Proceedings
of the Marine Safety Council

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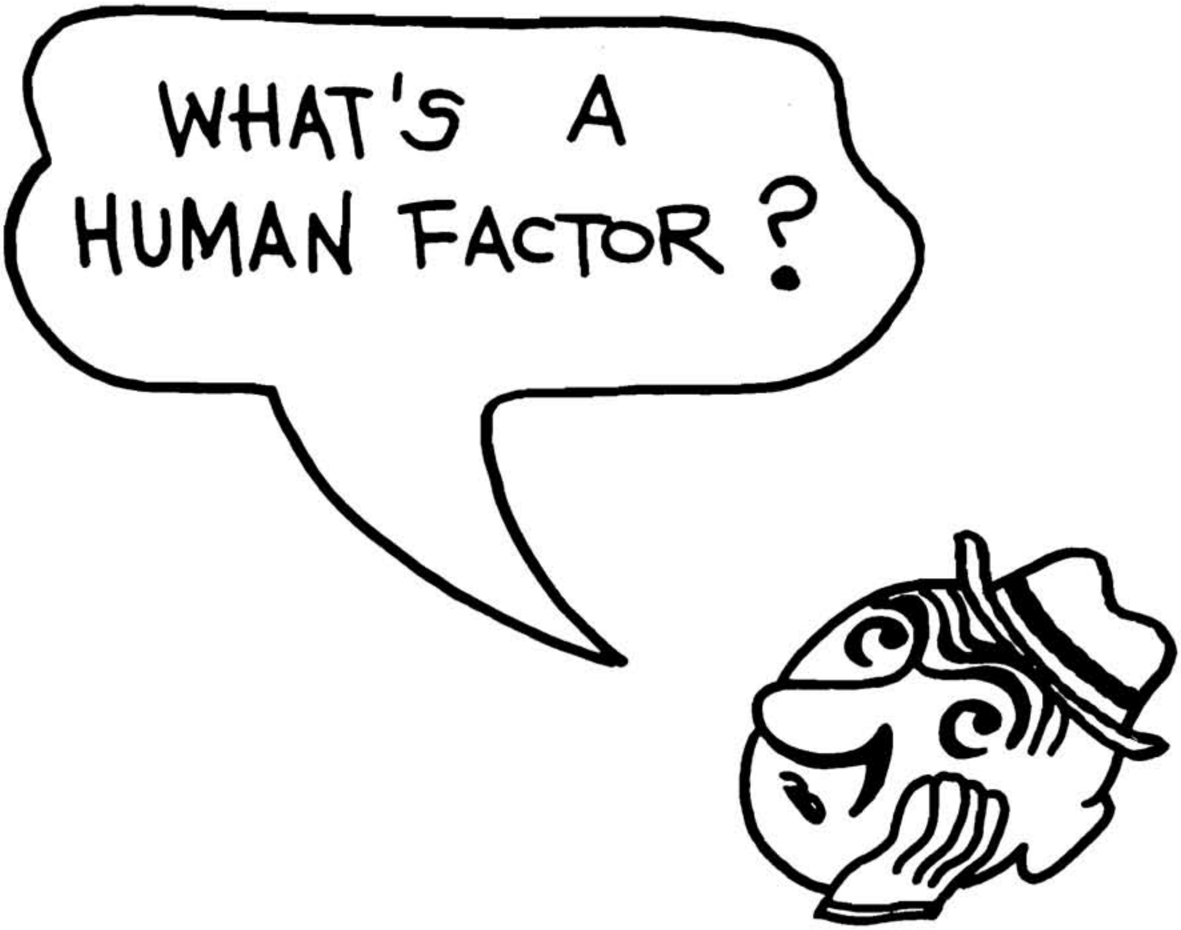

Proceedings

of the Marine Safety Council

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When you have finished reading this issue, please pass it on.

Contents

features

departments

cover

"Human factors" is a broad subject area which covers everything from the role of human error in casualties to the need to design ships and their equipment with the human operator in mind. This month's Proceedings *features four articles on the subject, beginning with "Shipboard Fire: No Time for a Coffee Break" on page 105.*

Letters to the Editor

After reading "Close Encounters of a Dangerous Kind" in the September/October 1981 issue, I feel compelled to offer my opinion. As a Tug Boat Captain in Port Everglades, Florida, I had to accept the fact that "close encounters" are a routine part of my job.

I don't believe that recreational boaters are intent on injuring or killing themselves or their families, nor do I believe that they have a vendetta against ships and tugs. Often after a dangerous incident has just occurred, they placidly sail away, completely unaware of the danger they have placed themselves in and the destruction they came very close to causing.

In the process of docking or undocking a ship, a tug must shift sides and reposition while the vessel is moving, and there are numerous variables involved. The tug should not be required to play Dodge 'em Boats with small recreational craft in that process. Maneuverability is often limited, and the tug and the vessel working together are extremely dependent on each other. A small recreational boat often limits maneuvering space even further and increases response time while the tug has to go around him to avoid him. The boater not only endangers himself but also the vessel, which in many cases contains volatile cargo, a potential catastrophe.

To help avoid these situations, more stringent requirements should be initiated to ensure that any boat operator, whether under power or sail, knows the Rules of the Road. What good are day signals, towing lights, etc., if only the maritime industry people know these rules? If we were the only ones sharing the waterways and oceans that would be fine.

Consider what it would be like if only a portion of the drivers on our highways had licenses or only a portion of airplane pilots had licenses. Gives a person something to think about, doesn't it?

Captain Richard Decker
Stuart, Florida

Every boating accident and even your excellent article "Close Encounters of a Dangerous Kind" in the September 1981 issue brings out a demand for licensing pleasure boaters. An alternative is to require that pleasure boaters have a Pleasure Boat Safety Manual aboard, approved or sold by the U.S. Coast Guard. When I sailed in Europe, I found this to be very practical. Bored crewmembers and especially kids loved to browse through the very colorful waterproof manual. Skippers would settle their arguments or enforce their threats by yelling "look at page so-and-so." Unfortunately the government and the U.S. Coast Guard have contributed to ignoring boating regulations by publishing laws, regulations, and brochures that cannot be understood by 12-year-old kids or 99 percent of the pleasure boaters. Knowing, however, that the government has the habit of publishing navigation and piloting handbooks containing enormous amounts of noncritical information that cannot be reread when [one is] entering an ominous nautical situation and formatting the books so large that they do not fit on most bookshelves of pleasure yachts, [I feel] the results may be nullified. The manual would have to be approved by most boating organizations and be of pocket size to get some assurance of quality and benefit to the pleasure boaters and mariners.

Henry Bernaerts
Annapolis, Maryland

Maritime Sidelights

Coast Guardsman Honored by Rescue Association

Seaman John C. D'Ornellas of the U.S. Coast Guard has been awarded the Association for Rescue at Sea's Gold Medal for rescue at sea. The award was presented by the association's president, VADM D. D. Engen, USN (Ret.), at ceremonies held at the Russell Senate Office Building in Washington, DC, on February 4.

D'Ornellas was a crewman on board a Coast Guard 44-foot motor lifeboat stationed at Winchester Bay, Oregon, when it went to the rescue of the fishing vessel GAIL off the Umpqua River Bar November 21, 1980. Because of 15- to 20-foot breaking seas on the bar, the fishing boat began to

The award to Seaman D'Ornellas (center) was presented by VADM Engen (left). Looking on is ADM J. B. Hayes, Commandant of the Coast Guard. Photo by PA3 Peter Grossetti

take on water before the lifeboat could escort it back to port. When the lone person on board the stricken vessel radioed that he had lost his autopilot, D'Ornellas volunteered to go on board to secure an open hatch and help steer. After several attempts to reach the fishing boat, D'Ornellas was able to leap from the 44-footer to Gail's afterdeck.

Even though the hatch was secured once, it broke free again, and the GAIL began to take on more water. Pumps were lowered from a helicopter, but they were quickly washed overboard. Then waves began breaking through the wheelhouse windows, and the inrush of water shorted out the radio. D'Ornellas knew that the fishing boat couldn't last much longer and persuaded the fisherman to abandon his boat and swim for the motor lifeboat that was standing a short distance away. The two men were retrieved by the lifeboat moments later.

D'Ornellas is the second person to be presented with the Gold Medal by the association, which was formed in 1976 to promote rescue at sea.

NFPA Now Accepting Proposals

The National Fire Protection Association (NFPA) is accepting proposals for changes in NFPA 306, the Control of Gas Hazards on Vessels. A report on the changes will be delivered by the NFPA's Technical Committee at the association's 1983 fall meeting.

Proposals will be accepted until July 23. They must be submitted on a required form, which may be obtained by contacting Charles L. Keller, Marine Field Service Specialist, NFPA, Batterymarch Park, Quincy, MA 02269.

MariChem 82 to be Held in Amsterdam

Key issues affecting chemical shipping and distribution will be discussed at the MariChem 82 Conference in Amsterdam June 22 - 24. The areas of concern to shipowners and port operators are reflected in the subjects of the conference sessions:

- Legislation and regulation
- The inert gas issue
- Operations
- Environmental protection
- Technical developments

The conference is the fourth in the series and follows the 1980 meeting in London. Full details of the program of speakers, exhibition participants, and technical tours can be obtained from the MariChem Secretariat at 2 Station Road, Rickmansworth, Herts WD3 1QP, England; tel.: Rickmansworth (09237) 76363, telex: 924312.

Hazardous Cargo Carriers Sought

Under contract with the Coast Guard, Goodyear Aerospace Corporation conducted a study to determine the feasibility of developing and using portable containers to offload hazardous chemicals at sea.

Floating, flexible, rubberized fabric containers are currently used for storing and transporting oil recovered from damaged oil tankers and barges. This same type of container would be useful in responding to hazardous chemical spills.

The ideal situation would be to have a common container for both oil and chemicals. However, many chemicals are heavier than water and can damage the existing flexible oil containers. For these reasons, less than half of the chemicals identified in the Coast Guard List of Hazardous Chemicals can be carried in existing flexible containers.

Goodyear Aerospace, which investigated different fabrics and construction techniques, came to the preliminary conclusion that a container could be built to carry 90 percent of the listed hazardous chemicals. Copies of the report, "Hazardous Chemical Container Feasibility/ Concept Design Study," can be obtained by requesting Report No. CG-D-05-82 from Commandant (G-DMT-4), U.S. Coast Guard, Washington, DC 20593.

New System Measures Pollution

The Coast Guard's Office of Research and Development has just released a report on the capabilities of an experimental system to monitor marine pollution. Measurements made by the system may be used to identify oil and other hazardous chemicals in the ocean or waterways.

The system consists of an underwater sensing device or "fluorometer," a shipboard controlling and monitoring unit, and a tow line and electrical cable connecting the two. In operation, the fluorometer is towed through the water, sampling the water for the presence of certain hazardous chemicals and transmitting this information to the shipboard unit. The system measures six different characteristics simultaneously.

The system has had an initial at-sea tryout on board the USCGC EVERGREEN. During this test, the basic design was evaluated, but no attempt was made to determine the sensitivity or accuracy of the system.

The report describes the construction, calibration, and operating procedures of the system. Copies of "Hazardous Chemical Fluorometer Development" can be obtained from Commandant (G-DMT-4), U.S. Coast Guard, Washington, DC 20593.

Underwater Inspections Studied

A recently completed study by the Office of Research and Development examined the feasibility of inspecting and even repairing vessels while they remain afloat.

For merchant vessels that require certification by the Coast Guard, a thorough inspection is generally performed every two years. Traditionally, the inspection has required drydocking, which can tie up the vessel, shipyard facilities, and Coast Guard inspectors for a considerable time.

The project's final report concluded that trained people using the latest in underwater inspection equipment could perform an inspection with the ship or structure still afloat. In the report, whose findings also have application to offshore drilling rigs, underwater pipelines, and other partially or fully submerged structures, known underwater inspection problems are presented along with means to overcome them. Most of the major underwater repair techniques are discussed. Illustrations and data on the products available to perform underwater inspections are also included.

Copies of the report, "Drydock Extension: A 1980 Underwater Technology Survey for Extension of Time Between Drydockings," can be obtained from the National Technical Information Service, Springfield, Virginia 22161, by specifying Report No. CG-D-15-81, Accession No. AD-A101131. ⚓

Keynotes

The following items of general interest were published between January 22, 1982, and February 22, 1982:

Final rules: CGD 82-003 Drawbridge Operation Regulations; Sioux City, Iowa, Revocation, January 25, 1982. CGD 3-81-1A Anchorage Grounds, Port of New York and Vicinity, January 25, 1982. CGD 12-81-100 Drawbridge Operation Regulations; Dutchman Slough and Sacramento River, California, January 28, 1982. CGD 81-054 Drawbridge Operation Regulations; Saginaw River, Michigan, January 28, 1982. CGD 80-106 Drawbridge Operation Regulations; Taylor Creek, Florida, February 1, 1982. CGD 5-81-11R Drawbridge Operation Regulations: North Landing (AIWW), Virginia, February 1, 1982. CGD 81-025 Drawbridge Operation Regulations; Kennebec River, Maine, February 1, 1982. CGD 1-80-9R Establishment of Special Anchorage Areas in Boston Inner Harbor, Boston, Massachusetts, February 11, 1982. CGD 5-80-22R Drawbridge Operation Regulations, Strong Creek, Maryland, February 22, 1982. CGD 17-81-03R2 Safety Zone, Gastineau Channel, Alaska, February 22, 1982. CGD 81-008 Annex I to Inland Navigation Rules, Correction, February 22, 1982. CGD 81-006 Annex II to Inland Navigation Rules, Correction, February 22, 1982. CGD 81-009 Annex III to Inland Navigation Rules, Correction, February 22, 1982.

Interim final rule: CGD 81-087 Disestablishing of COLREGS Demarcation Lines for Puget Sound and Adjacent Waters of Northwest Washington, Correction, January 25, 1982.

Notices of proposed rulemaking (NPRMs): CGD 81-107 Drawbridge Operation Regulations; Snohomish River, Steamboat Slough, and Ebey Slough, January 28, 1982. CGD 7-82-01 Drawbridge Operation Regulations, Garrison Channel, Florida, January 28, 1982. CGD 81-099 Drawbridge Operation Regulations; Corte Madera Creek, California, February 8, 1982. CGD 11-80-08 Anchorage Grounds, Los Angeles and Long Beach Harbors, California, February 8, 1982. CGD 79-173 Temporary Licenses and Endorsements, Withdrawal of Proposed Rule, February 11, 1982. CGD 5-81-16R Anchorage Regulations, Northwest Harbor, Baltimore, Maryland, February 18, 1982.

Notices: CGD 82-008 Security and Safety Zones; Notice of Temporary Zones Issued, February 1, 1982. CGD 82-007 Memorandum of Understanding, Coast Guard and Environmental Protection Agency, February 1, 1982. CGD 82-011 Notice of Qualification of SIBO, Kentucky, Incorporated, as Citizen of the United States, February 4, 1982. CGD 82-009 IALA Maritime Buoyage System, Notice of Meeting, February 8, 1982. CGD 82-014 Towing Safety Advisory Committee, Notice of Meeting 10 - 11 March 1982, February 18, 1982.

Questions concerning regulatory dockets should be directed to the Marine Safety Council (G-CMC), U.S. Coast Guard, Washington, DC 20593; (202) 426-1477.

* * *

Obsolete Load Line Regulations Revoked
CGD 80-120

In the early days of the shipping trade, ship owners would sometimes attempt to maximize their profits by dangerously overloading their ships. This would cause the ship to ride lower in the water, making it less stable in heavy seas and causing many casualties.

In the 19th Century the English required ships to inscribe marks on their sides to show the limit to which the ship could be safely loaded for different seas and seasons. Around 1930, the U.S. began adopting load line standards, the regulations for which were contained in Title 46 of the Code of Federal Regulations, Part 43 (46 CFR 43). In July 1968, a worldwide load line convention went into effect, superseding older conventions. The intent was to bring load line regulations up to date with modern ship construction developments and techniques. In some cases deeper loading of ships can now be safely permitted. The regulations promulgated from this convention appear in 46 CFR 42. The Part 43 load line regulations were retained at the time for vessels whose keels were laid before July 1, 1968. Since all vessels whose keels were laid after that date must comply with the Part 42 regulations and since Congress in 1973 repealed the statute authorizing the Part 43 regulations, the older regulations became obsolete. On February 1, 1982, the Coast Guard published a final rule revoking the Part 43 load line regulations and making authority citation corrections and editorial changes related to this revocation. A vessel whose keel was laid before July 1, 1968, may retain its original Part 43 load line, as long as the vessel is not significantly altered or has not been assigned a reduced freeboard (which would affect its original load line assignment).

Freeboard Assignment Revisions Proposed
CGD 79-153

The Coast Guard is proposing to amend the load line regulations by revising the subpart concerning the assignment of freeboards. This revision is based on Inter-Governmental Maritime Consultative Organization (IMCO) resolution A.320(IX), which is considered equivalent to Resolution 27 of the International Load Line Convention, 1966. The proposed regulations would simplify the assignment of freeboards by clarifying the language and improving the format of the existing requirements. This would not create any substantive changes to the existing regulations but would help make them clearer and easier to use.

The NPRM concerning freeboards was published February 4, 1982. A correction document to the NPRM was published February 18, 1982, since an appendix to the regulations was inadvertently omitted from the original document. For further information on this proposal, contact Mr. William Cleary, U.S. Coast Guard (G-MMT-5/12), Washington, DC 20593.

Final Rule Issued for Electronic Position Fixing Devices CGD 81-081

As of June 1, 1980, all vessels 10,000 gross tons or more were required to carry electronic position fixing devices. Vessels 1,600 to 10,000 gross tons will be required to carry this equipment on June 1, 1982. Under current requirements, acceptable electronic position fixing devices include Loran-C Type I or II receivers and hybrid satellite navigation receivers which contain an integrated continual tracking complementary system. Examples of hybrid systems are satellite-OMEGA, satellite-Loran-C, and satellite-doppler systems. The complementary tracking systems were required because it was felt that, with conditions of significant set and drift (tidal current effects on a ship), an error in position reading could occur between usable satellite passes.

The Coast Guard, however, assuming that a prudent mariner would not rely on any one position source, would consider accepting the use of "stand-alone" satellite navigation receivers. Grounding statistics for vessels with "stand-alone" satellite navigation receivers were reviewed and showed no groundings occurring on vessels with "stand-alone" systems. As a result of this finding and the Coast Guard's desire to make further studies, the requirement for complementary tracking systems has been delayed. Vessels having a satellite navigation receiver installed before June 1, 1984, need not install a complementary tracking system until June 1, 1987. Vessels having a satellite navigation receiver installed on or after June 1, 1984, must have a complementary system installed concurrently. After the additional review of groundings and satellite navigation systems is conducted, a notice will be issued proposing the elimination of the requirement for complementary tracking systems, if feasible.

The final rule delaying the dates for required complementary tracking systems was published February 11, 1982. For further information, contact Mr. Tom Falvey, U.S. Coast Guard (G-WWM-2), Washington, DC 20593.

Great Lakes Pilotage Rates Revisions Proposed CGD 81-088

The Coast Guard has completed a review of revenues collected and expenses incurred by three Great Lakes pilot organizations during 1981. The review indicated that revenues received by pilot organizations need to be increased to cover increased operating costs. While traffic has decreased, the costs of providing pilotage services have not, because many of the pilot association costs are fixed costs.

This proposed rule would increase the basic pilotage rates by 9 percent in the U.S. Great Lakes pilotage system and eliminate the smallest category in the "range of pilotage units" table. Pilotage units are determined by a formula taking into account length, breadth, and depth of a ship. Ranges of pilotage units are assigned a certain weighting factor, which, when multiplied by the basic pilotage rate, determines the rate a vessel pays for pilotage service. If the lowest range of pilotage units (0 - 99 pilotage units, weighting factor .85) is eliminated and that range combined with the next lowest range (100 - 129 units, weighting factor 1.00), pilot revenues will increase by an additional 1.5 percent.

The proposal would also allow temporarily registered pilots to hold stock and other financial interests in pilot organizations. The primary purpose of this provision is to allow pilots over the age of 70, who would otherwise have to retire because of age, to assist pilot organizations by sharing the benefits of their experience and possible managerial capabilities.

The NPRM was published on February 11, 1982. For further information, contact Mr. John J. Hartke, U.S. Coast Guard (G-MVP-4/14), Washington, DC 20593.

Effective Date for New Inland Rules Announced for Great Lakes CGD 82-012

The new unified navigation rules went into effect on December 24, 1981, in all areas of the U.S. except the Great Lakes. The effective date for the Great Lakes was delayed to accommodate Canadian legislation paralleling the new U.S. inland rules so that both sets of rules would become effective at the same time. At the recommendation of the Canadian government, the rules will become effective on July 1, 1982.

The notice establishing the effective date was published February 8, 1982. For further information, contact CAPT James Montonye, U.S. Coast Guard (G-NSR-3), Washington, DC 20593.

* * *

Actions of the Marine Safety Council

January Meeting

CGD 77-084 Licensing of Pilots (Supplemental NPRM)

As a result of the Port and Tanker Safety Act of 1978, an NPRM was published in the Federal Register on November 28, 1980, containing changes to the pilot licensing regulations. The resulting comments, both written and those received during the various public hearings, indicated a need to make substantive changes to the NPRM. The supplemental notice proposal includes the following modifications:

1. The number of round trips required for license renewal will be determined at the local OCMI level.

2. Tonnage limitations are deleted.

3. Refamiliarization trips will fulfill recency of service requirements.

4. Simulator training requirements are deleted.

5. Physical examination reporting requirements are amended.

The Council voted to forward the supplemental NPRM to the Commandant with a recommendation for approval.

The Council approved the following work plans:

CGD 78-151 Inland Waterway Navigation Regulations

This project would revise and update the navigation regulations for the connecting waters from Lake Huron to Lake Erie, including the Rouge River. An NPRM should be published this spring.

CGD 81-101 Implementation of Annex II of the International Convention for the Prevention of Pollution from Ships, 1973

On October 21, 1980, the Act to Prevent Pollution from Ships was signed into law. This act authorized development of regulations to implement Annex II. An advance notice of proposed rulemaking (ANPRM) is scheduled to be published in December 1982.

CGD 81-103 Fairways off the Southern Coast of Alaska

The Port Access Route study required by the Ports and Waterways Safety Act indicated a need for shipping safety fairways at the approach to Prince William Sound and through Unimak Pass. An NPRM will be submitted in June.

February Meeting

The Council approved the following work plans:

CGD 82-001 Numbering Fees

There is a need to eliminate the present inequity between numbering fees for undocumented vessels in states that administer their own numbering system and those in states in which the Coast Guard administers the system. This project would increase the fees for those states under Coast Guard administration. An NPRM should be published in June.

CGD 82-002 Suspension and Revocation Proceedings

The last major revision of 46 CFR 5 was completed in 1962. Another revision is now necessary to incorprate new policies, correct inaccuracies, and make changes dictated by legislative actions which are not currently reflected in the regulations. An NPRM will be published in June.

CGD 82-004 Offshore Supply Vessel Regulations

The Small Vessel Inspection and Manning Act (Public Law 96-378) requires, among other things, that Offshore Supply Vessels comply with Coast Guard inspection regulations. This proposal will develop regulations which consider the special characteristics of Offshore Supply Vessels, their operating methods, and the service in which they are engaged and will apply only to those vessels constructed on or after the effective date of the regulations. An ANPRM will be published this summer.

CGD 82-005 Inspection of Subchapter "D" and "O" Tank Barges

This project will:

1. Remove the conflict in internal and external examination intervals;

2. Reduce the financial burden of gas-freeing barges for the sole purpose of conducting redundant inspections;

3. Reduce the frequency of entry into confined spaces.

An NPRM will be published in June.

Shipboard Fire: No Time For a Coffee Break

by LCDR C. F. Guldenschuh
Chief, Commercial Vessel Safety Branch
Marine Safety Division
Ninth Coast Guard District

There can be no doubt that the Great Lakes Fleet has been swept up in the revolution of ship design and construction. Over the past several decades, technology has provided a great many improvements in the structural design of the modern vessel as well as its hardware. This new breed of ship is demanding a new breed of seafarer. The traditional yardsticks applied to seafarers are rapidly becoming a thing of the past.

For the last decade, at least, the industry and government regulators have attempted to make ships "sailorproof." This has resulted in a great many tools being developed to aid the mariner, but unless the seafarer can properly use these tools, they are worth absolutely nothing. A hard lesson has perhaps finally been learned: there is no black box that can replace qualified seafarers. Marine safety is vitally dependent on the human factor. The need to properly address the human factor is now being recognized both internationally and domestically. We have begun to realize how much a seafarer's ability to effectively function on board a modern vessel hinges not only on his training and his experience but also on his professional attitude. Perhaps this is one area we can all readily improve upon.

One way of determining how we can improve our future safety record is by seeing how we have done in the past. A review of past casualties on the Great Lakes will reveal that over 80 percent of them have been attributable to the human factor. I would like to demonstrate the negative side of the human factor in marine safety—in this particular case, vessel fire safety—by narrating a brief history of a casualty that should never have occurred.

Prelude

On December 16, 1979, a motor vessel 513 feet long, of conventional Great Lakes design, arrived at Toledo, Ohio, for winter lay-up. The vessel in question was one of the first Great Lakes vessels to be converted to a self-unloader and also had a relatively new engine room section. There were no major changes made to its forward deckhouse during conversion, and much of that deckhouse was constructed of wood. The vessel was built before most of the current structural fire protection standards and practices had come into being. On the morning of December 17, 1979, the master and all deck department personnel departed the vessel for the winter lay-up period. The Chief Engineer

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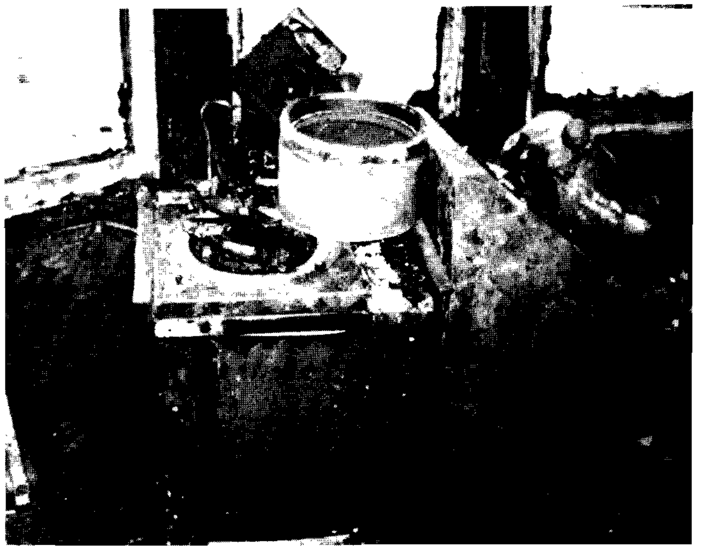


The fire that need not have occurred caused millions of dollars' worth of damage.

and his department personnel remained on board to take care of routine winter maintenance items. On December 17, the Engineering Department began routine lay-up chores. These included the draining of all steam and water lines to the forward end of the vessel, the opening of valves in these lines, and the opening of the fire and general service pumps. These routine winter precautions against freezing eliminated any immediate fixed firefighting protection for the forward end of the vessel.

The human factor is the most complicated and often the most unpredictable factor in the [safety] equation.

The Casualty

On December 26, the Chief Engineer assigned the task of renewing the port crossover-belt to a conveyorman and two gatemen. The next three days were used to move the belt, stowed on a reel and protected by cardboard material, from the storage location to a position between the port and starboard crossover conveyors. Early on the morning of the 29th, the three men began preparations to install the new belt. They discovered shortly that the new belt would not fit between the belt scrapper and the roller drum.

The conveyorman then decided it would be necessary to burn the scrapper bar off to install the belt (a new scrapper bar could be installed later). The burning operation was begun without delay and without the taking of any special fire precautions. Neither the new belt nor any of the cardboard packing material was removed from the immediate area.

At approximately 1330, the burning operation had been completed and the old scrapper bar removed. At this point, it was noticed that white smoke was coming from the hopper below the area where the burning had taken place. From the smell of the smoke it did not appear to be burning rubber. Since there was no fire protection in the area, the conveyorman went in search of the nearest portable fire extinguisher, which was located one deck above.

When he returned to the scene, a gateman took the extinguisher, which was a 15-pound B-II CO_2 bottle, and crawled a short distance down the inclined belt toward the tanktop. He reported that he could see the cardboard material burning. After giving the fire "two good shots" from the CO_2 extinguisher, he watched the flames disappear. He then gave the area one more "good shot" and returned to where the other two men were waiting. The three seafarers made no further efforts regarding the fire. They waited in the area about three minutes and were satisfied that the fire was out. They then proceeded to the spar deck and then aft to have coffee and wait for the area to clear of smoke. The time was approximately 1345.

The two gatemen proceeded to the galley

for coffee, and the conveyorman proceeded around the afterhouse looking for the Chief Engineer to inform him of the situation. Upon returning to the forward side of the afterhouse without locating the Chief Engineer, he noticed black smoke billowing up from the forward end of the vessel. The conveyorman immediately went forward, alone, to re-extinguish the fire. While attempting to reach the work area, he was repelled by the dense black smoke. He then proceeded aft to sound the alarm and alert the crew. The time was approximately 1355.

The ship's crew attempted to put out the fire but failed completely because of its inability to penetrate the thick black smoke pouring out of the area. The Toledo Fire Department was called at 1402. As soon as the alarm was sounded, the Chief Engineer ordered various pumps to be reassembled to remove water used in firefighting from the vessel. Two ship's pumps were returned to service.

At 1410 the Toledo Fire Department arrived on scene. It was unable to combat the fire because of the heavy black smoke and the firefighters' unfamiliarity with the vessel. The fire raged out of control until the early morning hours of December 30. It was finally extinguished at approximately 2200 on December 30.

As a result of the fire, the entire forward deckhouse, including all living areas, storage areas, and the pilothouse, were gutted. The conveyor equipment forward and as far aft as the #10 hopper was completely destroyed. Although there were no injuries or loss of life, the damage to the vessel ran into the millions of dollars.

. . . complacency can be the most dangerous of all shipboard conditions.

Analysis

There can be little doubt that the damage would have been less extensive had the vessel had the type of structural fire protection built into newer vessels. There can also be no doubt that this lack of protection played no part in causing the casualty. The safe and efficient operation of any vessel depends not only on the modern design and technology built into such ships but more importantly on the seafarer—the human factor.

The cause of this casualty was the abysmal breakdown of the human factor. A contributing cause to the casualty was the lack of fixed firefighting capability in the area. It is likely that had there been a charged fire hose strung out to the area where the burning operation was being conducted, this casualty would never have occurred.

What actions of the seafarers caused this casualty? They were:

1. failure to remove combustible materials from the immediate area,

2. failure to have several of the proper class portable fire extinguishers at hand and ensure that everyone was familiar with their proper use,

3. using the wrong type of fire extinguisher in a haphazard manner to attempt to extinguish the fire,

4. failure to overhaul the fire after it was thought to be out,

5. failure to set a reflash watch, and

6. on the part of the conveyorman, failure, after seeing smoke forward, to sound the alarm before setting out to re-extinguish the fire on his own.

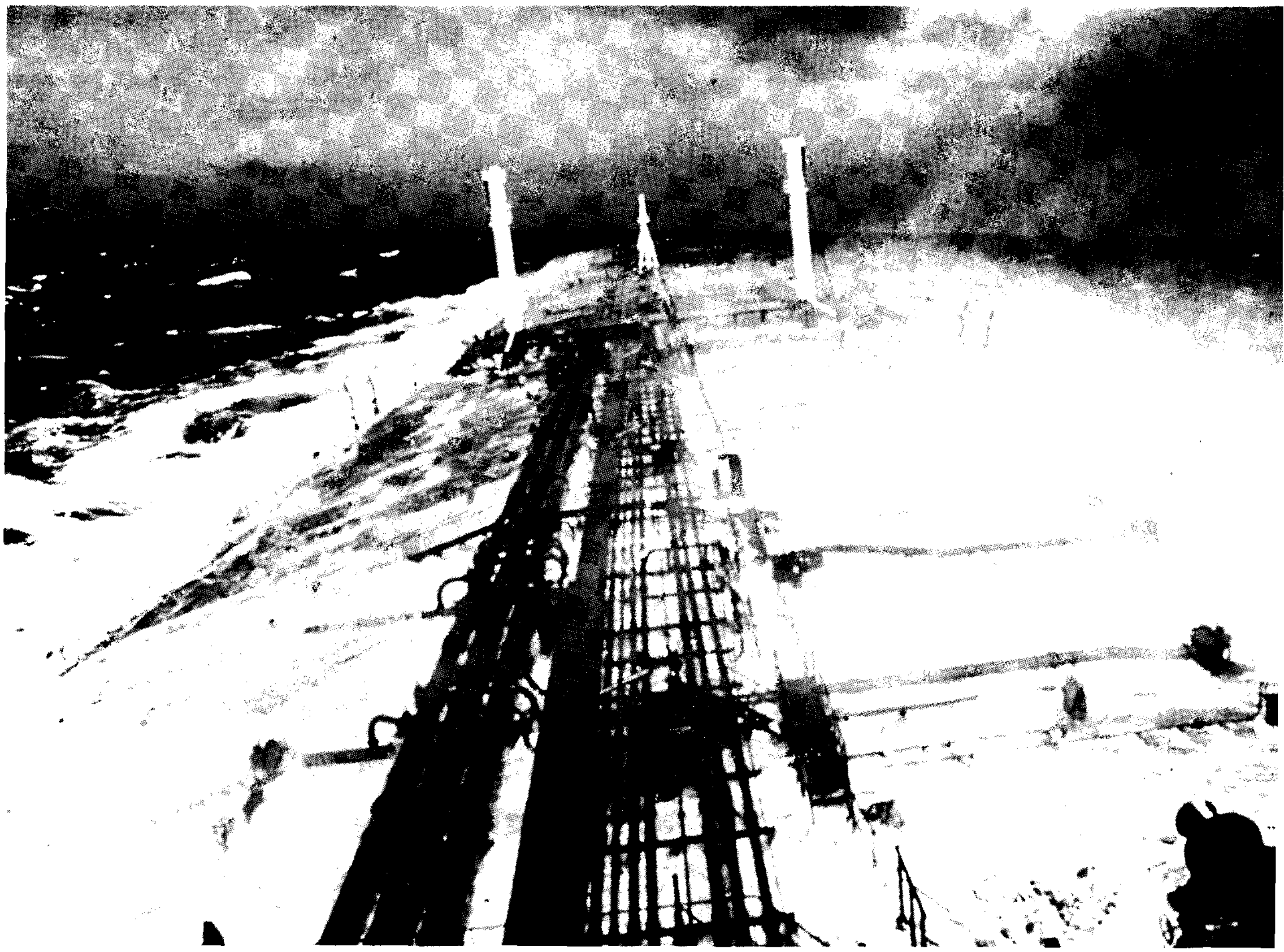
Conclusions

There are numerous factors which fit into the total vessel safety equation, but none is more critical than the human factor. The human factor is the most complicated and often the most unpredictable factor in the equation.

It is essential that the experience and training required of the seafarer be constantly reevaluated to ensure that the professional qualifications of the seafarer are kept in step with the times. Just as important is the seafarer's professional attitude. It is the obligation of the seafarer to ensure that his attitude remains as professional as the rest of his qualifications. As can be seen in this casualty, complacency can be the most dangerous of all shipboard conditions.

Safe and efficient vessel operations are impossible if the human factor in the safety equation is not a positive one. ⚓

Help for Human Beings--



Vessels like the 250,000-DWT tankship above often have to operate in heavy weather. (Phot courtesy of Frank Mueller-May)

it's Instrumental

by

H. Paul Cojeen
Ship Design Branch
Merchant Marine Technical Division

and

CDR Edward A. Chazal, Jr.
Planning Branch
Plans and Programs Staff

"Ships have never been and probably never will be failureproof . . . We have not adequately recognized the sailors' part in the system . . . The motions of larger ships, which are masked to the human sensations, can be measured by electronic means . . . here's an area [response instruments] which shows promise as a reliable way to back up the sailors' traditional sixth sense . . ."[1]

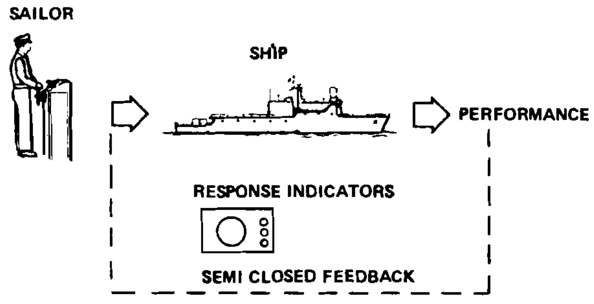
". . . [ship's officers] must realize that in bad weather, as in most other situations, safety and fatal hazard are not separated by any boundary line but shade gradually from one into the other. There is no little red light which is going to flash on and inform commanding officers that from then on there is extreme danger from the weather and that measures for the ship's safety must now take precedence over further efforts . . ."[2]

"Studies of marine casualties . . . verified the suspicions of many of us in the marine safety field that ship design and construction were only a part of the picture. Both people and maintenance were identified as extremely important elements which must be addressed with at least as much attention as was previously paid to the ship itself . . . During my tenure as Chief of the Office of Merchant Marine Safety I've watched with considerable interest the efforts made to solve people problems with equipment fixes. People problems require a greater realm of knowledge than the technical side of our training. They are generally more complex in their origin and normally more intricate in their resolution."[3]

[1] ADM J. B. Hayes, address to American Petroleum Institute, Coronado, California, May 1980

[2] ADM Chester Nimitz, following the loss of three destroyers of Halsey's Third Fleet in a typhoon east of the Philippines on December 17 and 18, 1944

[3] RADM Henry H. Bell, speech at Nor-Shipping, Oslo, Norway, June 1981



SEMI CLOSED LOOP SYSTEM

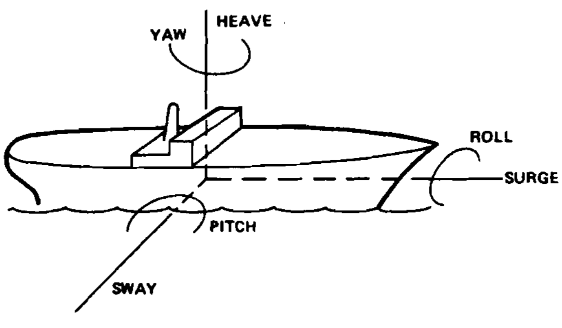
The quotations on the preceding page illustrate a basic theme: the human element, whether it is called human factors, or human engineering, or ergonomics, is the single most important element in the safe operation of our vessels and platforms. Giving a human being supplementary information on those responses of his ship he cannot "feel" can aid him in making prudent decisions.

Thanks to a number of research efforts in the United States, Norway, and the Netherlands, a simple, general-purpose response-monitoring instrument can now be brought to the navigating bridges of LNG and tank vessels, containerships, cargo and passenger vessels, naval combatants, cutters, and patrol boats.

What are (ship) motion responses?

A ship is a floating body propelled by some means over an everchanging water surface. It is subjected to various environmental "loads" (waves, wind, etc.). It is also influenced by self-generated forces such as propulsion and a variety of on-board "loads" such as shifting cargo, sloshing liquids, and vibrating machinery.

As a floating body, a ship has six degrees of freedom, as illustrated in the drawing below. It can move in any combination of directions—surge, heave, or sway—and can rotate in any of three ways—roll, yaw, and pitch. Any force upsetting the equilibrium will cause a change in speed or position. A vessel's reactions to the sea and wind are termed "motion responses."



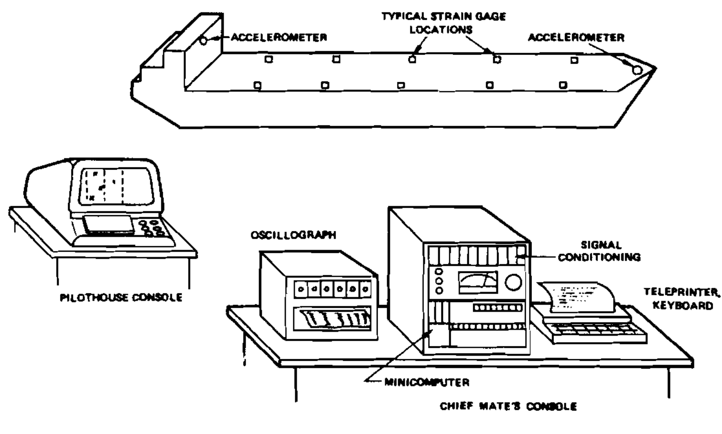
THE SIX DEGREES OF FREEDOM

Instruments which are sensitive and reliable can detect responses the sailor cannot. These instruments can be used to back up the sailor's own observations, creating a semi-closed feedback loop. The sailor knows that his actions will cause a change in conditions. The instruments enable him to measure the relative changes. This data must be available to him as a supplementary piece of information which he can use when he needs it.

A monitoring instrument should be so designed that the sailor can easily relate the information he gets from it to the overall picture. Otherwise, he might be lulled by a false sense of security, believing that the instrument will detect all possible oncoming hazards from the waves; his alertness would then be reduced, and situations not sensed by the instrument could take him by surprise. A properly designed instrument should provide information adjusted to the sailor's ability to interpret and act correctly.

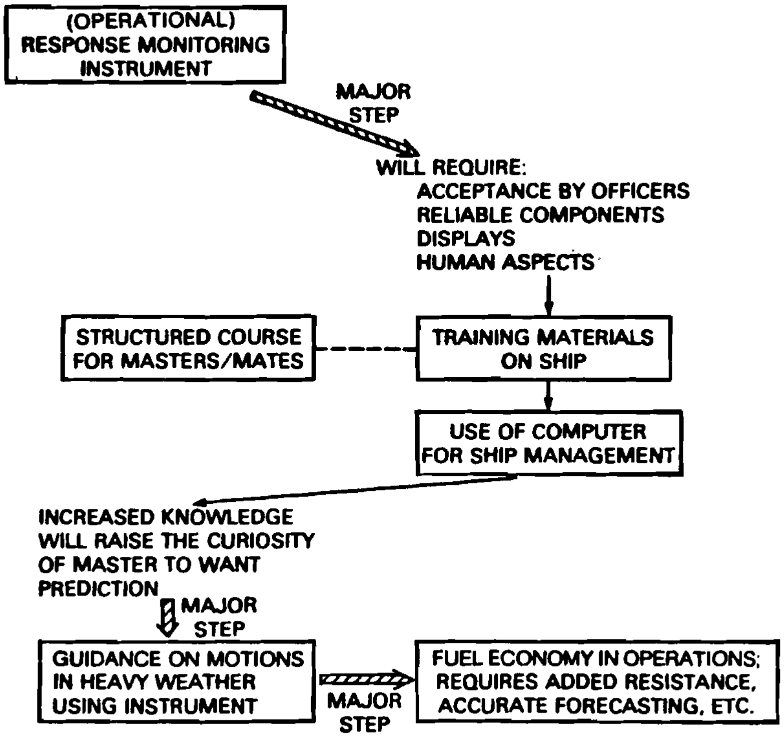
What is a response-monitoring instrument?

Response-monitoring instruments and the computational equipment used to analyze and interpret conditions are simply a tool for prudent seamanship. They provide information for the discretionary guidance of the deck officer,



GREAT LAKES INSTRUMENT LAYOUT

The system pictured above uses strain gauges to measure stress and accelerometers to measure motions. A small computer is used to translate the measurements into information which can be used by ship's officers. This information is displayed on a television-like screen in the pilothouse.



RESPONSE MONITORING

just as the various electronic navigation systems supplement the traditional celestial, pilotage, and dead-reckoning forms of navigation. The systems augment the sailor's own sense for the traditional "feel of the sea" and "working of the ship" even as radar extends the range of his eyes and ears to detect impediments to safe passage. They are alternate means of providing information to the master.

How and where has the development of response-monitoring instruments been pursued?

Research has been underway since the early 1960s in the United States, Norway, England, the Netherlands, and Japan. The recent availability of inexpensive, powerful mini-computers has had a significant impact on recent programs. The authors have evaluated the results of the research projects. This paper will discuss the findings of the Norwegian project and the Maritime Administration's projects on the LASH ITALIA, FURMAN, and BURNS HARBOR in detail and will touch upon the HELM, a U.S. effort that has gained considerable use in North Sea heavy lift operations.

There are various ways to go about monitoring responses. The diagram above shows the authors' approach to response monitoring.

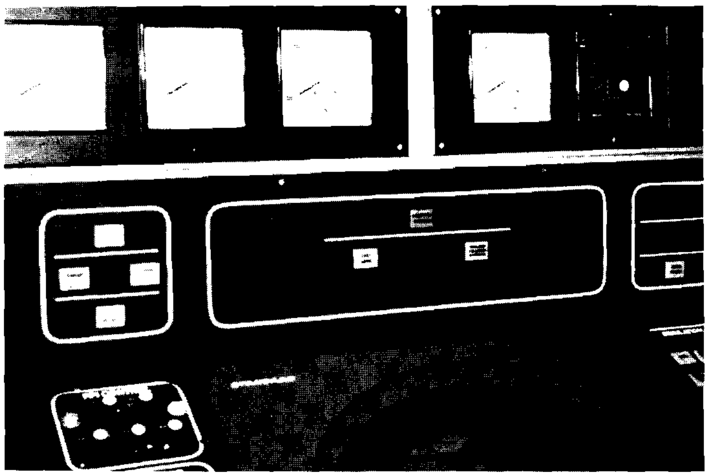
A ship's officer will accept a response-monitoring instrument only if he understands the meaning of the information he receives and knows how he can use it to make decisions. He must also be able to evaluate its reliability. The human must be able to adjust to the "new" way of presenting the "old" information.

Each of the projects to be discussed has shed light on the technical problems associated with the development of response-monitoring instruments and, more importantly, on the need for education and training in the use of these instruments.

The Norwegian project

In 1970, Det norske Veritas, the Norwegian classification society, established a research program on wave loads. From a growing concern over the problems experienced by masters who could no longer fully feel the effects of the sea when navigating supertankers in heavy weather, Det norske Veritas put forward the idea of providing an instrument on the bridge capable of indicating to the master the loads experienced by his ship. It was hoped that a better understanding of the influence of waves on the ship would increase the level of operating safety.

Following the loss of the ANITA and the NORSE VARIANT in heavy weather off Nova Scotia in March 1973, the Norwegian Maritime



The vertical and lateral accelerations, slam, and green-water events are displayed on dial gauges above the Data Bridge radar console. The computer used by the collision-avoidance radar also serves the response-monitoring instrument.

Directorate (the Norwegian counterpart of the U.S. Coast Guard) lent its support to the project.

FINDINGS: the instruments used in the Norwegian project initially featured basic monitoring and simple displays and later incorporated guidance functions. The guidance functions were intended to help mates gauge the effects of course and speed changes. Det norske Veritas found, however, that officers did not understand enough about ship motions and response to use the guidance functions. They also found a rough correlation between age and acceptance of a response-monitoring instrument. This correlation resulted in the navigators' being divided into three classes:

Older	Middle-aged	Young
How he feels about the instrument:		
Get it off the ship	Doesn't have full sense of ship	Supplements senses; wants to know what happens when simulate changes
What kind of instrument he would like to see:		
None	Simple gauge to input feel to his senses	With predictions

In the course of the Norwegian project, it was noted that the master of today has less practical experience in rough weather operations than his predecessor did. This reduces his ability to make "prudent" decisions. This is not a consequence of less education and training but of other factors:

- Improved social conditions have resulted in shorter time periods at sea and more frequent change of ship types, resulting in a reduced feel for each ship.

- Weather forecasts are becoming more reliable and cover larger areas, with the result that ships tend to avoid storms and the crews thus gain less experience from ship operations in heavy weather.

What this means is that the master of the future will have had even less experience with the operation of his ship in rough weather.

Simply buying equipment is not the solution. Proper training and education of ship navigators in the principles of seakeeping and the use of instruments is essential. The training program undertaken in Norway demonstrated that properly trained navigators are more likely to consult and use a monitoring instrument. If an instrument—even the simplest single-gauge monitoring instrument—is to be used, the navigators must be made aware of its potential and its limitations.

This situation led the sponsors of the Norwegian program to develop a structured course in shiphandling for deck officers. They concluded that a basic operational response instrument would be of great assistance to masters who were competent in its use.

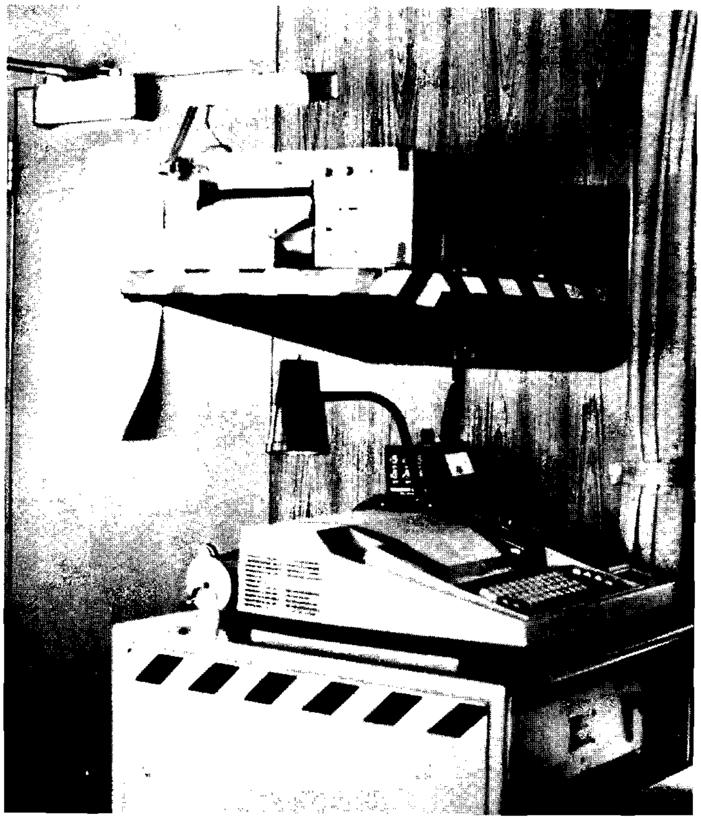
Maritime Administration (MarAd) projects

The instruments used in the SS LASH ITALIA, the USNS FURMAN, and the M/V BURNS HARBOR projects were derived from work on hull stresses started by the Ship Structure Committee over 20 years ago.

MarAd support of research on monitoring instruments was based on its interest in improving vessel productivity; the Coast Guard was more interested in the potential for reducing the risks and promoting safety of life at sea. (Although structural failures and vessel losses are rare, when they do occur it is usually with substantial loss of life.) Additional impetus has come from the National Transportation Safety Board (NTSB), which, from its investigation of the TEXACO OKLAHOMA and OCEAN EXPRESS casualties, has recommended that response-monitoring instruments be explored as a means of casualty prevention. The Coast Guard, through the Commercial Vessel Safety Program, has provided technical and funding support for the MarAd projects.

LASH ITALIA

Prudential Lines was concerned about the problems of cargo and hull structural damage resulting from heavy weather operations of its ships. The LASH ITALIA was selected for installation of a modified Heavy Weather Damage Avoidance System. (An earlier commercial installation on a ship carrying perishable fruit from California to Europe was only marginally successful). The LASH ITALIA's instruments included vertical and transverse accelerometers forward and strain gauges located at midships and on the bow side framing.



The LASH ITALIA's computer keyboard sits on top of the equipment box (computer, power supplies, etc.) adjacent to the chartroom. The strain gauges and accelerometers are located at midships and in the bow.

The first phase of the test and evaluation on the LASH ITALIA got under way in the fall of 1975. Operating in scheduled service between ports on the East Coast and the Eastern Mediterranean, the ITALIA had ample opportunity to experience severe sea states in the normal course of service.

FINDINGS: the large amounts of numerical data generated by the computer could not be understood and were not used by the master. On the voyages where a researcher rode the vessel and provided information that the master understood, he accepted the system. The attempts at training the deck officers in the use of the instrument (a computer terminal) were only partially successful—and then only with the younger officers. Computer terminals were not perceived as "friendly" devices by the deck officers, since they could not speak their language. Single command function keys were necessary so that the terminals could speak the mariner's language. Despite all the shortcomings of this first-generation response-monitoring instrument, the deck officers appreciated its potential.

FURMAN

In an effort to address problems similar to those faced by the ITALIA but in a North Pacific environment, the Military Sealift Command agreed to the use of its ship the USNS FURMAN. The project, sponsored by MarAd, the Coast Guard, and the Navy, was conducted from 1977 through 1981.

The FURMAN's devices were set up in much the same manner as the ITALIA's. There were strain gauges for midship bending and bow side framing, accelerometers for vertical and lateral sensing at the bow, and a gyro roll indicator located in the engine room. A cathode ray tube (CRT) display and keyboard were located on the bridge for information presentation.

FINDINGS: the master and mates acknowledged the need for response measurements and display, especially in heavy rolling situations where lashings of explosive cargoes are a serious problem. The initial displays were primarily numerical and were quite unsatisfactory. Ship's officers became involved in developing new displays that fit their traditional concepts. These modified displays (which were achieved merely by changing the computer instructions) were installed near the end of the test program. They allowed the master to display (pictorially) a four-hour trend of the average response and the highest measured response in each 15-minute interval. These modified displays were well received, since the deck officers had provided the key to their acceptance.

BURNS HARBOR

The April 1976 Great Lakes Seaway Port Development Shipper Conference designated the Maritime Administration as lead agency for the development of a stress-warning instrument for Great Lakes vessels. This action was taken in response to the the total loss of two Great Lakes vessels and their crews: the CARL D. BRADLEY in November 1958 and the DANIEL J. MORRELL in November 1966. The MORRELL and the BRADLEY were lost as a result of structural failure in a storm.

The need for a stress-monitoring instrument has increased since the opening of the Poe Lock at Sault Ste. Marie ten years ago. This lock permits the transit of vessels 1,000 feet in length, and the lengths of Great Lakes vessels have increased approximately 30 percent over the past ten years. These long ships are more flexible and thus more susceptible to high-frequency dynamic stress variations at sea.

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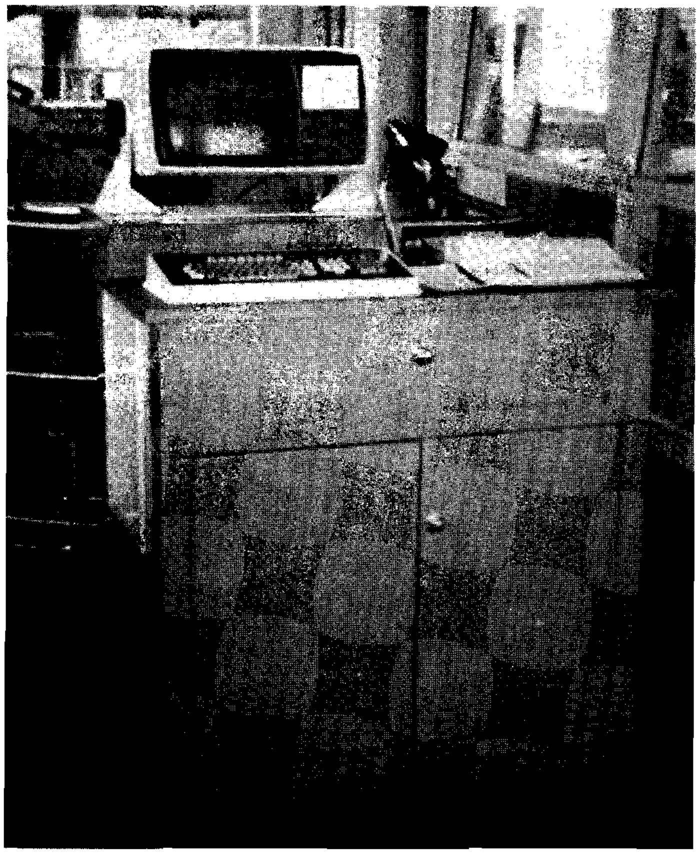
They require better control of hull loads and stresses during in-port operations.

A computer-based instrument was chosen for further study and installed on the Bethlehem ore carrier M/V BURNS HARBOR in 1978. Sets of strain gauges were installed at five locations along the hull girder for sensing hull response resulting from static and low- and high-frequency dynamic loadings. There is a vertical accelerometer at the bow and a lateral accelerometer on the bridge. Information is displayed on CRTs at several locations: in the wheelhouse, in the cargo control room, and in the computer room.

Considerable controversy regarding the use of warning signals was laid to rest when the owner's representative suggested the adoption of selectable alerts. These allow the master to leave instructions for a junior officer to summon him under a prescribed set of conditions. This provides a very active and interesting communication link between the generations: the "old" master can communicate with the "younger" officers. The response levels of the accelerometers and strain gauges become the common reference.



On the BURNS HARBOR, the pilothouse console, with CRT display, is located adjacent to the steering stand. Different displays can be selected at the push of a button.

FINDINGS: many significant findings have come out of the short and yet uncompleted research evaluation program on the BURNS HARBOR. Although the numerical displays were confusing to the master and to the mates, those which contained pictorials of the vessel were readily accepted. The displays associated with the static loading calculator, which the chief mate found useful, were also frequently used. Those displays that referenced wave-induced and springing stress responses were not used, since the crew did not understand the engineering jargon surrounding basic seakeeping or hull girder loadings. The officers expressed the desire to attend a structured training course to help them become familiar with seakeeping. Much hesitation remains because of the many displays to be viewed (these findings are consistent with those of the Norwegian evaluation). Some skepticism was a natural consequence of a few computer failures and minor hardware problems. These, though minor to a researcher who knows how to repair the system, seem "insurmountable" to a potential user. This is an unfortunate reality when an experimental instrument with sophisticated components is placed on a ship. Operational instruments will require a high degree of reliability, but that can be assured through proper design.

HELM

The HELM (Heavy Lifting Monitoring and Prediction) instrument was designed as a commercial venture based on Hoffman Maritime Consultants' participation in the MarAd projects. A change in conditions during heavy lift operations in the North Sea oil fields can have disastrous economic consequences. With such high economic risks, owners decided they could well afford the cost of instrumentation and highly trained operators. Development was swift, and acceptance by the users is high.

Where does a response-monitoring instrument fit into the operations/design of vessels?

The table on the facing page shows the five elements of successful ship operations and design.

The first, second, and third elements are generally the domain of the designer and shipbuilder. The owner, master, and crew are responsible for the latter two elements. Response monitoring, both in port and at sea, falls under adequacy of outfit, whereas training/education in the understanding of responses falls under competence of the crew. Although the table above is slanted toward commercial vessels, naval combatants and Coast Guard cutters face similar operating problems. They all face the same environment—the sea.

The human being is the most important resource and is the key element in the man/machine system. Although each human being is unique, all humans are affected by similar factors when called upon to make safety-related decisions. These include:

- innate personality
- skill and abilities
- the value they attach to their jobs and their abilities
- working conditions
- the goals they wish to achieve and the situations they wish to avoid.

> "... technology can readily provide [the mariner] with more information than he can effectively utilize ... A critical factor in future research should be the human engineering of the display so as to promote proper reactions by mariners ... The display of stress and motion data must be unambiguous and provide information of ready practical use to the mariner if it is to avoid leading him into mistakes ... the data selected for display must not divorce the sailor from a concurrent appraisal of the physical sensory indications he has relied on historically."
>
> RADM G. H. Patrick Bursley, referring to the paper from which this article was adapted

The next step: development of a simple, general-purpose response-monitoring instrument

The authors joined forces with two noted research engineers to present a comprehensive "status report" on these instruments. The forum for the report was the 1980 Spring Meeting/STAR Symposium of the Society of Naval Architects and Marine Engineers. The authors' goal was to close the loop between research and application, since each project had focused on putting technology in place under operating conditions. The paper served to "feed back" to the technical community the reactions and needs of the operators; prominent and respected operators, owners, managers, and researchers commented on the paper. A consensus emerged from the comments: what was needed was a simple system consisting of no more than two or three sensing devices that could be installed on different ships. Since personnel move between companies and ships, the "indicators" placed on containerships and those placed on tankers should have a common element.

The criteria for any instrument to be developed are as follows: 1) the instrument must be

THE FIVE ELEMENTS OF VESSEL DESIGN AND SAFE OPERATION

ADEQUACY OF BASIC DESIGN	ADEQUACY OF OUTFIT	ABILITY TO CARRY SPECIFIC CARGO	COMPETENCE OF CREW	DILIGENT MANAGEMENT
• STRUCTURAL, INCLUDING FIRE PROTECTION	• TOWING, MOOR	• TANK/HOLD DESIGN	• TRAINING: OPERATIONS, NAVIGATION EMERGENCIES	• OWNER AND MASTER SAFETY CONSCIOUS
• HYDRODYNAMIC — POWERING AND MANEUVERING	• NAVIGATION — RADAR, LIGHTS DIRECTION	• VENTING AND PIPING	• LEADERSHIP — COMMUNICATIONS	• PREVENTIVE MAINTENANCE, REPAIR
• HULL INTEGRITY	• OPERATIONAL AIDES	• TANK CLEANING COWS	• LANGUAGE BARRIER — CREW, PILOT	• COOPERATION WITH REG. AND CLASS.
• REDUNDANCY — COMPONENTS	• RESPONSE MONITORING — AT SEA AND PORT	• UNDERWAY OPERATIONS	• UNDERSTANDING OF VESSEL RESPONSE	• PROVISION OF HAND-OFF OF INFORMATION TO PILOT
• ARRANGEMENTS — GENERAL AND EMERGENCY	• LIFESAVING AND FIREFIGHTING	• CARGO HANDLING AND EQUIPMENT	• • •	• PORT ENGINEERING
• • •	• • •	• • •		• • •

able to provide the master with meaningful information that is not misleading; 2) it must be free from electronic and mechanical drift; and 3) it must not desensitize the master to his ultimate responsibility for the safe and prudent operation of his vessel. In addressing these problems, the following must be considered:

Human factors - It is important that the master be given enough information to sail his vessel safely and efficiently. His senses must not be occupied with information that is not useful. Consideration must be given to the abilities of each ship's officer when the instrument is implemented. Equipment designers and shipbuilders have to address these human factors issues more today than ever before. The recent explosion in microprocessor technology could easily leave the ship master with ten times as much information as he needs and, even worse, no greater understanding of this additional information. In short, the instrument must be designed for his use, not for exercise of his deciphering skills.

Usability of the display - A display that is cluttered with too many numbers or too much information stands very little chance of being accepted by ship's officers. The displays must be designed to present information in a familiar manner. For example, a simple display of the vertical accelerations at the bow might be represented by a vertical display, or a record of the envelope of bending stress might be a set of horizontal stars which portray the envelope of extremes over the last 15 minutes. A computer/CRT lends itself to changing display formats. The use of single keys to command a display will make the instrument easy to use.

Location of the display - The display should be in the pilothouse and accessible for reference in shiphandling situations. The location of the instrument display in the pilothouse should be directly related to its utilization in a particular aspect of ship operations.

Structured instruction in vessel response and loadings - Training of ship's officers in the operation of the instrument will require more than an explanation of how to start it up or how to shift from one display to another. It will require a structured course on the fundamentals of vessel response to its loadings. This can best be taught in a classroom environment. The course work would be more complex than that done by deck officers in a radar school. Although deck officers at the various schools are currently introduced to the fundamentals of naval architecture, they must also be given a basic understanding of ship motions and loadings. The Norwegian project has considered this a key element of its overall program. Some of the topics covered in the Norwegian course are:

- general ship knowledge, weather facsimiles, and heavy weather damage experience
- statistics, wave/weather interaction, and abnormal wave conditions
- specific examples of motions for different ship types.

The Norwegian course has been taught 15 times. The Coast Guard, to take advantage of the existing course material and teaching experience, invited the Norwegians to teach a demonstration course for masters and mates from selected companies in the U.S. who are operating vessels with response-monitoring instruments. In March 1981, a group of senior deck officers took part in the two-day demonstration course on shiphandling in rough weather held at the United States Merchant Marine Academy. Among the 15 attendees were representatives from a number of major U.S. shipping firms, maritime education institutions, and related government agencies.

Conclusion

The authors have concluded that there is a need for easily understandable response-monitoring information. From the findings of the various research projects, the authors have singled out vertical and lateral accelerations as reliable and meaningful responses. Reliable components and inexpensive (micro)computers to measure the responses are already available. The authors have agreed on a basic design for the "ideal" ship response monitor, or "SRM," and a panel of engineers and ship operators is now preparing specifications (type of sensors, computer, display, etc.) for the SRM. ⚓

"A Status Report on the Application of Motion and Stress Monitoring on Merchant Vessels," the paper from which this article was adapted, was authored by Edward A. Chazal, Jr., and H. Paul Cojeen of the U.S. Coast Guard, Kaare Lindemann of Det norske Veritas, and Walter M. Maclean of the Maritime Administration. It was presented at the Spring Meeting/STAR Symposium of the Society of Naval Architects and Marine Engineers held in Coronado, California, June 4 -6, 1980, where it won an award for best paper.

Human Error?

by D. Todd Jones, P.E.
Office of Research and Development
U.S. Coast Guard Headquarters

An airliner is approaching San Diego. In the cockpit, a guest crew member is riding in the observer's seat. The guest, the captain, the first officer, and the flight engineer are engaged in a spirited discussion of retirement benefits. The San Diego controller comes on the radio to give routine landing instructions, adding information about a light aircraft in the area and inquiring whether the pilot can see it. The copilot responds that he thinks he sees it but several seconds later comments that he has lost it. The conversation about retirement benefits continues unabated. The flight recorder captures the pilot's exclamations as a midair collision occurs.


"I HAVE MIXED FEELINGS ABOUT OUR NEW SKIPPER—HALF FEAR, HALF PANIC!"

It is 0005 hours on January 31, 1975, and a U.S.-flag commercial tanker is outbound from the Monsanto dock at Marcus Hook, Pennsylvania. A Liberian-registered tanker is still unloading at the British Petroleum dock on the other side of the channel.

The weather is clear and cold, visibility is eight miles, and the tide is flooding at 1.6 knots. The pilot of the American tanker is on the port bridge wing, the master is on the starboard bridge wing, and the mate remains in the wheelhouse.

The pilot assumes the conn and orders the rudder hard left, bow thruster on full right, the engines dead slow ahead, and the lines cast off. As they clear the dock in a slow turn to the right, the pilot orders the rudder to right full. As they turn toward buoy D, the pilot uses his portable radio to contact a second U.S.-flag tanker, upbound on the river.

As the first tanker approaches buoy D (about 0010 hours), the pilot releases *the assisting tug and orders the engine half ahead. Shortly thereafter, the master expresses his concern to the pilot about whether they can make the turn without danger to the Liberian-registered tanker. The pilot assures the master that the turn can be made and that there is room in the channel. The pilot resumes his conversation with the second American tanker from the port bridge wing.*

About five minutes later, the master again expresses concern about the maneuvering and recommends putting the engines astern. He receives no reply, as the pilot is still talking on the radio.

Minutes later the bow lookout reports that they are too close to the Liberian-registered tanker, leaves his position, and runs aft. The master orders the engines full astern. The pilot, hearing the order, recommends a "double jingle" (emergency action) engine order and the dropping of the anchors. The master concurs, rings the engine order, and orders the anchor dropped, but the bow lookout has already left his post. The master then sounds the general alarm. Moments later, the two tankers collide.

It is 4 a.m. on March 28, 1979. In the control room at the Three Mile Island nuclear power plant, operators are working as usual. They do not notice that a cardboard maintenance tag attached to the control panel is covering the light that indicates the feedwater valve is closed.

When the system shuts down (in the well-known incident), the operators watch for the emergency cooling system to go into effect. Unbeknownst to them, the entrance of the cooling water is blocked by the closed feedwater valve. Compounding the problem is the fact that a relief valve has stuck open, allowing what cooling water is in the system to be driven out by the heat and pressure. The operators assume that the system has resealed and that auxiliary cooling water is entering. They become concerned primarily about what they think is the unusually high water level and how to shut off the "excess" water that may cause damage.

As is now history, they made an incorrect diagnosis. For approximately two hours they did not recognize that rather than too much cooling water, they had too little. Indeed, the particular combinations of temperature and pressure in the reactor meant it was boiling dry and the fuel rods were being damaged. Such a condition can lead to lack of control of a reactor and result in serious damage to the reactor itself and the release of radiation.

Three tragic accidents, each attributed to "human error." The context and specific details varied from situation to situation, yet there were certain similarities. In each case, the operator was performing a "routine" task; he continued performing that task in conditions that turned out to be unusual. In each case, the operator failed to act on new, vital, and pertinent information calling for a response that deviated from the familiar. In none of the three cases did a single, unique causative human error occur; problems developed over time.

Human error

"I was in a hotel restaurant when the check came. I signed my name to it but couldn't remember the number of my hotel room. So I looked at my watch."

A woman got into her automobile, started the engine, and then noticed that the windshield was dirty. She turned on the wipers and squirted water on the windshield. When the windows were clean, she intended to turn off the wipers. She turned off the ignition instead.

Human errors abound in today's technical society, but most of them are subtle and inconsequential; they pass unnoticed and do not result in accidents. Research, however, indicates that human error accounts for between 60 and 80 percent of all accidents. Yet allowance for human error has decreased greatly with the introduction of large, fast, and highly sophisticated ships, and the consequences of human error have become greater.

What exactly is meant by "human error"? The term "human error" as used in discussions of marine safety often connotes some shortcoming or failure. When an accident occurs, for example, ship operators are typically said to have "not recognized some environmental disturbance" such as current or "not properly aligned the vessel within the channel." Another typical example is the operator who "failed to sound the proper whistle signal" in violation of the Rules of the Road. The implication is that the operator ought not to have made such a mistake and that the undesired event would not have occurred if he had not. Although this position might be defensible in some cases, it oversimplifies the problem.

First, it assumes that an accident is the result of a single factor. Second, it assumes that a) the "environmental disturbance" (or any other information bit) can be perceived with precision (in time for action), b) to perceive it is to know what to do about it, and c) the disturbance can in fact be compensated for by both the human operator and his vehicle. A third assumption is also implied. The human error explanation of accidents generally gives the impression that the system is otherwise perfect: information is readily available, its implications are clear, the vessel can respond, the operating area is suitably designed, and the Rules of Road, if followed, ensure safety.

. . . we must see human errors as indicators of underlying problems.

Given the foregoing notion of error and the assumptions it implies, it is easy to understand why the majority of accidents are said to result from human error. With this definition of human error, anything short of outright mechanical failure within the system or an act of God is a human error. In fact, one could argue that even outright mechanical failures are human error—in design or maintenance.

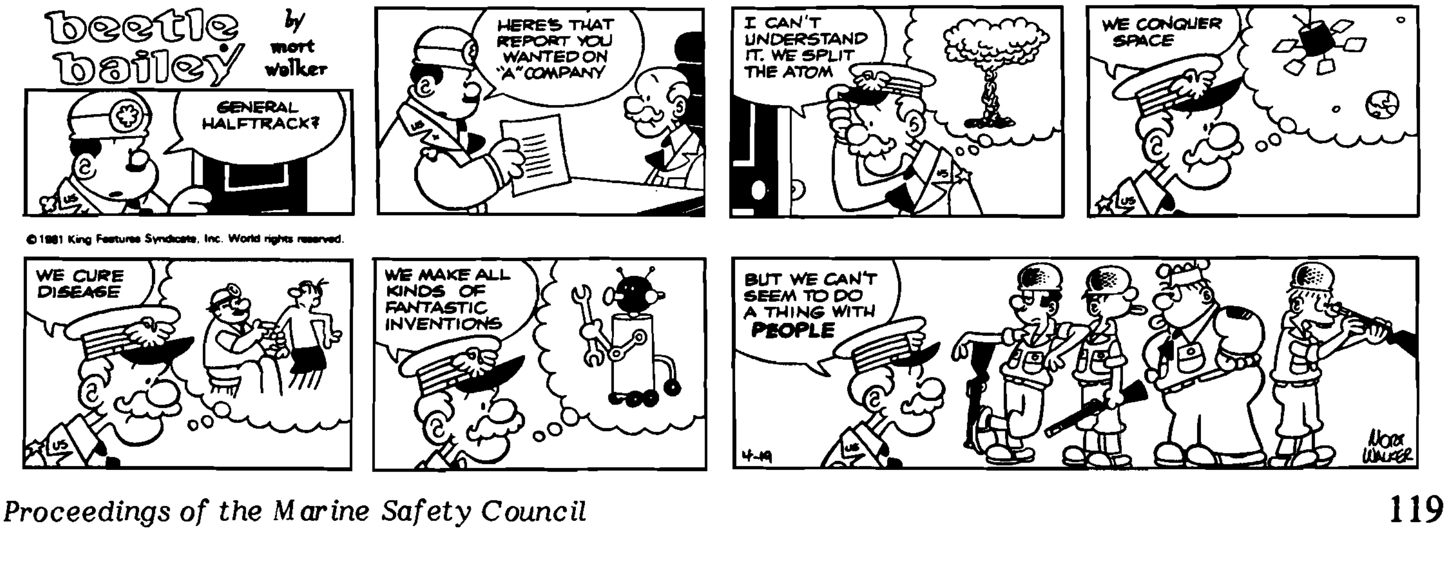
Human error is perhaps more realistically and productively defined as some human action or inaction, regardless of fault, which ultimately results in an undesired event. Such error can be subdivided into two basic categories: "human-caused errors" and "situation-caused errors." To make a distinction, "human-caused error" refers to what the operator did, did not do, or could not do, regardless of fault or blame, while "situation-caused error" refers to the factors that contributed to the operator's behavior. The latter term takes in both human attributes and other system attributes.

Human-caused errors may be further subdivided into two categories: competency errors and incompetency errors. Incompetency errors are those made by incompetent or incapacitated personnel. People may be inattentive, careless, reckless, poorly informed, or incapacitated, temporarily or characteristically. These errors generally represent a small percentage of the human-caused errors and are difficult to reduce except by proper personnel selection and qualification and frequent medical check-ups.

Two sales clerks in a catalog order department were both on the phone at the same counter, each talking with customers and filling out forms for charge-card purchases. One had to pass behind the other in order to get a form, and so the clerks changed positions. When the first clerk finished her phone call, she hung up the phone. She hung it up on the wrong instrument, thereby cutting off her coworker's conversation.

In getting ready for a party, one person carefully prepared a cake and a salad, then put the cake in the refrigerator and the salad in the oven.

Competency errors, on the other hand, are made by operators who are considered reasonably able, who perform their work successfully day after day, and who are not apparently incapacitated at the time of an accident. Within this category, the errors made by the operator can often be attributed to any number of factors; rarely, if ever, is a competency error the result of a single factor. Competency



errors can be divided into groups. Errors in the first group are related to man's ability to make a decision. Errors in the second are related to man's ability to carry out the decision. Situation and response are interactive, altering each other and both contributing to the negative outcome.

Man's ability to make correct decisions at any given time can be affected by a number of factors (we are assuming that all the information necessary to make a satisfactory decision is available). These include intelligence, motivation, perception, stress, fatigue, confidence, and training and experience.

Says a ship's captain:

"I get more calls (to the bridge) between 10:00 p.m. and 5:00 a.m. This is because, with the contract, inexperienced watch officers are on duty when no one else is around."

The greater the training and experience a person has had, the better qualified he will be, in most cases, to make a correct decision. By the same token, he is less likely to make a mistake than a less qualified man with less training. Performance under stress varies from person to person. Some will remain calm and not regard the situation as stressful or critical; others may become excited and nervous. Experience and training can have a great bearing on personal performance under stress.

There are other short-term factors that affect performance as well. The most common of these is fatigue. All too common are situations where officers, especially masters, pilots, and first mates, are called upon to make decisions after long hours of duty.

"The 12-4 (watchstander) is perpetually tired, and he misses a meal. My 12-4 brought the ship in, stands a watch until 5 a.m. tonight, and will take the ship out at midnight tonight."

Situation-caused errors are related to the environment a person is working in. Some of the elements which make up a person's work environment are his thermal environment, his visual environment, his acoustic environment, and his chemical environment (sight, sound, taste, smell, and heat). These factors can all have significant effects on human performance and thus on the probability of errors being made. Such factors include:

a) lighting levels on the bridge, work surface lights, instrumentation light levels;

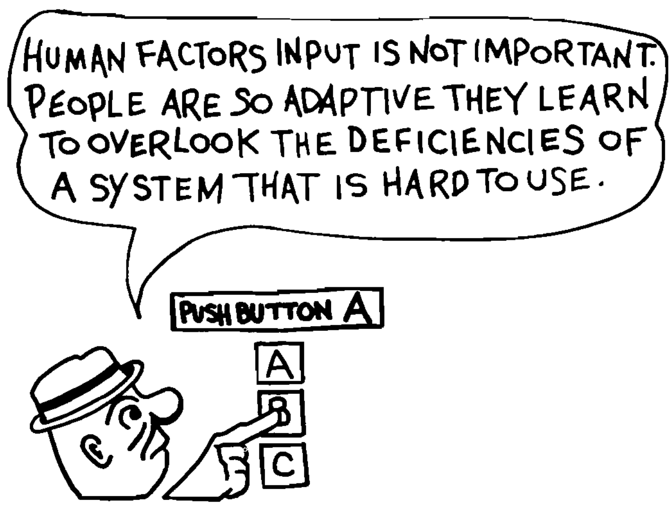
b) ambient and transient noise levels, including intensity, duration, and location;

c) heating and ventilation levels; and

d) pollutants and toxicants in the air.

A malfunctioning feed pump was being repaired on a "Falcon" Class Tanker. This caused a red light to appear in a spot on the bulkhead of the bridge in a panel array. The engineers told the mate on watch not to concern himself with the light, that it was under repair, etc. In the early morning hours when the Second Mate was "shooting stars," another red light went on. It was located directly below the other light, next to a window with early morning light as a background. Busy with his navigational duties, the Mate did not observe it. The light turned out to be an oil light, indicating that valves in the engine had burned out. The resulting damage sent the vessel into dry dock for extensive repairs.

A second group of factors deals with the design of the work space. Consideration should be given to the operator's position, posture, and reach in the design of the work space. Although these factors may affect performance (and hence errors) only indirectly, their importance should not be overlooked or underestimated. Indeed, these factors are attaining increasing importance with the development of bridge design aimed at one-man control of the vessel from the bridge. Here the navigation



and control instruments are brought together into a console at which the man is seated and from which he can control the vessel.

A third group consists of factors associated with machine design. Chances of an accident are increased, for example, if machines do not operate in predictable ways:

A major international automobile manufacturer designed the windshield wiper controls on the right side of the steering wheel and the light controls on the left. Several years later on a newer version of the same car, the controls were reversed.

The U.S. Air Force had problems with the newly accepted F-111B, a sweep-wing, two-seat, jet aircraft. Pilots with plenty of flight time and experience in the aircraft were crashing. Examination showed that the original design for the control of the wings called for the wing control rod to be pulled back to sweep the wings in for faster flight. Pilots, in emergency situations or under stress, would pull back on the throttle and the wing controller, causing the aircraft to lose power and lift.

A new major Army radar system would not operate for the Army testing crew. The contractor was called out to inspect the system and make repairs. The system designer, when he arrived, could find no errors. Closer examination of the system and observation of the designer performing tasks on the radar showed that the designer was left-handed.

During an emergency there is little time to identify controls by the labels. Operators claim that they learn "patterns" of control locations and lights and pay no attention to labels. This is fine for more frequent and familiar situations. It is the less frequent ones that are of concern.

Errors, then, result from the poor design of machines as well as from the inadequate skills of the human operators. They may also result from what goes on inside the operator's head. The latter cause of error we know little about and can do nothing about right now, but the other kinds of error are within our control.

Control of error

Individual research efforts in the United States, Norway, the Netherlands, Germany, and Great Britain have reaffirmed that, as the Maritime Transportation and Research Board puts it,

". . . accidents usually develop through relatively long sequences or chains of events, the interruption of which anywhere along the path (before a certain point) will normally preclude accident occurrence."

In marine accident investigations it is important to recognize the limits of the investigative reports insofar as human factors are concerned. Investigations of vessel accidents currently focus on finding a "cause" (normally a violation of the law, a regulation, or established procedures) rather than reconstructing the accident. This unfortunately fosters the view that the "system" is near perfect and whatever bad results have occurred have been the result of some human fault.

If we continue to perceive human errors this way, we will continue to see them as the causal event in most accidents. If anything is to be done about accidents beyond talk and litigation, however, we must see human errors as indicators of underlying problems. We must get away from the tendency to pronounce an operator at fault and close the case.

As previously stated, most accidents result from a series of events. The more complex the system, the more accident-enabling factors or error opportunities there are. Conversely, each of the many causal factors in the accident equation offers the opportunity for correction—elimination of any one of those factors will usually interrupt the sequence of events and prevent the accident from occurring. Given the difficulty of pinpointing the factors in human-caused errors (i.e., motivation, perception, vigilance, etc.) and the lack of data on such errors, it is more likely that improvements in system safety will come from control of situation-caused errors.

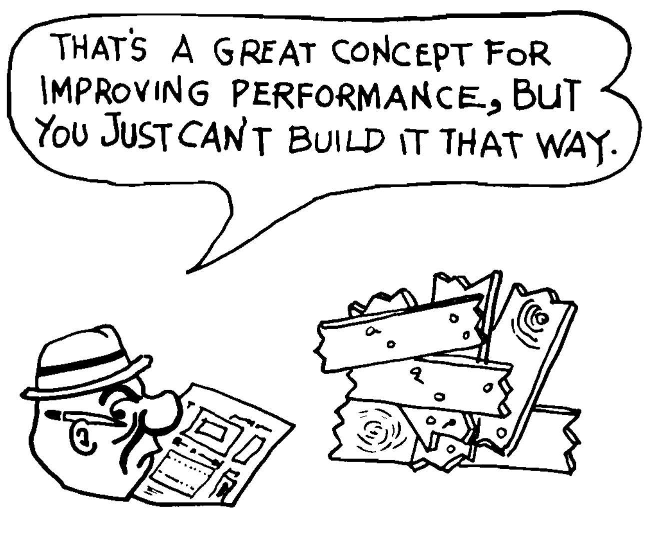
Chances of an accident are increased . . . if machines do not operate in predictable ways.

Care, however, must be exercised in introducing system improvements. Casually assuming that "one more piece of equipment" or "additional training" will solve the problem is not sufficient or realistic. Proper preliminary research and an understanding of the actual problem (not necessarily the perceived problem) are prerequisites to acceptance of any solution.

Such caution will prevent a repeat of the phenomenon that occurred in the mid-1950s. At that time it was felt that additional "sensors" were required to assist bridge watch standers in determining the presence of other vessels. This belief was accepted uncritically, and radar sets were extensively installed on vessels. Over the subsequent years, it was noted that vessels with radar were involved in collisions about as frequently as vessels without radar. In certain conditions (notably fog) the availability of radar fostered a false sense of security, thus contributing to what has been termed "radar-assisted collisions."

How, then, to best reduce, remove, or eliminate sources of human error? Several methods exist, but none of them can be implemented alone, for each attacks only one aspect of the human error problem.

If mariners are making errors because they have difficulty operating the equipment, the solution is proper equipment and work environment layout. There currently exists a strong need for standardization of equipment and bridge layouts. Basic equipment design and data inputs to the watch keepers should be defined and then standardized. The obvious place to start any effort at standardization is the ship's bridge. There are lots of things that are "bad" about current bridge designs—windows that you cannot see through because they are in the wrong direction, panes of glass that give dazzling reflections, inconsistent labeling of



instruments (some have white letters on black, some have black letters on white), indicator lights that are far too bright and blind you—this sort of thing is repeated time and time again in ships.

There is a great deal that can be done to prevent human error by improving the design of a ship's bridge. There is also plenty of room for improvement in machinery control spaces, the radio office, and so on, but, because of its importance, the bridge is the place to start.

There are currently two major draft bridge design "codes of practice" available, one issued by the British government and the other issued by the government of the Netherlands. Anthropometric considerations (i.e., how high, how far, where to place for easy control, etc.) are the underlying principle for bridge design in these proposed standards. This is a start, but additional work must be done before complete bridge design standards or recommendations are accepted internationally.

What about other kinds of mistakes? Consider training. A lot can be done in the way of building and operating ship training simulators. Quite a few of these are appearing around the world. The Dutch were the first in the field. The Dutch have had simulators at Delft and Wageningen for some years now. Other simulators are currently operating in Great Britain, Germany, Japan, the United States, Sweden, and Norway and are planned or under construction in Finland and the Soviet Union. The simulator provides a ship's bridge complete with all its instruments. A computer is programmed to simulate such conditions as the deterioration of steering in shallow water and the effects of wind and current. Such a machine can be used for training not only one man at a time but a bridge team; it can take the crew through all crisis situations and mishaps, groundings, failure of steering gear, and so on, and drill the crew repeatedly until crewmembers automatically respond correctly.

Although simulators are used for training, they are not always used well. One simulator examined did a good job of simulating sea conditions and required tasks. What it did not do was record the complete transaction between man and machine. Such a complete record is essential if a simulator is to be used not only as a simulator but also as a selector, a trainer, and an assessor and maintainer of skills.

What seems to be lacking is an overall plan that puts all the parts together in a systematic way and assures that human operators are kept at a desired level of efficiency. To do that, companies must not only upgrade selection and training procedures but also must figure out ways to constantly monitor and maintain the skills of their key operators. By periodic retraining of personnel in simulators, companies can prevent lapses in performance and reduce errors.

The simulator can also be used to reconstruct accidents and to determine the probable causes in accidents. No doubt there are more uses. Simulator development is well underway and will yield increasing benefits as the years go by.

Where do we go from here?

The increasing complexity of ship and shore-based systems, the tremendous increase in ship dimensions, the growing professionalism of the people who operate ships, the need for economy, and the changing attitude toward pollution and safety require a ship transportation system that is designed to operate safely, efficiently, and harmoniously.

As a consequence of these requirements, shipbuilders, waterway and harbor builders, designers of navigational aids and other subsystems, as well as lawmakers and regulatory authorities have to take into account that people can perform adequately only if their tasks are suited to the capabilities, limitations, attitudes, and needs inherent in human nature.

It is easier to promote technical development than to cope with difficulties regarding ship operation, crew training, and international relations. Hence, the human component is too frequently relegated to the background, when it is not simply forgotten altogether. While it is true that much progress has been made in ship design, equipment, navigational aids, etc., serious gaps of a technical nature still exist. These make it even more difficult to resolve the problem of human errors. It is absolutely essential that human factors be given more importance.

. . . people can perform adequately only if their tasks are suited to the capabilities, limitations, attitudes, and needs inherent in human nature.

"Anybody can design a machine that man can use, for, after all, isn't the designer a man, too?"

Look closely at the control room of any "continuous" process, such as one finds at refineries or chemical manufacturing plants, and you will see a large number of dials and controls, warning lights, pressure gauges, and indicators with electrical readings in watts, amperages, and volts. What is happening is virtually automated. Indeed, if plant designers had their way, the human operators would be present merely as window dressing: to satisfy government regulations and to reassure the public that if the machines fail (but, of course, the designer doesn't really think they will) someone will be there to cope.

There is an increasing tendency to "design the man out" of the system . . .

Although there are many small failures and a few large ones in these systems, they are, overall, remarkably reliable. This reliability is the basis of a paradox: the human operator has virtually no actual experience doing the thing he is put there to do. Therefore, the more reliable the machine, the less reliable the human operator.

Most complex systems involving men, machines, and computers are designed as if the human components are afterthoughts. Yet, all too frequently, human factors engineers and psychologists are called in because the operator cannot work the equipment or because accidents occur. This is a pattern that will continue. Since less than 5 percent of the world's funds for research and development, test and evaluation, or design and construction go to solve "human problems," although "human error" accounts for between 60 and 80 percent of all accidents, accidents, too, will continue to occur. There is an increasing tendency to attempt to "design the man out" of the system, yet in most cases man is still required to monitor the system, "be there if anything happens," or make decisions based on what the equipment tells him. ⚓

The Mariner is a Human Resource

by LCDR Robert W. Henry
Ship Design Branch
Merchant Marine Technical Division

The managerial personnel practices routinely associated with a modern business enterprise have evolved over many years. Today they form the basis of a sophisticated science known as human resource management. Application of these principles by the maritime community has been slow because of the generally conservative nature of the industry. With the increased focus on accidents resulting from "human error," there has been a growth in research applying human engineering principles to the mariner in the hope that this will reduce the vessel casualty rate. The objective of this article is to comment on these trends, both internationally and nationally, and to speculate on their effects on the Coast Guard's Commercial Vessel Safety Program.

International

The currents that gathered force during the 1970s to shape the design and operation of commercial vessels can only intensify during the 1980s, forcing the marine industry to extend its adaptation of human engineering. Several factors have influenced and will continue to influence the international maritime community's efforts to reduce the number of accidents attributable to human error. There will be intense international competition to attract and hold qualified and dedicated seafarers, a scarce resource, especially in Europe. The complexity of shipboard systems will steadily expand, requiring an accompanying increase in the education and technical sophistication necessary on the part of the marine professional.

The Inter-Governmental Maritime Consultative Organization (IMCO) sponsored the 1978 Conference on Training, Certification and Watch Keeping of Seafarers. Although it will be years before its impact is felt, the conference has already resulted in a stronger focus on the competence of the mariner. IMCO has also recognized the significance and scope of the human error problem and has resolved to become the international forum for discussion of the subject. IMCO is presently addressing the topics of bridge design and layout, vessel maneuvering standards, and trim and stability instructions to the master.

The international community has also recognized that the application of human engineering principles to vessel design and operation can yield valuable rewards. The following trends already established during the 1970s will grow during the 1980s. A managerial approach to the functions of vessel navigation will bring about increased use of methods such as bridge team training on marine simulators. In fact, there will be an increased use of sophisticated simulators by all marine disciplines. Rapid advances in technology will make simulators available to many users.

Time at sea is traditionally thought of as "99 percent boredom, 1 percent stark terror." The simulator will enable trainees to concentrate on that 1 percent stark terror.

Participatory management by the crew will grow and will erode the traditional distinction between officers and rated crewmembers. Increased emphasis on shipboard equality and greater crew motivation and stability will lead to a reduction in the high crew turnover rate. In addition, there will be greater use of cooperative superstructure design workshops during the conceptual stages of a vessel's design.

National

Because of the small size of the U.S.-flag fleet and the generous wages paid to U.S. mariners, the problems associated with European crews do not exist to the same extent in this country. However, improving the quality of the American seaman and the manning standards of foreign vessels operating in U.S. waters is a task that will receive emphasis during the 1980s.

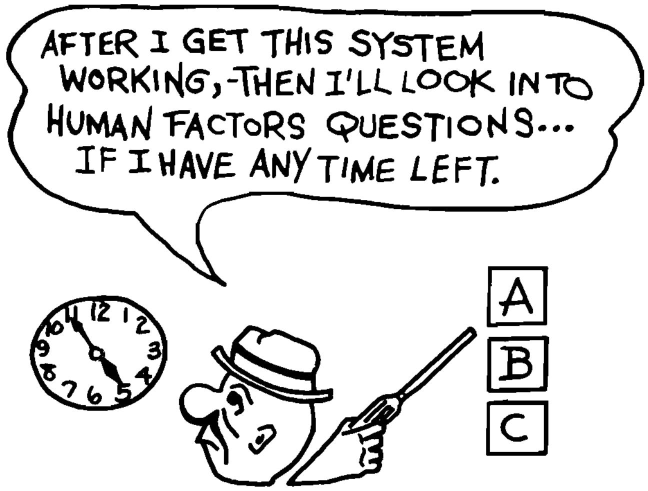
As in the rest of the world, the marine simulator will play an increasing role. Better understanding of its uses and benefits and increased accessibility will entice groups that have traditionally resisted this type of technology to use it. Increased industry acceptance and use of marine simulators will aid in teaching good shipboard standard operating practices. Time at sea is traditionally thought of as "99 percent boredom, 1 percent stark terror." The simulator will enable trainees to concentrate on that 1 percent stark terror (dangerous situations, casualties, and adverse weather). Here is where the bridge teamwork concept can be forged. Greater reliance by vessel operators on "passage planning" and its effective implementation and tighter control of the watch-changing routine will also be emphasized as a means of reducing problems associated with human error.

Technology will make available devices that will allow a ship's operator to better assess stress and motion influences that would otherwise be masked by the sheer size of his vessel. Increased use of new motion- and stress-sensing technology will aid the bridge watch keeper to "feel" bow flare and bottom slamming on large vessels.

Anticipated reductions in Maritime Administration vessel operating subsidies and renewed pressure on maritime unions to further reduce crew size will significantly influence vessel design from the bridge to the machinery space. The U.S. maritime community will be under pressure to compete in a world market that is generally years ahead of it in the adaptation of progressive management to human resources and productivity. Improvements in shore-based and shipboard management of personnel and the relationship between the shore-staff and the ship will be necessary. This is best described as management of human resources and will extend to the following areas:

1. Defining and satisfying the social needs of the mariner while realizing that shipboard problems such as boredom cannot always be solved by means such as higher habitability standards.

2. Developing methods to reduce excessive reliance and task loading (pressure)



on certain shipboard individuals such as the master or officer of the watch.

3. Improving bridge designs with greater attention to lighting, temperature and humidity specifications, and placement of equipment.

4. Fostering more effective approaches to shipboard safety and accident prevention. Vessel safety should be recognized as a problem requiring the initiative of all levels of management, not just the individuals on the vessel.

Commercial Vessel Safety

The Coast Guard, like most Federal agencies, will be under increased pressure to reduce its regulatory impact on the public. Although the Commercial Vessel Safety Program is being restructured, vessel safety itself will not be sacrificed. Further work on bridge visibility and bridge design and layout, including an assessment of information flow on the bridge (amount, type, format, and suitability), will be continued. The Coast Guard can review non-safety-related habitability regulations that impede innovations in the design of the superstructure. This effort may be integrated into an overall project to streamline Coast Guard vessel safety regulations.

The Coast Guard will continue to take those steps necessary to reduce the rate of serious marine casualties. The following steps could help in achieving this objective:

1. Investigating the possibility of:

   a. equipping vessels with devices similar to the flight data and voice recorders now on commercial aircraft

   b. the voluntary reporting of "near-miss" accidents.

These would aid in vessel casualty analysis.

2. Developing a standard format for the use of the Coast Guard maneuvering simulator as a casualty-analysis tool.

3. Evaluating the means of ensuring swift and accurate investigation of major casualties by knowledgeable individuals.

4. Assessing "competency errors" in mariners. It has been noted that the absence of anxiety or anticipation before a casualty is indicative of the need to instill "defensive awareness" in mariners and to reduce their high level of acceptance of calculated risk.

In response to international conventions and new U.S. laws, the Coast Guard is planning to evaluate various changes in personnel licensing procedures. License qualifications, periodic performance testing of license holders, and the use of simulators as a partial substitute for at-sea experience for license applicants are topics that will receive careful consideration. Work is presently under way to validate marine simulator training effectiveness and skill retention. This project could be extended to evaluate standards necessary in the accreditation of marine simulators for training and licensing.

The maritime community, in the hope of improving the marine casualty record, is paying increased attention to the subjects of human engineering, human error, and management of human resources. There has been some skepticism shown toward this approach by those who feel that the best way to improve the casualty record is the traditional one—adding more sophisticated equipment to the bridge. In rebuttal to this philosophy, we can reflect on the words of Dr. John S. Gardenier, an operations research analyst with the Coast Guard's Office of Research and Development: "No major progress can be made as long as we look for the solution where the 'light' is clearest, rather than where the problem lies." Sooner or later the real issues behind "human error" will have to be addressed by the marine community. ⚓

. . . the absence of anxiety or anticipation before a casualty is indicative of the need to instill "defensive awareness" in mariners and to reduce their high level of acceptance of calculated risk.

Acetaldehyde:

CH_3CHO

synonyms:	acetic aldehyde ethanal ethyl aldehyde
Physical Properties	
boiling point:	21°C (70°F)
freezing point:	-124°C (-191°F)
vapor pressure at	
20°C (68°F):*	750 mm Hg
21°C (70°F):	760 mm Hg (1 atm.)
Threshold Limit Values	
time weighted average (TWA):	100 ppm
short term exposure limit (STEL):	150 ppm
Flammability Limits in Air	
lower flammability limit:	4%
upper flammability limit:	60%
Combustion Properties	
flash point (c.c.):	-39°C (-38°F)
autoignition temperature:	175°C (347°F)
Densities	
liquid (water = 1.0):	0.8
vapor (air = 1.0):	1.5
Identifiers	
U.N. Number:	1089
CHRIS Code:	AAD

* considered "room temperature"

The chemical acetaldehyde (pronounced as-it-AL-duh-hide) is found as a natural product in many fruits; it is an intermediate product in the respiration of many plants. One of its more interesting uses, in fact, is as an indicator of "ripeness": the amount of acetaldehyde present in fruit held in cold storage is a sign of how ripe the fruit is.

The first artificially produced acetaldehyde was made by the Swedish chemist Karl Wilhelm Scheele in 1774. In 1835, Baron von Liebig, a German chemist, defined its chemical structure and gave it the name "aldehyde," a combination of the translation from Latin meaning alcohol dehydrogenated (alcohol from which some of the hydrogen atoms have been removed). The name "aldehyde" is now used for a class of chemicals, of which formaldehyde (HCHO) is the simplest member, followed by acetaldehyde (CH_3CHO).

Earlier in this century, the primary method of producing acetaldehyde was a process that used ethyl alcohol as the main starting material. During the early 1960s, this gave way to a method employing oxidation of the chemical ethylene. A third method of producing acetaldehyde, hydration of acetylene, has also been largely replaced by the safer ethylene oxidation method; what little use of the acetylene method still exists is found mostly overseas.

Acetaldehyde was first used commercially during World War I as an intermediate in the production of the chemical acetone. Today it is used in the manufacture of such chemicals as acetic acid (which in 1976 accounted for 60 percent of its use), acetic anhydride, cellulose acetate, and vinyl acetate resins, to name a few. These, in turn, are used to make paints, plastics, dyes, fuels, and synthetic rubbers, among other things.

Acetaldehyde, which boils at room temperature, presents health hazards in both its liquid and vapor states. Its vapors can cause irritation of the eyes, nose, and throat, and high concentrations will cause dizziness or drowsiness and could eventually lead to unconsciousness. The liquid, if splashed in the eyes, could cause irritation and burning. Ingestion (swallowing acetaldehyde) causes drowsiness, unconsciousness, kidney damage, and breathing difficulties. Repeated or prolonged exposure can cause an allergic skin rash.

Persons working around acetaldehyde should wear protective goggles or a face shield, gloves, impervious clothing, and boots. If clothing becomes wet with the liquid, it should be removed and cleaned before being used again. Anyone entering a tank or enclosed space containing acetaldehyde vapors should be sure to wear proper respiratory protection such as a self-contained breathing apparatus.

In cases of exposure to the liquid, affected skin areas should be washed with plenty of soap and water. The eyes, if involved, should be thoroughly flushed with water. If acetaldehyde is ingested, the victim should be given large quantities of water to dilute the substance; vomiting should then be induced. Victims overcome by breathing acetaldehyde vapors should be removed to fresh air and, if breathing has stopped, given artificial respiration. In all cases of exposure, medical help should be sought immediately.

Acetaldehyde vapors will form flammable or explosive mixtures with air over a wide range of concentrations. If not protected by a blanket of inert gas such as nitrogen, liquid acetaldehyde will react with oxygen in the air and may form shock-sensitive peroxides. Acetaldehyde is easily oxidized and polymerizes readily; these reactions can be violent if even traces of initiators (substances which can set off reactions), such as sulfuric acid, are present.

Refrigeration is one method of liquefying acetaldehyde for shipping and storage. The more usual method is to maintain the acetaldehyde in a pressure vessel without refrigeration. The tanks, valves, piping, and hoses used in transport and storage of the chemical should be made of steel, stainless steel, and aluminum. Copper and alloys with copper can form explosive copper compounds if exposed to acetaldehyde and should not be used in systems that come in contact with the chemical. Since acetaldehyde vapors can form flammable mixtures with air, all of the metal components of its shipping and storage system must be properly electrically grounded. If this is not done, static electricity may generate sparks, which would serve as a source of ignition for these flammable vapor mixtures.

The Coast Guard has designated acetaldehyde in its liquefied gas form a Cargo of Particular Hazard (COPH) and a Certain Dangerous Cargo (CDC). Regulations for its carriage are found in Subchapter O of the Code of Federal Regulations. Internationally, acetaldehyde is covered by the Inter-Governmental Maritime Consultative Organization (IMCO) Gas Code for gas tankships. Both IMCO and the U.S. Environmental Protection Agency consider acetaldehyde a Category C Pollutant.

Hazard Evaluation Branch
Cargo and Hazardous Materials Division

Lessons from Casualties

In September 1980, an Offshore Service Platform, commonly called a lift boat, capsized and foundered in heavy weather while in its jacked-up mode adjacent to an unmanned satellite platform. This casualty was the result of a number of circumstances including bad weather, possible mechanical failure, and possible poor vessel design. By discussing them here, we hope to alert other operators to the problem and possibly prevent similar occurrences on other rigs.

The vessel was self-propelled and had a barge-like hull 62 feet long and 24 feet wide with three cylindrical legs positioned one amidships on the stern, one on the port bow, and the third on the starboard bow. Each leg had been modified from an original length of 60 feet to a length of approximately 90 feet, and each had a pod at its base that measured 8 by 12 feet. The barge was raised or lowered on the legs by hydraulic motors with power supplied by the vessel's main propulsion motors. Jacking was accomplished by gears that engaged a toothed rack running the length of the legs. The legs traveled in lubricated funnels permanently welded to the vessel.

The vessel had not been constructed to any classification standards, nor was it required to be inspected by the Coast Guard. The owners were not provided with any operating limitations such as maximum water depth by the builder. The owner's insurance company had, however, imposed a 40-foot operating depth limit on the vessel prior to the modification of the legs. According to the captain, that limit had been increased, but he didn't know by how much. Further insurance company restrictions required that the vessel not be jacked up or down in seas exceeding five feet.

The vessel was jointly owned by two men who also alternated as captain of the vessel. Both men had approximately $2\frac{1}{2}$ years' experience operating lift boats of the type involved in the casualty. The only additional member of the boat crew was a deckhand.

At the time of the casualty, the vessel was leased to an oil company. It was being used by a crew which the oil company had contracted to sandblast and paint various platforms. No contract existed between the boat owners and the painters and sandblasters. The oil company specified which platforms needed to be serviced, then either a company representative or the foreman for the sandblasting and painting company directed the vessel's movement. The vessel's captain was consulted on matters of mutual concern, but the contract responsibilities of the two were distinct.

The sandblasting and painting crew consisted of eight men, including a cook, with varying degrees of experience offshore. One member of the contract crew was spending his first hitch offshore with the company. Apparently none of the men was familiar with the American Petroleum Institute (API) RP-T-1, Recommended Practice Orientation Program for Personnel Going Offshore for the First Time. No emergency drills were conducted, and the cook learned where the life jackets were stored only because he chanced to open the locker in the galley containing them.

While the vessel was in its jacked-up mode and operations were being conducted on an unmanned satellite platform in 54 feet of water, the weather deteriorated because of a tropical depression. Operations were halted because of the weather, and the crew spent the day in the mess room watching TV, playing cards, and talking.

There is some doubt about the amount of air gap between the bottom of the hull and the surface of the water. The captain stated he had between 10 and 12 feet, but no accurate measurement of the distance was made. At the time of the casualty the seas were running in excess of 6 feet. Calculations made after the casualty placed the height of the hull above the water as "most probably" approximately 6.6 feet. This is far less than the captain's estimate and does not include consideration for a rising tide and any storm surge.

At approximately 0215 on the morning of the casualty, the captain was awakened by waves striking the hull. He proceeded to the bridge/control room, where he attempted to raise the barge. The leg on the port bow would not move, and all efforts to move it failed. When he had exhausted all possibilities of getting his vessel above the rough waves, the captain realized the peril the men were in and went through the galley and contract crew's quarters ordering everyone to don a life jacket and go out onto the platform. He then raised the stern about three feet, moving the barge closer to the platform and facilitating evacuation.

After raising the stern, the captain, at great risk to his own safety, again passed through the galley area to ascertain that the vessel had been abandoned. He found three men in the dining area and repeated his order to don life jackets and move onto the platform. Had the captain not made the second trip through the vessel, all three men very probably would have still been in the dining area when the vessel capsized. As it was, however, a large wave raised the barge off the bottom before any of these men reached the platform. As the vessel settled back onto one or two of its legs, another wave swept it over onto its side, dropping the four men and all the equipment from the deck into the water. The barge then drifted into another platform nearby.

By midday three of the men had been recovered suffering varying degrees of injury. (The cook, one of the three, probably owes his life to the fact that he had earlier stumbled upon the life jackets.) The fourth man, the foreman of the sandblasting crew, remains missing and is presumed dead.

A number of questions are raised by this incident:

1. Was the failure of the port bow leg to function the result of the heavy seas' putting too much pressure on an over-extended bearing surface, effectively locking it against its jacking funnel?
2. Should more attention have been paid to the deteriorating weather conditions and action to raise the barge been taken sooner?
3. Would drills and emergency instructions for the members of the paint crew have made them any more self-sufficient in the face of the emergency?
4. Can the reader remember occasions when he, or a vessel he's been aboard, has been in a similar perilous situation and escaped mishap by sheer good fortune? ⚓

The following items are examples of questions included in the Third Mate through Master examinations and the Third Assistant Engineer through Chief Engineer examinations.

DECK

1. Calcium carbide must never be stowed near

A. copper.
B. foodstuffs.
C. flammable solids.
D. combustible solids.

REFERENCE: 49 CFR 172.101

2. Which vessel must show a masthead light abaft of and higher than its identifying lights?

A. a 55-meter vessel engaged in fishing
B. a 55-meter vessel engaged in trawling
C. a 100-meter vessel not under command
D. a 20-meter vessel engaged in pilotage duty.

REFERENCE: Navigation Rules

3. An advantage of dry chemical over CO_2 fire extinguishers is

A. its greater range.
B. its effectiveness on more types of fires.
C. its cleanliness.
D. all of the above.

REFERENCE: Marine Fire Protection, Firefighting and Fire Safety

4. A relative bearing is always given from

A. true north.
B. magnetic north.
C. the vessel's beam.
D. the vessel's head.

REFERENCE: Bowditch

5. Which of the following statements about the use of portable electric lights on tankers is correct?

A. The fixture must be explosion-proof, and the line must have a ground wire.
B. They can be used only when the compartment is gas-free.
C. They must be explosion-proof, self-contained, battery-fed lamps.
D. No portable electric equipment of any type is allowed.

REFERENCE: 46 CFR 35.30-30

ENGINEER

1. A reheater in an air-conditioning system is designed to control the

A. chilled water temperature.
B. dew point temperature.
C. primary air temperature.
D. dry bulb temperature.

REFERENCE: Dossat

2. The delivery rate of an axial piston hydraulic pump is controlled by varying the position of the

A. sliding block.
B. pintle.
C. reaction ring.
D. tilting box or swash plate.

REFERENCE: Vickers Hydraulic Manual

3. Intercooling of a multistage air compressor has the advantages of reducing the work of compression on the succeeding stages and

A. condensing part of the original water vapor content.
B. reducing the maximum piston loads.
C. increasing the volumetric efficiency.
D. all of the above.

REFERENCE: Harrington

4. The final heating of feedwater in a flash-type distilling plant is done by

A. heat exchange in the first-stage feed box.
B. vaporization in the first-stage fluid chamber.
C. heat exchange in each stage of the distiller condenser.
D. the admitting of low-pressure steam to the feedwater heater.

REFERENCE: Harrington

5. Excessive oil foaming in the crankcase of a refrigeration compressor is most likely to occur when the compressor

A. has run continuously for a long period.
B. suction pressure is below normal.
C. oil level is below normal.
D. starts after a long idle period.

REFERENCE: Dossat

ANSWERS

DECK
1.A;2.B;3.A;4.D;5.C
ENGINEER
1.D;2.D;3.D;4.D;5.D

The Mourning of the TITANIC

by Ensign Michael A. Cicalese
International Ice Patrol

"Today marks the 70th anniversary of the tragic sinking of the British luxury liner RMS TITANIC after striking an iceberg in position 4046 N 5014 W. We take pause to remember the more than 1,500 lives lost. May they rest in peace."

On April 15, 1982, the International Ice Patrol will add the above passage to the daily message that is broadcast to ships moving through the transatlantic shipping lanes. Each year on this date, this passage is added as a traditional mourning for one of the greatest maritime disasters of all times.

Another tradition is also upheld by the Ice Patrol. Each year on this date, a Coast Guard Hercules C-130 flies some 400 miles southeast of Newfoundland to that forsaken position in the Atlantic, where the Ice Patrol drops a ceremonial wreath, hoping that it will come to rest near the gravesite of the TITANIC, two miles below the surface. The wreath is donated by the Titanic Historical Society.

The flight is over two hours in duration from its take-off point on the Canadian coast. Along the way, the Ice Patrol crew searches for icebergs. It is an unusual way to spend the day. But then again, this day mourns an unparalleled tragedy for those souls aboard the TITANIC honored by the maritime community, as well as the crew of the Ice Patrol. ⚓

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