. Our new carrier, Argonaut Insurance Co., sent to Palmetto William T. Corley who by his own admission had little background in longshoring safety but who in my opinion is the best safety oriented man I know. He lived and breathed safety. He was full of ideas. He believed that the waterfront could be made a safer place to work and he believed that Palmetto had a soluble problem. He gave us a great deal of his time, talent, and energy.

One of his first recommendations was that a safety committee within the company be formed. He recommended that the stevedore superintendent, the gear shop superintendent, and I be on this committee and that I be the chairman. My father didn't like the chairman bit, but he did agree. Bit by bit we evolved a safety program, and the basic premise for this program was that safety is a matter of attitude, involvement, and motivation. We needed to motivate our people, we needed to change some attitudes, and we needed to get every one involved.

How do you go about changing attitudes? Where do you start and with whom? Well, you start at the top in this instance and you work down the organization. Management was already concerned—hadn't we just had our insurance cancelled? Hadn't we just paid out an exorbitant premium? Wasn't the superintendent concerned? You bet he was. He got it from both sides when accidents happened. So who came next? Our foremen. Ah, yes. How do we do that?

Our superintendent called a meeting of all the foremen. When they were all present I bid them a pleasant good morning and tried not to show that I was aware of the closed, slightly wary look in their eyes. The news that our new insurance company had recommended that I be safety chairman and that our president had approved the suggestion brought no outward response, but I could sense an inward withdrawal. The statement that I needed their cooperation to do this job also got no verbal response but brought a "you bet you do, sister" look to their eyes. Then I quietly passed out copies of our last retrospective premium statement. That brought a response.

As I explained the statement and they began to realize the significance of all those large confusing numbers, they began to get interested. As I said before, stevedores are smart cookies. It doesn't take much explaining for them to see the relation of accidents to accident rates to bid rates to bids gotten to work available. It doesn't take much to make them see the relation of overhead to profit to donations in their behalf to the profit sharing fund. I won't say we didn't have our problems with the foremen after that, but we had jumped the big hurdle—their attitude had changed. They now realized that safety was a necessity both from the humanitarian and the financial point of view, and the only way to start correcting our safety procedures was through cooperation.

We emphasized that we now had a new carrier who wanted to help, not criticize, and so we had a chance for a fresh start, a new beginning—that we were going to do a few things differently and add a few new procedures but not without their prior knowledge and approval—how we needed their ideas because they were the ones with the knowledge and ability—how we needed their leadership in setting an example for the men they were responsible for.

Obviously, in such a situation there are a few holdouts. We did not immediately get 100 per cent cooperation, but we had a start. Some who were skeptical began to see it our way as the months passed. One who thought it was all foolishness (and probably still does) no longer works for our company. Nobody misses him. His replacement never had a chance not to think safety—he was indoctrinated from the first day on the job.

The next attitudes to change were those of the headers. We instituted regular monthly safety meetings with all headers and foremen present. The first of these was similar to the one just reported, except they got no copy of the premium statement. They were simply told that each accident has a bearing on the cost of insurance which has a bearing on overhead which has a bearing on bid which has a bearing on the work we get. They understood that. As ever, money talks. They were each given a sheet of paper on which the number of accidents they had had the previous year—type, number of days lost, and cause—were listed. We asked for their suggestions, especially in regard to our equipment, and were told that any suggestions for safer equipment would be acted on. They were told we would have a meeting each month and discuss all accidents the previous month. Last, but not least, they were told that for each month they did not have a lost time accident they would receive an incentive award (in plain words, cash), but they must be at the meeting to get it. We stressed that medical cases did not count against them in receiving this award; in fact, medical attention for minor infuries would be beneficial in preventing lost time. Case in point—a minor cut unattended could lead to infection two weeks later that could result in lost time.

Over the months the headers began to get involved; their attitudes were changing too. They made valuable suggestions that were adopted or acted on, they were given forms to fill out which they began to keep properly, and things began to improve.

This was the psychology of our program. Now to the concrete steps that were taken:

1. Monthly Safety Meetings. Accidents discussed with emphasis on how to prevent similar ones in future. Chart posted showing each header's frequency ratio from month to month on a yearly basis.

2. Incentive Awards. On a monthly basis with an annual award to header with best overall yearly record including LT accidents, attitudes, citations, and medical cases. Other annual awards to headers with NLT accidents for year (this award: money). The first year we had one header with no LT accidents, the second year three headers, and this last year three headers.

3. A Picture is Worth 1,000 Words. We gave each foreman a camera, and slides were taken showing hazardous conditions and procedures, and correct procedures and conditions. These were shown at safety meetings on a "Can you tell what's wrong or right about this," and a "Is that *you* Hershell," or "Buster" or "Sol," as the case may be.

4. Office Records. Kept on every header gang-wise and also on every individual man showing how many and what kind of accidents and commodity involved.

5. Accident Prone Men Pinpointed. These were garnered by delving into all the dusty files as far back as our records went. More than three LT by one man or accidents that he involved other men put that particular man in this category. Men suspected of being accident prone were put in jobs where they were the least liable to hurt themselves or fellow workers and were cautioned periodically to be careful.

6. Gloves and hard hats were made available at the job site at cost. More about hard hats later. Safety shoes could be purchased and charged to our company and deducted a

bit at a time from pay check.

7. First-Aid Kits. After consultation with our company doctor and including only that which he deemed suitable, small first-aid packets were made available on the job to men who had small minor surface wounds that did not require a doctor's attention.

8. First-Aid Course. A multimedia first-aid course for all foremen and headers and gear shop mechanics was given. They were on the payroll for those eight hours, and the course was adapted to make it comprehensible to those who could not read. This adaptation involved reading aloud the work books. Try it sometime. I couldn't talk above a whisper for three days when it was over. This pleased my husband.

9. Hard Hats. We pushed hard hats for a year before OSHA made it mandatory on the waterfront. This was our big failure, and I thank OSHA for making this part of our program a success later. We could require our foremen to wear them even tho' they weren't enthusiastic about them, but there was no way to convince checkers and longshoremen that they were worth the bother. We got samples from several companies and let the headers choose the one they wanted, but still, getting them on their heads was another thing entirely. I heard all kinds of excuses from, "It gives me a headache," "It gets in the way," "It will fall off if I bend over," to "It'll mess up my hair" (and they say women are the vain sex). I had only one immediate convert—a header who just by chance had his hard hat on when a loose, swinging chain banged him right on top. He never went without his after that. Most of the time, I knew, the hats went on only when I was known to be in the vicinity. At the end of the first year I had one more convert; the header who had won the annual safety award was presented a white hard hat (the others were green) with an envelope inside. But I must confess, it was a very uphill struggle until OSHA gave the word it was law.

10. Forms. The bane of every active, outside man is forms, paperwork. We instituted two new forms.

One had to be kept by the header, and much to their credit they did cooperate, reluctantly at first, but their new awareness of the place of safety in their work day and the constant urging of our foremen did bring cooperation. This was a Hatch Check List. The headers fill these out for each hatch worked on each ship each shift. It serves two purposes: first, at the very beginning of each working day they are reminded of safety first, and second, it is a fairly comprehensive check of conditions before work begins. If an item cannot be checked, no work is to be done until the hazard is corrected. These come to me with the time sheets. At first quite a few of these were returned to the headers because they were incomplete or incorrectly done. When they learned they had to redo them I had no more problems.

The second form was what we call a Refusal Slip. Any man who is injured either goes to the doctor or signs a slip stating he has been offered a doctor's attention and does not choose to go. These slips give us a chance to evaluate the injury and insist on medical treatment if we deem it necessary, and it lets the man involved know that we are concerned with his welfare.

11. A Port Safety Association. In a port where you may at times use gangs that belong to another company, our company felt there was a great need for a port-wide safety program. In 1969, one meeting was held at which all stevedoring companies were asked to send a representative to try and form such an association. They came, but we could generate no enthusiasm and no association resulted. Again, I must thank OSHA for the prod that brought this part of our program into being.

As a result of OSHA, all of a sudden everyone got excited and concerned. "We'd better do something" was the prevalent attitude. A few local companies called the Department of Labor District Office and were told to talk to me, that I had a program going that they had been helping me with, and I could possibly help them.

So on July 21, 1971 the Port Safety Association of South Carolina was born. Our association is composed of representatives of both management and labor. The executive board is composed of three members from each. We are still in our infancy, just a little over a year old, but we have managed to accomplish a few things. We hope to accomplish more.

What have we done? First of all, we have engendered a cooperation between management and labor, on this issue at least. We have a common interest in safety.

As for accomplishments, they are as follows:

1. Hard Hats. our association arranged for the purchase and distribution of hard hats to all union members. Management paid for the initial hats, and the union agreed that if lost or misplaced the man himself must pay for replacement. The union also backed management to the extent that they agreed we were justified in telling a man "No hat, no work."

2. A film on lift truck safety was shown to all lift drivers and any other interested persons. This was shown at the union hall three times and at two of our terminals to make sure all lift drivers had the opportunity to see it. Cards were issued to all who attended, and it was agreed by the union that although this card was not a certification that the man was a qualified driver, no man could drive a lift without one.

3. Demonstrations by the local fire department as to the use of fire extinguishers were given at all terminals and at the union hall.

4. A meeting at which all headers as well as association members were present had as its program a film on the "Texas City Disaster," and the Coast Guard executive officer discussed how to control or behave in case of a major disaster in a port.

5. A program on CO poisoning was given to the association members and leaders.

6. Quarterly meetings were set up, to be held at the union hall with association members, headers and any others interested attending. Accidents on a port-wide basis are discussed and methods of preventing similar in future. Each company submits his accidents for the quarter, and one or two pertinent to all are picked for discussion.

7. A committee has been set up to investigate and submit suggestions for a long range, port-wide safety training program.

8. An awards committee is presently working on our first Annual Port-Wide Safety Awards which will be given this month.

All of these activities have brought a renewed awareness on the part of both labor and management of the need for a concerted cooperation in the field of safety. We will always have divergent attitudes about a certain subject but we can all agree that safety is a necessity, and work together from there.

In the past, management has been at fault because they haven't cared enough about safety. They tend to push production and forget safety. Labor has fallen down on the job, too, for the simple reason they have felt safety is all management's problem.

There should be a mandatory training program for all men on the waterfront. Some areas have this, but a lot don't. This is labor's responsibility as well as management's. Sure, management is responsible for safe working conditions, but labor should be responsible for providing trained and able men. Management and labor are both at fault for not seeing the other person's side, for not admitting the other right just out of pure obstinacy.

The Department of Labor, too, has not at all times lived up to its responsibilities. Our area does not have this problem, but from conversations with people in other areas I have found that there is little cooperation and no rapport between the Department of Labor and management. I guess we are blessed in our district. We have Department of Labor officials who are more concerned with safety than writing citations (not that they don't write them—I have some to prove it), who are willing to get information or direct you to people who can help you with your problems, and who are willing to go all out to assist you in any way possible to promote safety. What I am talking about is the nit-pickers, the compliance officers who are out to rack up the highest score of citations. There is no true safety feeling in a man who is looking to trick you or see all your faults and none of your virtues.

Last but not least, OSHA fails in one important respect for those of us who work state docks. Government agencies are exempt from these inspections and citations. It is difficult to provide safe working conditions in a situation where dock repairs and warehouse deficiencies are not your decision, and where bad pallets are the only ones available for use.

But if we all care enough, all this and more can be corrected.

Caring about and working for safety works, it gets results. In my company, when we started our concentrated effort three years ago we had, insurance wise, a 198 per cent debit. This year we have a 29 per cent credit. You can take that in terms of money, if you are mercenary, or in terms of lessened human suffering, if you are humanitarian. In either case, it is a plus.

SAFETY TRAINING VS SKILL TRAINING

By O. W. UHRHAN
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How do we promote safety in the stevedore or longshore industry and make it work? Consider how long we have had meetings of employer personnel and joint meetings of employer/employee personnel, how long we have put out directives, how long we have made speeches and posted posters and pleaded with each other to little avail. What now?

Before we try to answer that question let's step back and review what happens when an employee enters our industry. While reviewing I'm going to ask a lot of questions which I hope you will try to answer in your own minds. Is the newcomer indoctrinated into the intricacies of his new job? In nomenclature? (Truly, ours is a foreign language.) What about lines of authority? Relationships between stevedore, terminal, steamship company, trucker, railroad, or what have you? Do we even teach him how to build a load? How about safety? In some cases, perhaps. In many cases, I suspect somebody tells him how to get to the job, who he reports to, and maybe he is assigned to an old timer as a partner. Now "Newcomer" is at the mercy of "Old Timer." Old Timer may be a familiar type who says, "Let him learn the hard way. That's what I had to do." Or he may be truly interested in helping this young feller. If the latter is true, Newcomer learns all the good or all the bad habits of Old Timer. At best then, our new addition to the work force has one chance out of three to learn a safe and efficient way to work.

Let's assume the best, that this young man is getting his start in life, buying a home, raising a family, and is ambitious. He learns well from the willing old timer. Given so much seniority, so much time in the hold or what have you, he now aspires to the prestige and the monetary benefits of a skill; fork lift operator, winch driver, crane operator, etc. What do we do with him now? Teach him what makes this machine tick, what it can do, what it can't do, preoperational checks, post-operational checks? Do we let him practice in a non-production situation? Do we try to instill some respect for the equipment, some concern for the safety of others? Or does he just climb on and try it?

Let's further assume that our not-so-young man now has, in spite of the system, become a good, safe, and efficient operator. One day some company needs a boss and because of his work record, or personality, or connections, all of a sudden he is it. After 15 or 20 years kicking boxes and learning to operate machines, he no longer needs his acquired skills. Now he has to consider the complexity of the whole job and, most importantly, he has to handle people. Some of these people will be his old partners, who may be jealous of his job, some will be untrained newcomers. Tough as he may seem outwardly, his guts are probably ice water. He is bound to overreact and perhaps blow his stack. Tempers flare, production goes down, cargo and equipment are damaged and people hurt.

There is no question but that our progress in vessel and equipment technology and improved methods have outstripped our handling of people.

What should we or what can we do about this? What about some form of entry training as a prerequisite to union affiliation or employment? On the West Coast we have a 12-hour entry and safety training program, completion of which is jointly required. This is a step. However, it is in the classroom and, for the most part, is pure safety. Here again we attempt to sell safety without having time to tie it into the actual work process. I am afraid that to many new men on the front this turns out to be just so many words. Our unique language alone is enough to lose him, even if he really tries. We dearly love our old terms, particularly if they have local flavor. It allows us to confuse other people, and we like to do that. Hardly a way to make sure we get a point across. In waterfront terminology, how many people in the room know what a bull is? A pukka? If I asked you for a Hyster what would you give me? How about a Hi-lo or a jitney? A snapper-grabber? To the man off the street, even the words "'tween deck" are meaningless.

I recall one of my very early days on the waterfront. The boss yelled and told me to call the office and get a Ross Carrier. I didn't know what this was, but neither did I want to appear stupid. So I ordered it and then waited on the dock until it showed up.

I suggest that our industry owes itself a complete program of training from the start and throughout the successive steps during a man's working life. In this type of program safety and skills, safety and supervision, safety and production, etc., would not be separated but attacked as integrated problems. As an example, when a well trained operator climbs aboard a piece of equipment and checks the surrounding area, checks the fuel, the brake system, the limit switches, etc., would you call him a safe operator or an efficient operator whose production will bring home a buck? The chances are he is both. Why not teach it that way? In other words, let's tie safety to actual job situations.

We have reviewed what happens in most cases when a man enters our industry. Let's take a look at what might happen under our suggested program.

A prospective longshoreman would be required to successfully complete a five-day program, starting off with a classroom session covering but not limited to the following subjects; nomenclature, over-all safety, loss and damage prevention, relationships of various types of people and companies on the waterfront. Motivation would be primed by a description of his future training and promotion opportunities.

Classroom sessions would be followed by practical work on the front in such categories as building loads and palletizing, handling dunnage, slinging loads, rigging gear, opening and closing hatches, stowage, etc. Safe work practices would be emphasized along with efficiency and the need for production in work situations.

This man now reports for work with at least some knowledge of his new job, can better understand orders, can perform basic tasks without taking so much time of other people, and certainly should be able to work faster and more safely.

Some time later, if he has been motivated one way or another, he wants to operate a piece of equipment. At least by now he understands the lingo and something about the basic work process. So in training him to safely and efficiently handle a machine, we can concentrate on that machine.

Skill training should also start in the classroom away from noise and other distractions and where questions can be raised without feeling self-conscious. Models, mockups, and films are useful in outlining how this machine works. Safety as it applies to the particular piece of equipment is emphasized. Operating instructions should be available to each trainee, including both pre-and post-operational checks, capacities, what to do in case of trouble, etc.

The next step would be training on the equipment itself, but in a non-work situation with dummy cargo and simulated conditions, where production is not affected and chance of cargo damage or injury is minimized. Here the instructor demonstrates the safe and efficient way, then the trainee practices, with a chance for the instructor to correct mistakes. Questions can be answered on the spot.

When the man understands his machine and can operate it reasonably well, he moves on to a third phase, that is, in production, but under the guidance of the regular operator. This stage is necessary because no matter how well the trainee did on his off-the-job phase, some people just don't react well to the pressure of production with other people working near or under them.

The final phase is testing and certification. Testing, of course, must be unbiased and, hard as it may be, those incapable of safe efficient operation weeded out.

There are two most important ingredients in these skill training programs. First, both union and management must believe in the program and agree to joint cooperation completely apart from labor relations. Let's sit around the table to discuss safety and training, not across from each other. The second most important thing is the instructor. All planning, financing, lesson plan and manual preparation, development of training aids, etc. is for naught if you don't wind up with a good instructor.

With as many ports as widely dispersed as there are on the Pacific Coast, it would be utterly impractical to put permanent instructors on the payroll for each skill in each port. Hence, when a training program is scheduled to start in a given port, both the union and the various companies involved are consulted and asked for the names of the best operators for the particular skill in that port. The lists are matched, and men whose names appear on several lists are assumed to be good operators. They are then called in for interview. Assuming that he wouldn't be there if he was not well skilled, the questions are: Can he communicate so to pass his knowledge along? Does he have a feeling of responsibility so he can be placed in charge? Does he have the courage to fail the brother who can't hack it? Selection of the trainers is then made after what proves to be some very interesting sessions. Selection is followed by intensive indoctrination into the job of being an instructor and running a training program.

Since the inception of these programs, pools of instructors have been developed in the various ports. These men return to their regular work when a program is completed and are then on call for future programs.

The value of the foregoing method of training has been proven time and again where existing operators have been tested without training. On the average, of these people who were already operators, from 40 to 45 per cent failed. After training the same people, the failures fell to about two per cent.

One other point as regards skill training—physical examinations should be mandatory. A crane cab high in the air with a heavy load on the hook is no place for a man who is physically handicapped.

Once trained, tested, and certified our man should be issued a wallet card indicating his qualification. Then when he reports to the job, the boss will have no doubts.

A lot of interesting and unusual things happen in the course of these training programs. Try as you will, things are overlooked and things happen. One such thing with safety overtones occurred in an early fork lift truck training program. One lift had a spinner knob on the steering wheel. These things are considered unsafe, so it was taken off. Later, a trainee was driving beautifully but with one finger in the hole where the knob was. He hit a bump, the wheel spun and broke his finger.

These days the paper work often controls the speed of loading or discharge. Hence, we also need to develop programs for clerical help. They can be set up in the same format; that is, classroom, off-the-job in simulated situations and, finally, on-the-job. Safety is, naturally, still important. Who is in a more vulnerable situation than an inexperienced clerk wandering around a container yard?

Even a longshoreman who works casually as a clerk or transfers to that line of endeavor needs some training in a job which is new to him in spite of his waterfront exposure.

Let's go back to our man who finally acquired a skill and has worked in it for a period of years. He is now up for selection as a boss. He is experienced in handling methods, stowage, and machine operation. However, he is probably totally ignorant of the job of supervision. How does he relate now to his former fellow workers? Is he a leader, a pusher, a screamer?

Have we given our new boss a chance to learn a little bit about why one man is a good boss and another is not, even though he may have been tops in a skill? Have we given him some indoctrination in labor-management relations, something about contract administration, how to nip some beefs at the first step? Does he know whether he has a good beef or a bad one on his hands?

Does he need some information concerning the economics of our complex industry? On how much knowledge does he base his decisions on things which will affect costs or the eventual profit or loss on a particular ship?

First-aid training provided the forum for an experiment along these lines. The law required at least one man certified in first-aid on each vessel. The walking boss, ship boss, foreman, or whatever you call him was chosen. As long as first-aid training provided a captive audience, the program was expanded into a three day seminar where some of the things I have mentioned were discussed. A bonus was provided by the chance for the men to discuss mutual problems. For example, one boss said he always had problems with a certain man. Another said he used to too, and then told how he solved it.

By now you have undoubtedly come to the conclusion that I have outlined an ambitious training program and, probably more to the point, a very expensive one. You are right. However, as in any other situation, costs have to be matched to alternatives. I suggest that we need more than a sales pitch to effectively increase production and to reduce accidents and injuries. If we can increase production and reduce accidents and injuries, even by a relatively small percentage, these programs can more than pay for themselves.

No program is successful unless top management is deeply involved and supports it wholeheartedly. If it is going to cost money, believe me they will be involved. It is up to us, then, to convince top management that accidents and injuries don't help production, they hinder it, that accidents and injuries cost a lot of money, and that good programs can substantially increase production, reduce costs, and are worth it.

I am convinced that integrating safety into skill training programs will do more for us as an industry than all of our meetings, awards, directives, or what have you. Integrating to the point where we no longer speak of *production* on one hand and *safety* on the other, but think and act in terms of *safe productivity*.

MATCHING STEVEDORE EQUIPMENT WITH SAFETY REQUIREMENTS

By WILLIAM J. BROWN
Vice President, I.T.O. Corporation of Baltimore, Baltimore, Md.

I have lived through the period of the mechanized revolution on the waterfront, coming from Baltimore, Maryland, now referred to as "the Baltimore Era," the home of Bethlehem Steel's Sparrows Point plant, the largest waterborne steel facility in the world.

We consider our port as the largest steel port on the Atlantic coast. Handling the heavy steel cargoes requires us to think mechanization. We are aware that without constantly redesigning and upgrading our mechanical equipment, we cannot stay abreast of the advancing transportation systems being developed at the present time. Without up-to-date equipment, stevedores, terminal operations, and even ports cannot maintain the competitive position that exists in today's market.

Being associated with a company that has grown in stature by the equipment it controls, we are ever mindful that unless safety is built into such equipment we would not be long for this industry. We are either sold on the idea of building safety into equipment planning or are convinced that it will be built in by the manufacturer. Our industry represents control of millions of dollars worth of equipment, and has the financial power to sway any manufacturer to incorporate any safety feature that it requires.

I will discuss three phases of matching stevedoring equipment with safety requirements: Phase 1—the need; Phase 2—the order; Phase 3—the use.

First, let us talk about need. I have been in this industry since 1939, and I have seen and worked all types of cargo. When I first worked steel pipe, bars, and packages, we stowed them with bars and rollers. We used to move heavy lifts into the wings of the vessel by using snatch blocks and pulling wires. The progress made in unitizing—palletizing and packaging—along with the new ship design, has given the stevedore a challenge to keep up with the times and match this progress with his ability to move cargo using equipment that is designed for the job, designed to handle the challenge efficiently and safely.

Here is your need, to bring your material handling equipment up to date to match this revolution in the industry. But what about safety? Is there really a need or concern for safety in the material handling equipment?

The Williams-Steiger Occupational Safety and Health Act, better known as OSHA and often called other four-letter words, was enacted by Congress December 29th, 1970.

The Act itself grants the secretary of labor and all authorized inspectors working on his behalf to enter any terminal, board any vessel, or go through any gearroom for the purpose of inspecting working conditions and to determine compliance with the standards. The newest standards give the summary table on use of industrial trucks in various locations and the requirements for mechanically powered vehicles used aboard vessels. These are now the law. I say "the law" because willful or repeated violations of the standards can result in fines up to $10,000 for each offense. Failure to correct cited violations or the death of an employee caused by a willful violation could bring additional fines plus imprisonment up to six months. I'm sure there is not a man in the safety field who does not feel that he is knee deep in legal opinions concerning OSHA. It is not my purpose to render legal opinions, but to make you aware of the requirement to include OSHA in your need for mechanical equipment.

Let us now incorporate the need with the order. In placing an order for a piece of mechanized equipment, most of the time you are talking of a sizeable outlay of capital. You should consider the needs of the other areas that can also be satisfied by utilizing this equipment. You should consider the attachments or modifications that can be put on the equipment that will make it more useful in your overall operation. Planning the need and placing the order for any piece of equipment should require a lot of time and thought.

But what about safety? OSHA Section 1910-178 (a) (2) says, "All new powered industrial trucks acquired and used by an employer after February 15th, 1972, shall meet the design and construction requirements for powered industrial trucks established in Part II ANSI B 561-1969."

Does this mean we are able to place the responsibility for compliance on the manufacturer? Does the law require that the manufacturer of the equipment certify that the equipment complies with the standards? The answer is *no*. The employer is responsible for compliance. It is your responsibility to be sure the equipment in use meets the applicable standards, regardless of who made it originally. The manufacturers will certify by name plate that the equipment will comply with ANSI B561-1969 specificiations, but they are not required to certify that it meets with OSHA standards.

To follow a single order, we must consider one specific piece of equipment. I have chosen the fork-lift truck, or Hi-Lo as it is sometimes called. Remember now, the order must contain all the requirements to satisfy the need. The order department must know the complete story of the equipment that is being ordered. The user must take the responsibility to see that all the requirements are made known, so when the equipment is finally delivered it is the machine required to do the job efficiently and safely.

What are a few of the facts that should be considered in ordering fork-lifts? We at I.T.O. have fork-lifts that range from a 3,000 pound capacity to one big container lift that is capable of lifting 70,000 pounds. So you see, you just don't order a fork-lift. You must consider the need. What will it lift? How much will the lift weigh? How big is the lift? Where will it work? What type of surface will it work on? Will the area support solid tires or does it require pneumatic tires? Are there any grades in this area? Are there any problems that could disrupt a smooth, safe operation?

After considering all the immediate requirements, you should project your future needs. Will the equipment being ordered be obsolete when it is delivered? Will it last the full projected period for depreciation? If not, why not? I.T.O. ordered three 15-ton machines for vessel operation at Bethlehem Steel. The primary purpose was to stow 12-ton coils of steel that were being shipped to the West Coast. Within one year after the machines arrived, the weight of the coils had reached 18 tons. If it had not been for proper planning, we would have three machines on our hands.

Finally, before placing your order, you should consult with the man on the job, the man who is going to use the equipment. Most of the time, this guy can shed light on the pertinent questions. He is aware of the pitfalls. But most of all, consulting the people who are going to use the equipment is the first step in driver education.

If you are the person in the position of placing the order, you could now be at that stage. If you must go to another department, you are now prepared to answer all the questions they will ask.

After the order is placed, you just don't sit back and wait for delivery. You must realize that you, as employers, have just put your OSHA responsibility on the line. You don't have accidents by placing an order. The possibility of the accident starts when the equipment arrives. Your job during this period is to prepare to use the built-in safety that we planned for in the *need* and the *order*. Remember, all manufacturers were guided by the ANSI code. It covers all elements of powered industrial truck design, and it is intended to promote safety in that design as well as in the construction, application, and operation.

But, back to safety! To supply a safe truck is not enough. In an excerpt from Prentice-Hall *Personnel-Management-Labor Relations* I read: "'Employers must do more than provide safe equipment for their employees,' said the OSHA Review Commission. 'They must be sure that it is being used properly in order to comply with the job safety and health laws. On special equipment, this means operators must be trained and qualified.'"

First, this means the operator must be authorized to drive.

Second, it means that he must thoroughly understand the safety techniques—basic education in safe driving and load handling techniques are absolutely necessary to prepare the operators for proper defensive driving habits and enable them to anticipate the unexpected.

How does the employer go about setting up an operator training program? This should have started in phases 1 and 2. Most of the major industrial truck manufacturers have developed training programs and will make them available through their dealers. Most of the programs for fork-lifts cover basic principles, operations, load handling, stacking, travelling, safety rules, and operational maintenance. Most dealers will train your personnel while you are waiting for your equipment to be delivered.

When the new equipment does arrive, you should have qualified drivers to operate this equipment. In an industry as large as ours, where we need many qualified operators, it is a sizeable cost to train people. The question so often asked is: Who pays for this training period? What will it cost? My answer is, it won't cost as much as one accident. But who should pay? The company will get the benefit of the knowledge after the man is trained. The company will get the savings from an accident-free operation. The company has all to gain.

How about the man? Everybody gains when you gain knowledge. The man gains in a safe job. It is like an insurance policy on himself. How about your ports? The industry as a whole stands to gain through efficient handling of cargo without disabling injuries or accidents.

Everybody gets his share of the goodies. It's a joint effort and responsibility. We must all do our part to insure safe operating people are made available for this mechanized revolution. In Baltimore we are aware that unless we have properly trained equipment operators, we will not be able to keep our port competitive. We are negotiating with the I.L.A.-S.S.T.A. to establish a workable solution to give us a training facility to properly train for all jobs in this industry.

Material handling equipment is the backbone of the maritime industry. If we know what we need, order it properly, and use it safely, we will survive. But we must start thinking safety from the first need. We must build in safety through the drawing boards. We must train and educate safety into our people, and when we put this combination together in one operation, it will spell success for the employer.

ADDRESS

By RADM ALBERT A. HECKMAN

Masters and pilots alike once again demonstrated their professional competency in a season marked by few incidents. This, of course, comes as no surprise to those who know that the Great Lakes fleets have continually set world safety records and, I might add, have done so while operating in some of the world's most restrictive rivers and channels and, in some cases, operating vessels which were launched early in the century.

This admirable record was marred by the unfortunate collision in the St. Clair River in late spring, which resulted in the sinking of the *Sidney E. Smith*. However, n the tedious months that followed, in which the fuel oil aboard the *Smith* was removed by the Coast Guard, and the hulk salvaged by the Corps of Engineers, masters and pilots had ample opportunity to prove again that they are among the most skilled in the world.

They also demonstrated, together with their companies, the spirit of cooperation between the federal government and the marine industry characteristic of the Great Lakes.

When the Coast Guard determined that emergency traffic control measures would be necessary for the duration of the salvage operations, masters and pilots cooperated fully, and with few complaints, in the one-way traffic system which the Coast Guard's captain of the port in Detroit had devised. In the rare instances where an informal complaint was registered concerning a delay or similar problem, the comments were always extended in a constructive vein, thus enabling the Coast Guard to improve service during that difficult period. It is noteworthy that of the thousands of vessels, foreign and domestic, which transitted the Detroit and St. Clair rivers during these months of restricted operations, in a river system already constricted and difficult, there occurred only one collision. Not only did these thousands of ships transit the rivers safely, but generally with very little unnecessary delay as well.

Among the vessels which safely made the difficult passage of the Detroit, St. Clair, and the St. Mary's rivers were the one thousand-foot *Stewart J. Cort*, the eight hundred fifty-eight-foot *Roger Blough*, and the eight hundred and six-foot *Charles M. Beeghly*, all nearing the end of a first and safe operating season.

Events of the summer, especially the sinking of the *Smith*, are making their impact felt upon the coming winter navigation season. While there were few unnecessary delays due to the *Smith*, there were times when vessels had to wait at anchor, even overnight, to transit the rivers. For this and other reasons, stockpiling of ore, limestone, and other commodities has not reached its normal level for this time of the year. Consequently, at a meeting of fleet operators, the Coast Guard, and other interested agencies in Cleveland last month, most fleet operators expressed their intention to operate more vessels later into the season than ever before.

In regard to late season operations, you may recall, this winter marks the second year of the three year demonstration program for the extension of the navigation season as authorized by Congress. You may also know that the polar icebreaker *Edisto*, which operated effectively last season, thus greatly increasing the efficiency and coverage of our domestic icebreaking program, lost the use of her rudder and one propeller to the Arctic ice while on deployment near Greenland. It is hoped that *Edisto* will be fully repaired and back in the Lakes prior to the 15 December closing of the Welland Canal.

Come what may, the Ninth Coast Guard District is prepared to again shoulder the demands placed on our cutters with icebreaking capabilities. Last season the cutter *Raritan*, now homeported in Grand Haven, Michigan, successfully tested a wetted hull system designed to reduce the friction in ice. This year the buoy tender, *Sundew*, for many years one of our key icebreaking vessels, will also sport a newly designed wetted hull system, which should make her of even greater value in assisting the *Edisto* and *Mackinaw* in the Straits of Mackinac/St. Mary's River area.

One of the major problems to be overcome if we are to work toward a possible year round navigation in the Lakes is, of course, the hazard to safety posec by operation in the ice environment. Indeed, much of our marine safety program at the present time revolves about the problem of safe operation in winter.

Under the heading "Accident Prevention," the Coast Guard will again this winter study new equipments to supplement those conventional aids to navigation which are not closed down or removed during the winter months. These devices will again include an array of newly designed ice buoys of various sizes and designs, ranging in size from five feet in diameter to 16 feet in diameter.

Also scheduled for testing in the St. Mary's River is a range system using the laser beam. The beam will be eight inches in diameter at its point of origin on Neebish Island. It will shine down the center of the five mile channel to Nine Mile Point, and should appear as a blue-green beam overhead. Ships will be able to ride under the beam like a trolley car rides under an electric wire, thereby transiting that stretch of river in safety, using a minimal number of conventional aids.

The buoy tender *Acacia* will again test Loran C, which has shown great promise as an electronic position fixing system, particularly in view of the electronics industry's present capability of manufacturing receiving sets well within the economic limits of fleet operators. At present, Loran C has proven itself capable of determining a ship's position within narrow limits where coverage exists, even in conditions of zero visibility and without the assistance of visual aids. As a matter of interest, the Coast Guard has recently awarded close to one half million dollars in development contracts for a rivers and harbors navigation system which would provide pinpoint electronic position fixing and keeping in restricted waters.

The Coast Guard's Ice Navigation Center in Cleveland will operate with increased efficiency this year thanks to the presence of a full time weather and ice forecasting representative of the National Oceanographic and Atmospheric Administration at the Center.

All of these steps, in conjunction with similar projects to be undertaken by the Maritime Administration, Corps of Engineers, and others, are expected to solve many hazards to safety inherent in winter navigation.

The Coast Guard has the responsibility for determining the numbers and types of lifesaving gear that is carried aboard commercial vessels. With our statutory mandate to promote marine safety, we are engaged in a systematic review and study of the overall lifesaving equipment spectrum. In conjunction with the extended season demonstration, we on the Lakes are working on the cold weather aspects of our overall program.

Our efforts are being directed toward improving the reliability of conventional life rafts, davits, and boats in the winter environment. Conventional life rafts, we have found, may take as long as thirty minutes to fully inflate in sub-freezing temperatures. Davits, as well as life vest lockers and other equipment, become ice-encrusted, virtually inoperative and, consequently, useless.

During the coming months the Coast Guard will work with United States Steel in testing a large number of conventional life rafts now in use by their fleet. At the same time we will be testing a wide range of inflatants, including air aspirators, compressed air, CO_2, nitrogen, and cool gas generators to determine the best and most practical alternatives to the inflation problem.

This summer the Coast Guard and industry tested various types of rescue boats aboard the *S.S. Pontiac* and *S.S. Medusa Challenger*. While final evaluation is pending, the tests appear to have yielded important data. We expect them to continue tests in the near future that include testing of davit launched life rafts and a davit launched Brucker capsule, a type of enclosed life boat which would protect crewmen from the elements. The

Coast Guard recently let a contract with the Battelle Institute of Columbus, Ohio for the testing and evaluation of various types of exposure suits which may be of value in emergency situations.

Other tests yet pending will include the use of a modified aircraft evacuation slide and the use of various anti-ice encrustment devices such as vibrators, stored energy raft deployment systems, and inflatable storage housings.

In essence, the Coast Guard is committed to the principle that if we are to have an extended navigation season, it must have safety factors included to complement the outstanding record of safety enjoyed during the normal shipping season.

While continuing to strive for a high level of excellence in the performance of our traditional port safety and marine inspection duties, the Ninth Coast Guard District is committed additionally to the overall development of those aids to navigation, life saving devices, and improved icebreaking techniques which will assure continuity of safe navigation in the winter environment.

I trust that you join with me in aspiring to this goal.

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Great Lakes Area Safety Committee—EUGENE T. GILMORE (Chairman), Columbia Transportation Division, Oglebay Norton Company, Cleveland, Ohio; PETER J. COLLINS (Vice Chairman), The Cleveland-Cliffs Iron Company, Cleveland, Ohio

East Gulf Safety Committee—JAMES R. O'DONNELL (Chairman), Maritime Safety Consultant, New Orleans, La.

West Gulf Safety Committee—RICHARD WILLOCH (Chairman), Marine Manager, Texaco, Inc., Port Arthur, Tex.

Inland Waterways Area Safety Committee—S. H. STRASSNER (Chairman), Safety Director, National Marine Services, Inc., Hartford, Ill.; ROBERT H. HERTZBERG (Vice Chairman), Marine Superintendent, Cargo Carriers, Inc., Minneapolis, Minnesota

Pacific Area Safety Committee—VERN NEWTON (Chairman), Asst. Coast Director, Accident Prevention, Pacific Maritime Association, San Francisco, Calif.

Alaska Safety Committee—ROBERT EMMERT GRAY (Chairman), Vice President, Southeast Stevedoring Corp., Ketchikan, Alaska

Staff Representative—F. J. PARKER, National Safety Council, 425 N. Michigan Ave., Chicago, Ill. 60611

National Safety Council

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Respectfully,

Robert J. Marecek

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