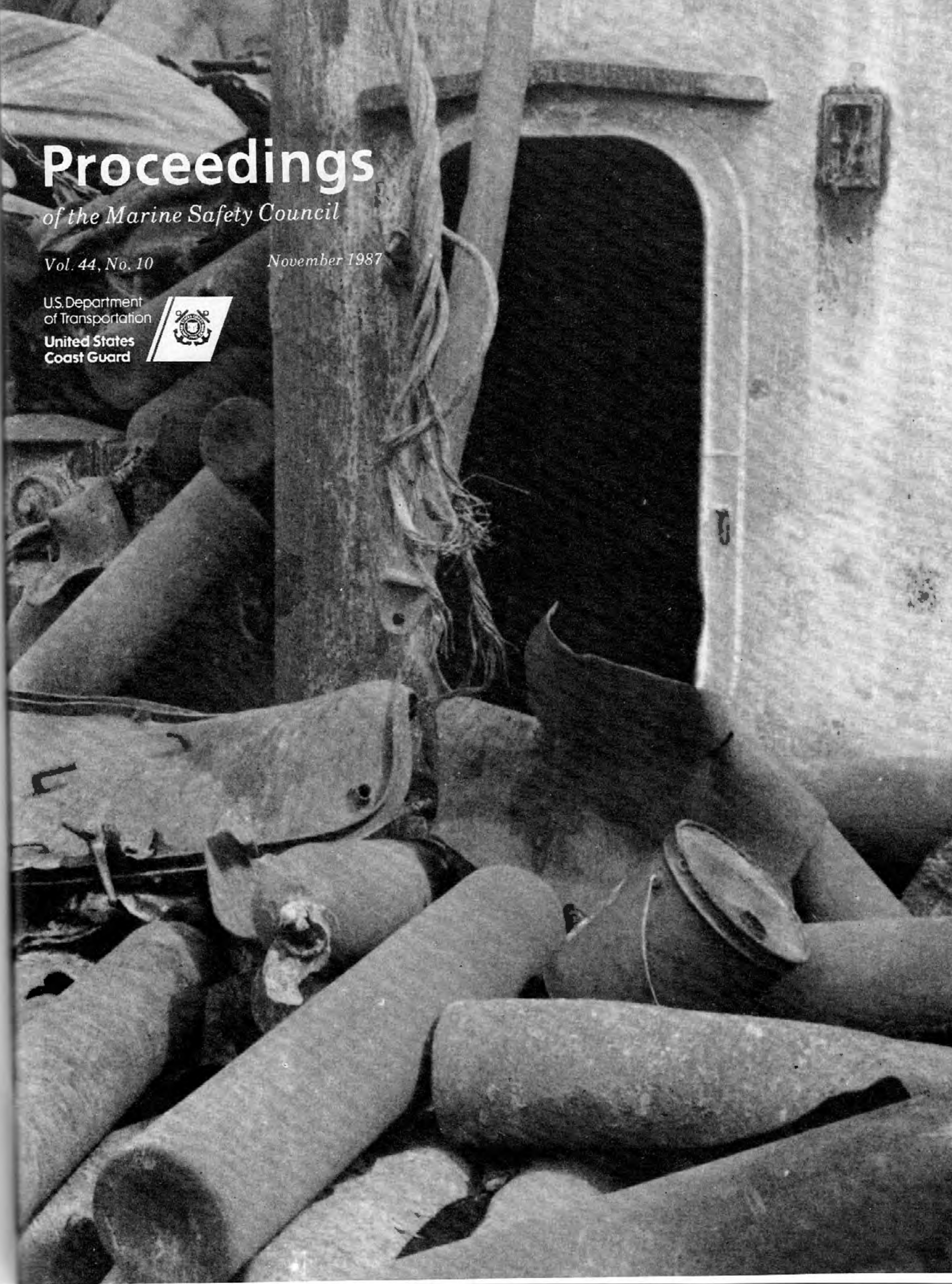
# Proceedings

*of the Marine Safety Council*

*Vol. 44, No. 10* *November 1987*

U.S. Department of Transportation

United States Coast Guard



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# Proceedings
## of the Marine Safety Council

*November 1987* *Vol. 44, No.10*

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*U.S. Coast Guard photo by LT William J. Uberti shows exploded bottles of compressed oxygen and nitrous oxide, as well as fire damage, aboard the* Letitia Lykes.

# Fire and Explosion on the Letitia Lykes

LCDR Christopher Walter

The crew of the **Letitia Lykes** was preparing to get underway for convoy exercises in the afternoon of May 8, 1985, when they heard a popping noise and hissing in a container filled with oxygen bottles near the No. 3 cargo hatch. This was followed closely by a second "pop" and more hissing. The after end of the container bulged; red sparks shot out and were trailed by gray, acrid smoke and bright, reddish-orange flame. Within seconds, oxygen bottles began to explode with concussive waves that rocked the entire ship. Shrapnel blasted thousands of feet in all directions, slicing through other containers and penetrating the deckhouses. The blasts were so violent that other ships anchored in the tropical lagoon at Diego Garcia prepared to get underway, fearing that an ammunition ship had detonated. The first container was totally demolished as fire spread across the deck, feeding itself on 126 tons of oxygen bottles. Ten hours later, with the assistance of three tugs with fire monitors, the fire was extinguished. Miraculously, no one was seriously injured.

## The Ship

The **Letitia Lykes** is a U.S.-flag vessel owned by Lykes Brothers Steamship Company. The **Letitia Lykes** was built in 1968 as a break-bulk freighter with six cargo holds, four of them in front of the house. The vessel is 515 in length, of 10,723 gross tons, and is propelled by a 12,500 horsepower steam turbine plant. At the time of the casualty, the **Letitia Lykes** was under charter to the U.S. Navy as part of Military Sealift Command Preposition Group One in Diego Garcia, British Indian Ocean Territories, about 900 miles south-southeast of India. Cargo holds one through four are divided into an upper 'tween, lower 'tween, and lower hold while holds five and six have upper and lower 'tween holds.

## The Cargo

At the time of the casualty, the **Letitia Lykes** was loaded with four complete mobile army surgical hospitals (MASH) for use by the U.S. Marine Corps. The equipment for the MASH units was stowed in the holds as well as in 102 20'x8'x8' containers which were on deck on top of and next to the cargo hatches. The cargo holds primarily contained ambulance vehicles while the containers had an assortment of medical equipment and supplies. A wide variety of dangerous cargo was located in the containers, including thousands of oxygen bottles totaling 134 *tons* in weight, 41 *tons* of nitrous oxide bottles, and 49 *tons* of acetic acid. The containers also held poisons, organic peroxides, compressed flammable gases, compressed nonflammable gases, flammable liquids and corrosives, the total of which was measured in tons.

The U.S. Marine Corps Logistics Base in Barstow, California, packed all of the 51 containers that had dangerous cargo; they were loaded on the **Letitia Lykes** by the U.S. Naval Construction Battalion Center in Port Hueneme, California, on May 31, 1983, along with other containers with unregulated cargo. A second set of nine containers with dangerous cargo was loaded on the **Letitia Lykes** at Diego Garcia on July 14, 1984.

## Firefighting

When the fire was first observed, the ship's electrician got a dry chemical fire extinguisher from an on-deck motor generator house; before he could exit the house, however, a series of explosions started. This initial series of explosions lasted 3 minutes. The Master was notified of the fire, and he went to the pilothouse and sounded the general alarm. He then ordered the discharge of carbon dioxide from the ship's

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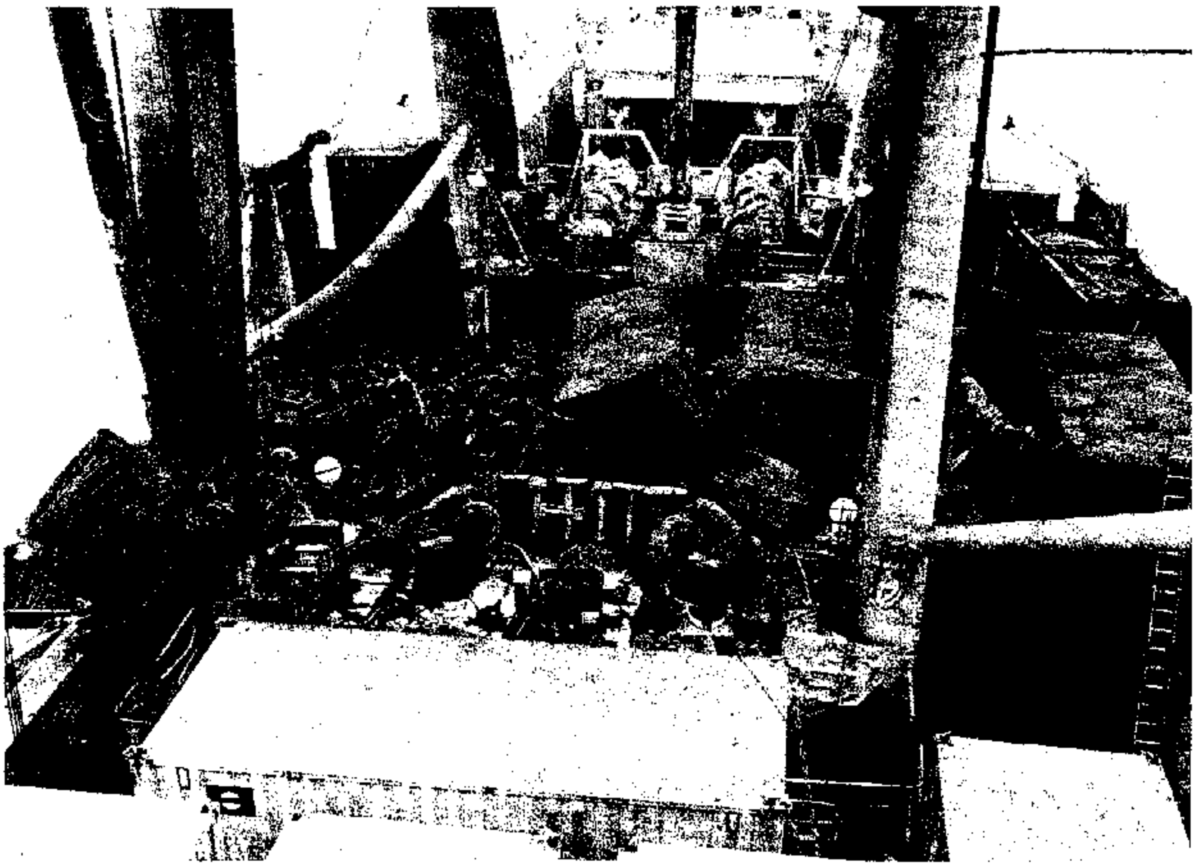

**Fire damage to cargo gear and containers on main deck of Letitia Lykes in way of Nos. 2, 3, and 4 cargo holds. Majority of damage is over No. 3 hold.** *(Official U.S. Coast Guard photo by LT William J. Uberti)*

fixed system into the upper 'tween decks of Nos. 2, 3, and 4 cargo holds. The Chief Mate, Third Mate, and Chief Engineer went to the carbon dioxide room and, despite the placard which listed the amount of $CO_2$ needed for each hold, released only half of the amount required to protect the spaces from fire. The vessel's electric fire pump was energized, and the ship's officers and crew fought the fire, taking advantage of the cover of the deckhouse for protection from exploding compressed gas bottles.

Nine minutes after the fire started, a second series of thundering detonations began, and the discharge pressure from the electric fire pump dropped. The First Assistant Engineer thought the pressure drop was caused by a clogged sea chest; he told the pilothouse personnel to reduce the number of hoses fighting the fire. The steam fire pump was then started, and it provided sufficient firefighting pressure. Unknown to the ship's personnel, the fire main on the main deck at the starboard side of No. 3 hatch had been crushed, and a fire station on the port side had been completely destroyed by the explosions. At no time did any ship's personnel attempt to isolate the damaged portion of the fire main.

Ten minutes after the onset of the disaster, the Master requested assistance from the Diego Garcia Fire Department, and three tugs were on the scene within 10 minutes. The tugs initially stood off from the **Letitia Lykes** because of the compressed gas "bombs" that were wrecking the main deck. Their caution was well rewarded. After they arrived but before coming alongside the **Letitia Lykes**, one or two containers on the port side of No. 4 cargo hatch exploded and were blown over the side of the ship, tearing out 10 feet of the bulwark as they went.

When the savage explosions subsided, the tugs moved in and, along with the ship's crew and U.S. Navy firefighters, attacked the fire, bringing it under control at 11:00 p.m. and eventually extinguishing it at 2:30 a.m. on May 9, 10 hours after it started. The vessel would have been lost if shoreside personnel and tugs were not available to fight the fire.

## The Damage

No one was killed or seriously injured. One of the ship's crew suffered a minor case of smoke inhalation; another crewman and a U.S. Navy petty officer received minor cuts from flying shrapnel. Dollar damage to the vessel and cargo ran into seven figures. The No. 3 hatch cover was completely devastated. All booms, cargo gear, winches, and boom rests for No. 3 cargo hold were badly damaged. Motor generator houses 2 and 3 were repeatedly holed by shrapnel; they and all associated electrical equipment were virtually destroyed. The main deck on the port side of No. 3 hatch was set down 6 to 10 inches from the terrible heat of the fire. In seven places, holes 6 inches in diameter were punched through the deck where ruptured oxygen bottles were trapped against the deck and acted like gigantic cutting torches. All windows in the forward side of the deckhouse were pitted by flying debris or blown out, and the house itself was scorched and marred with numerous dents and one 10-inch puncture.

Containers with 126 tons of oxygen bottles were completely destroyed. This tremendous release of pure, medical oxygen fed the fires which ravaged the vessel for 10 hours. All 41 tons of nitrous oxide were destroyed. Containers with 19 of the 49 tons of acetic acid were badly damaged or demolished. Containers with compressed nitrogen, liquefied propane, organic peroxides, silver nitrate, chloroform, flammable liquids, and poisons were also damaged or destroyed.

All 26 containers in way of the No. 3 hatch were destroyed. Three on No. 2 hatch were destroyed as well as three on No. 4. Thirty-two containers were a total loss; 9 others were badly damaged or scorched. The containers on No. 5 and 6 holds, which were aft of the house, were not damaged. They were, however, cluttered

Fire damage to cargo gear and containers on starboard side of main deck of Letitia Lykes in way of No. 3 hold. *(Official U.S. Coast Guard photo by LT William J. Uberti)*

Exploded compressed oxygen and nitrous oxide bottled in way of No. 3 hold on port side of Letitia Lykes. (Official U.S. Coast Guard photo by LT William J. Uberti)

with debris that shot up and over the house to land on the after part of the ship.

## Lessons Learned

The civilian crew of the **Letitia Lykes** consisted of 33 officers and men. Only 16 of the 33 had ever attended a formal firefighting training course before this casualty. Of this 16, only 3 had been trained in the past 5 years. The average time since the 16 crew members had attended firefighting school was over 17 years. One had attended his only firefighting school in 1945. This lack of training, as well as the stress from noxious smoke and hundreds of violent detonations, led to the error with the $CO_2$ flooding and the failure to isolate the fire main damage.

The regulations in Title 49, Code of Federal Regulations, govern the classification, marking, packaging, and stowage of dangerous cargo for the purpose of preventing casualties. During the casualty investigation, investigating officers from Coast Guard Marine Safety Office Hampton Roads examined the vessel's dangerous cargo documents and inspected the damaged and intact cargo containers; numerous discrepancies were uncovered. These discrepancies included the following:

- The vessel carried dangerous cargo that was not listed on the dangerous cargo manifest.

- The dangerous cargo manifest contained an abbreviated identification number for the containers while the container stowage plan listed the whole number.

- Most of the dangerous cargo containers did not have placards showing the type of dangerous cargo in them.

- The dangerous cargo manifest was not signed by the master or his appointee.

- Several containers were listed incorrectly.

- The dangerous cargo manifest for the cargo received on July 14, 1984, was not signed or dated by the preparer.

- Six items of dangerous cargo had improper shipping names.

- Individual hazard classes were not listed for 10 items.

While none of these violations caused or contributed to the casualty, these types of errors can aggravate firefighting difficulties and, in extreme cases, contribute directly to the cause of a casualty.

## The Cause

What caused the casualty? The exact cause of the fire could not be determined since the container in which it started and all of its contents were totally consumed in the conflagration. The popping sounds and hissing heard by the crew suggest that oxygen bottles were venting inside the container. Pure oxygen, plus an unknown ignition source, caused the fire.

## Summary

This casualty points out the need to properly stow and mark dangerous cargo and to account for it on the dangerous cargo manifest. The firefighting errors made by the crew suggest that merchant mariners should be formally trained in firefighting at shorter intervals than the 17 years since the last training experienced by half of this crew. Finally, the seriousness of this fire points out not only the hazards of going to sea but also emphasizes why dangerous cargo is called "dangerous."

What happened to the **Letitia Lykes**? While still at Diego Garcia and under the supervision of a marine inspector from Marine Safety Office Hampton Roads, temporary repairs were made to the ship's fire main and main deck, and a sturdy wood and tarpaper temporary hatch cover was fabricated for No. 3 hold. The **Letitia Lykes** discharged her cargo in Guam and proceeded to a repair yard in Japan where permanent repairs were completed on July 25, 1985, under the supervision of marine inspectors from Marine Safety Office Honolulu. The **Letitia Lykes** then returned to Preposition Group One in Diego Garcia and settled into a much quieter routine than it experienced on the eighth and ninth of May 1985.

*(The author wishes to thank LT W. J. Uberti, Coast Guard Marine Safety Office Hampton Raods, who investigated this casualty, for his suggestions and review of the article; and PAC H. L. Ceney, Fifth Coast Guard District, for his assistance with the photographs used in this article.)*

***Note:*** Even though oxygen is a nonflammable gas, an oxygen-enriched atmosphere will support a more rapid and intense rate of combustion than an air atmosphere. The probability of combustion will depend on the concetration of oxygen, the combustibility of the material, and the temperature. The severity of combustion will depend on similar factors.

## ASTM Committee F-25 on Shipbuilding Meeting

The ASTM Committee F-25 on Shipbuilding will be holding its semi-annual meeting in Bal Harbor, Florida, December 9 through 11, 1987.

The tentative semi-annual meeting dates for 1988 are May 6 - 8, 1988, in Baltimore Maryland, and December 6 - 8, 1988, in San Diego or Long Beach, California.

The ASTM Committee F-25 on Shipbuilding is actively developing a body of national shipbuilding standards which addresses the design, construction, installation, and testing of numerous shipboard systems and components.

For further information concerning ASTM F-25 activities and the December meeting agenda, please contact Ms. Katherne Schaaf, F-25 Staff Manager, at ASTM Headquarters, 1916 Race Street, Philadelphia, PA 19103; telephone (215) 299-5529. (The May 1987 issue of *Proceedings* contained an article on ASTM and Coast Guard participation in the National Shipbuilding Standards Program.)

# CHRIS? Who's CHRIS?

**Dr. Michael C. Parnarouskis, Mr. Michael D. Morrissette, and Mr. Curtis G. Payne**

CHRIS? Who's CHRIS?

This question has been asked many times by many different people. Actually, CHRIS is not a person, but an acronym which refers to the Coast Guard's Chemical Hazards Response Information System.

Various pieces of legislation enacted since 1970 have given the Coast Guard the responsibility for providing an On-Scene Coordinator at the scene of oil and hazardous material spills which occur in coastal or Great Lakes regions, and for coordinating the federal response to those spills. These new responsibilities and authorities led to the development of the Chemical Hazards Response Information System (CHRIS), which, as its name implies, is a system of chemical and hazard-related information, both quantitative and qualitative, developed to be used by Coast Guard field personnel in responding to emergency spill situations.

The CHRIS system is composed of five basic elements: four manuals and the Hazard Assessment Computer System (HACS). CHRIS was designed to support two basic modes of response to hazardous material spills. The first encompasses the very early stages of involvement by Coast Guard personnel. These early stages of response, lasting from a few minutes to several hours at most, principally involve immediate on-scene Coast Guard personnel, whose actions will be primarily limited to cautionary measures, rescue, first-aid treatment, observation, and reporting.

The second or later response mode involves concerted efforts by Coast Guard personnel to eliminate or correct the hazardous material spill situation. These actions demand the involvement of technically trained personnel and detailed information on chemicals, their hazards, vulnerable resources, and response methods.

## A Condensed Guide to Chemical Hazards

This handbook, designated Commandant Instruction M16465.11a, contains information to facilitate "early response decisions" during emergency situations. It is a compact, convenient source of chemical-related information with specific reference to bulk-shipped hazardous materials. The guide is intended primarily for use by those Coast Guard personnel who may be first to arrive at the site of an incident and need readily available, easily understood, descriptive information about the hazardous nature of the chemical and the situation confronted. It will assist those personnel in quickly determining proper, responsible actions that must be taken immediately to safeguard life, property, and contamination of the environment.

This guide consists of a compilation of chemical data sheets summarizing fire hazards, health hazards, and first-aid measures, response methods for spills or leaks, and effects on marine and wildlife. Descriptions of color, odor, phase, and physical action on release are included.

Data sheets are filed alphabetically by the chemical name that is specified in the Code of Federal Regulations (CFR) or other government documentation. Reference to the chemical name is aided by the coded three-letter alphabetic designation (CHRIS Code) for each chemical, and by the thesaurus that cross-references synonyms and trade names with the official name. In addition, the manual contains explanatory material on the interpretation and use of its contents, and a guide to the compatibility of chemicals.

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## Hazardous Chemical Data

The Hazardous Chemical Data Manual (Commandant Instruction M16465.12a), often called the cornerstone of CHRIS, contains detailed, largely quantitative chemical, physical, and toxicological data necessary for formulating, evaluating, and carrying out response plans. It is intended for use primarily by the On-Scene Commander's (OSC) office and the Regional and National Response centers. This manual contains the hazard assessment code which is essential to selecting the appropriate calculations procedures for the hazard assessment, and provides the chemical and physical data which are necessary to perform the hazard assessment calculations in the Hazards Assessment Handbook and in HACS. There are currently 1,016 chemicals contained in the manual.

The bulk of the manual is comprised of data sheets, one for each chemical, filed alphabetically by chemical name. Reference to the chemical is aided by a set of complete cross-referenced lists indexing each chemical by its chemical name, three-letter CHRIS Code, synonyms or trade names, and reactivity group designations.

For each chemical, summary information appearing in the Condensed Guide is repeated, followed by detailed data in the following categories:

1. Cautionary and corrective responses
2. Shipping labels
3. Chemical designations
4. Observable characteristics
5. Health hazards
6. Fire hazards
7. Chemical reactivity
8. Water pollution
9. Shipping information
10. Hazard assessment codes
11. Hazard classifications
12. Physical and chemical properties

## Hazard Assessment Handbook

The Hazard Assessment Handbook (Commandant Instruction M16465.13) provides trained personnel and other hazardous material specialists with simplified methods and procedures for rapidly estimating the maguitude and location of the threat presented by the potential or actual release of a hazardous material. It includes procedures for predicting the rate of release of the chemical from its container, the movement and dispersal of the chemical in water and air, the thermal radiation from fires, and the area over which the resulting toxic, thermal, and explosive effects may threaten vulnerable resources.

The manual consists of four major parts:

1. Method of determining on-scene information needs by acquiring information pertinent to the spill situation.

2. Selection of the appropriate simplified calculational procedures.

3. Approach to actual hazard assessment.

4. Tables and charts in support of the assessment procedures.

The hazard assessment procedures in the manual have been reduced to a simple set of manipulations that, with elementary calculations, utilize graphs and tables presented in the manual. Worksheets are provided for each procedure with a solved example of a hypothetical assessment on the left side; blank spaces to be completed for the actual emergency situation are on the right side of the worksheet.

## Response Methods Handbook

The Response Methods Handbook (Commandant Instruction M16465.14) is a compendium of descriptive information and technical data pertaining to methods of responding to threatened or actual spills of hazardous materials. This document was written for Coast Guard On-Scene Coordinators and other response personnel who have had some training or experience in pollution and hazard response, and serves as a guide during emergencies, an aid in contingency planning, and as a training device.

This handbook treats both cautionary and corrective response methods. Cautionary responses include monitoring the incident, issuance of warnings, restricting access to the area, and evacuation. Corrective responses encompass commodity transfer, containment and motion control, removal, chemical and physical treatment, and dispersal and flushing.

Operational, engineering, and logistic requirements associated with the different response methods are presented, and the limitations on the use of specific methods by environmental conditions are treated. Methods are presented for selecting specific response procedures based on the chemical spilled and the conditions that exist during the incident. Also included in the manual are detailed manufacturer's data on various types of response equipment.

## Hazard Assessment Computer System

The Hazard Assessment Computer System (HACS) is a computerized simulation system which models the physical behavior of hazardous material spills and provides information describing the extent of the hazards associated with these spills. HACS is perhaps best described as the computerized counterpart of the Hazardous Chemical Data Manual and the Hazard Assessment Manual. The main objective of HACS is to both quickly and accurately provide quantitative estimates of the type and extent of the hazards associated with actual or potential spills in large quantities.

In the interactive operations of HACS, users interface with the computer system by means of a data terminal for input of data and displays of hazard assessment results. HACS contains an internal master data file, and the operation of the system is governed by specific procedures to obtain the required data from the user and then store the data in the master file. When sufficient input data have been obtained from the user, HACS will run an assessment model and display the results at the user terminal. When all assessment calculations to be performed have been obtained and validated by the user, the hazard estimation information can then be communicated to the appropriate personnel.

## CHRIS Codes

One element of CHRIS, the CHRIS Code, needs to be discussed in greater detail. Many people use CHRIS Codes every day; however, few know all the applications or how and why they were developed in the first place. You may be aware that they are in some way connected with chemicals or hazardous materials. But if your work involves port safety, marine inspection, or spill response, you've probably come in contact with them on an almost daily basis.

The development of the Codes started during the early 1970s when the Coast Guard was in the process of developing the CHRIS system. A method was needed to identify chemicals in a precise way through verbal communications. The approach taken was to assign a unique, three-letter code to every chemical in the CHRIS system so that the identity of the chemical could be communicated using the phonetic alphabet. This enabled communication over a radio between persons unfamiliar with chemicals and their names, where broken transmissions or mispronunciations can occur.

The original set of Codes consisted of a list of 400 chemicals. Included were all 284 bulk cargoes listed in 46 Subchapter O (bulk dangerous cargoes carried on vessels) and Subchapter D (petroleum products with flammability hazards). The remaining chemicals were selected from a preliminary list of Hazardous Polluting Substances developed by the Environmental Protection Agency. Later, 500 additional chemicals of commercial importance were selected by the Coast Guard to be included in the CHRIS system. Each of these was also assigned a three-letter Code.

Over the years, as use of the three-letter Codes expanded into other areas, Codes were assigned to cargoes that would probably never be included within the CHRIS system. For example, many have been added to take care of the new cargoes with pollution properties that were incorporated into the IMO Chemical Codes and the corresponding U.S. Regulations with the implementation of Annex II to MARPOL 73/78 in April 1987. Some Codes have been assigned to cargoes which are mixtures of isomeric chemicals and others to water solutions of chemicals; these types of cargoes will not be added to CHRIS since the pure components are already in the CHRIS system. There are now about 1,500 entries in the CHRIS Code list, but only 1,016 of these are authentic CHRIS chemicals.

When a Code is assigned to a cargo (this is now done by the Coast Guard's Hazardous Materials Branch, G-MTH-1), an attempt is made to relate the Code to the name as closely as possible; for example, BNZ for Benzene or SAC for Sulfuric Acid. When the product is a chemical element, its chemical symbol (taken from the periodic table of elements) is used and followed by Xs. Examples are HXX for Hydrogen, SXX for Sulfur and CLX for Chlorine. In those cases where the chemical industry has already adopted a Code of its own for a product, it is assigned as the Code whenever possible. Some well-known chemicals with existing Codes are Toluene diisocynate (TDI) and Ethylene Dibromide (EDB). With over 17,000 possible three-letter combinations, a good match has been found for nearly all products.

Where does the Coast Guard use these CHRIS Codes? Originally they were only used in the CHRIS manuals to allow field personnel to positively identify a chemical. (Those unfamiliar with chemical terminology found it much easier to say "DSA" than to pronounce "Dodecylbenzenesulfonic acid.") When a decision was made to computerize the Hazard Assessment Manual, the CHRIS Code was chosen as the method of telling HACS which chemical was involved. This allowed the use of an indexed file as the storage medium for the chemical data that HACS needs, thereby speeding up the execution time required to complete a hazard assessment. This also saves the user time in running the Hazard Assessment Computer System (HACS), since in the event of a chemical spill onto water, the user need only enter the three-letter Code rather than a complex, easily misspelled chemical name.

Later, as field personnel became more familiar with them, the uses for the Codes expanded. Today they are used extensively in the Coast Guard's Marine Safety Information System (MSIS), both to enter the cargo properties window and to designate cargoes on Certificates of Inspection issued for U.S.-flag vessels and Certificates of Compliance for foreign-flag vessels. CHRIS Codes are employed in other computer data bases as well. The Pollution Reporting System tabulates water pollution incidents by Codes, and the Coast Guard Hazardous Materials Branch's new computer program "POLCAT," used for determining pollution categories and shipping requirements under Annex II to MARPOL, can be accessed by the CHRIS Code.

The CHRIS system, however, is not used exclusively by Coast Guard Headquarters and field personnel. Many other federal agencies, such as the Environmental Protection Agency, the Federal Emergency Management Agency, the National Transportation Safety Board, and the Department of Defense, use the CHRIS manuals and the HACS system as a source of information for dealing with actual or potential hazardous materials spills. HACS has also been used in post-accident analysis to determine if actions taken during a response were appropriate and whether observations made during the incident compared favorably with model predictions.

CHRIS is also extensively used outside the federal government by various state agencies, fire departments, police departments, and others who are involved in hazardous materials spill response. The information contained in CHRIS is used to train emergency response personnel and to develop contingency plans for handling spill emergencies within their communities. In addition, many non-government users, such as refineries, chemical processing plants, trucking companies, and barge and ship companies use the information contained in CHRIS to train their personnel to be aware of the hazards of the chemicals they deal with as well as what to do in case of an accidental release. In addition, they extract information from CHRIS and use it to prepare cargo information cards and material safety data sheets.

The CHRIS system is presently available to the general public from several sources. Published manuals and on-line systems that can be accessed by remote terminals through a subscription service or through software available for use on IBM-compatible personal computers are available. Sources for these are as follows:

- *Manuals:* Only two of the four CHRIS manuals, the Condensed Guide to Chemical Hazards and the Hazardous Chemical Data Manual, are currently available for purchase. Both may be purchased from the Superintendent of Documents, Government Printing Office, Washington, DC 20402.

- *Computerized versions of the Hazardous Chemical Data Manual:* Current sources include subscription to the Chemical Information System (CIS), available from Fein-Marquart Associates, Baltimore, Maryland; by purchase of software and data files on floppy disk for IBM-compatible PCs, also available from Fein-Marquart; and by purchase of software and data on compact disk for IBM-compatible PCs with compact disk drive, available from Silver Platter Information Services, Wellesley Hills, Massachusetts.

- *HACS source code:* Available from U.S. Coast Guard (G-MTH-1), Washington, DC 20593-0001 (send blank 1/2-inch magnetic tape).

# Intrinsically Safe and Nonincendive Systems

Bruce A. Jackson

Where flammable gases or vapors may be present, such as on the drill floor of a mobile offshore drilling unit or in the pumproom of a tankship, special precautions must be taken to ensure that electrical equipment is not a source of ignition. For low power applications, such as instrumentation and control, the use of "intrinsically safe" and "nonincendive" systems can reduce the likelihood of fire or explosion due to the ignition of flammable gas mixtures by electrical arcs or high temperatures. However, safety depends on their proper application, as these two forms of protection are not equal. The purpose of this article is to briefly describe these systems and to emphasize their differences.

## Classification

Before intrinsically safe and nonincendive systems can be addressed, a basic understanding of how locations are classified is necessary. National and international codes and regulations classify hazardous locations based upon (1) the experimentally determined properties of the hazardous material that may be present and (2) the likelihood that a flammable or combustible concentration or quantity of that material is present.

North American standards identify hazardous locations using the scheme described in Tables 1 and 2. International standards use a different nomenclature, but their classification philosophy is essentially the same.

As an example of this classification scheme, an area involving gasoline vapors would be a Class I, Group D location. Where gasoline vapors would be present under normal conditions, the area would be a Division 1 location. Therefore, equipment installed in this location must be suitable for use in Class I, Group D, Division 1 locations.

This classification system requires the use of some individual judgment, especially in the designation of "Division." To promote consistency and ensure safety, standard-setting bodies and regulatory agencies have developed detailed standards, recommended practices, codes, and regulations applicable to specific situations. For example, both the International Maritime Organization (IMO) Code for the Construction and Equipment of Mobile Offshore Drilling Units (MODU Code) and the Coast Guard's Electrical Engineering Regulations classify outdoor locations within the boundaries of the drilling derrick up to a height of 10 feet (3 meters) above the drill floor as a Division (Zone) 2 location.

Once a specific location is classified, the permitted types of electrical equipment are easily determined. The National Electrical Code (NEC) is incorporated by reference, in part, by Coast Guard regulations, and contains explicit provisions for the installation of specific types of electrical equipment in the various hazardous locations.

## Nonincendive Circuits

Section 501-3 of the NEC states:

*In Class I, Division 2 locations ... switches, circuit breakers, and make-and-break contacts ... shall have enclosures approved for Class I, Division 1 locations ... EXCEPTION: General-purpose enclosures shall be permitted, if current-*

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*interrupting contacts are ... in circuits that under* **normal conditions** *(emphasis added) do not release sufficient energy to ignite a specific ignitable atmospheric mixture, i.e., are nonincendive.*

The word "nonincendive" means that under the conditions specified, there is insufficient energy to cause ignition. Nonincendive systems are only permitted in Division 2 and non-hazardous locations.

**Table 1**

**Classification of Properties of Hazard-Producing Materials**

**Class I -- Locations where flammable gases or vapors may be present, including:**

| | |
|---|---|
| Group A: | Atmospheres containing acetylene. |
| Group B: | Atmospheres such as butadiene, ethylene oxide, propylene oxide, acrolein, or hydrogen (or gases or vapors equivalent in hazard to hydrogen) |
| Group C: | Atmospheres such as cyclopropane, ethyl ether, ethylene, or gases or vapors of equivalent hazard. |
| Group D: | Atmospheres such as acetone, alcohol, ammonia, benzene, benzol, butane, gasoline, hexane, lacquer solvent vapors, naphtha, natural gas, propane, or gases or vapors of equivalent hazard. |

**Class II -- Locations where combustible dust may be present, including:**

| | |
|---|---|
| Group E: | Atmospheres containing combustible metal dusts or other combustible dusts or similarly hazardous characteristics. |
| Group F: | Atmospheres containing combustible carbon black, charcoal, coal, or coke dusts. |
| Group G: | Atmospheres containing combustible agricultural or plastic dusts. |

**Class III -- Locations where easily ignitable fibers or flyings, such as cotton fibers, sawdust, and wood shavings,** may be present.

**Table 2**

**Classification of the Probability that Material May Be Present in Flammable or Combustible Quantities**

| | |
|---|---|
| Division 1: (Zone 1) | Where material can exist under normal operating conditions, or frequently because of repair, maintenance, or leakage. |
| Division 2: (Zone 2) | Where material can exist under abnormal conditions (accidental rupture or breakdown, abnormal operations, etc.), or locations adjacent to a Division 1 location where material may occasionally be present. |

**Note:** International standards and codes use the term "Zone" instead of "Division" and include a "Zone 0" designation for locations where vapors are assumed to be present, such as inside a tank or in a tankship pumproom. Although North American standards, such as the National Electrical Code (NEC) do not include a comparable "Division 0" designation, the Coast Guard's Electrical Engineering Regulations achieve the same effect by limiting electrical installations in these locations to the type permitted for Zone 0 applications, i.e., intrinsically safe systems.

In the past, much of the nonincendive circuitry that found its way into Division 2 locations was neither designed nor intended for use in hazardous locations. Only when a Division 2 application arose for a specific item was the circuit examined to see if it was nonincendive. Regulatory bodies typically reviewed manufacturer's analyses to see if voltage and current levels fell below the appropriate ignition curve with a reasonable margin of safety. If they did, the circuit was accepted to be nonincendive.

Today, much of the equipment installed in Division 2 locations has been designed to be nonincendive. This is especially true of sophisticated electronic equipment used in the drilling industry. Furthermore, manufacturers are recognizing the need for independent third-party approvals. In North America, standard-setting bodies, such as the Instrument Society of America, Underwriters Laboratories, Inc., and the Canadian Standards Association, have published or are presently developing safety standards for nonincendive equipment. Third-party certification agencies are using these standards to evaluate and list or label nonincendive equipment. Listed or labeled equipment provides the end user with a greater degree of confidence that the nonincendive equipment has been properly evaluated and will not present an unnecessary risk of fire or explosion.

## Intrinsically Safe Systems

Section 500-2 of the NEC states:

*Equipment and associated wiring approved as intrinsically safe shall be permitted in any hazardous (classified) location for which it is approved ... Intrinsically safe equipment and wiring shall not be capable of releasing sufficient electrical or thermal energy under* **normal or abnormal** *(emphasis added) conditions to cause ignition of a specific flammable or combustible atmospheric mixture in its most easily ignitable concentration.*

Intrinsic safety goes several steps beyond the bounds on nonincendive circuits. Electric arcs and high temperatures must not be a source of ignition under abnormal conditions and equipment faults, as well as under normal conditions. Intrinsically safe systems are permitted in all hazardous locations (Division 1, Division 2, And Zone 0), provided they are approved for the proper hazard group.

Intrinsically safe portable battery-powered equipment, such as walkie-talkies and combustible gas detectors, are evaluated based on their internal circuitry. However, equipment that is interconnected to other equipment, such as to the vessel's electrical system, is evaluated on a system basis. Since evaluations for intrinsic safety consider failure modes, faults in connected apparatus such as power supplies, meters, and recorders (regardless of their location, i.e., hazardous or non-hazardous) may affect energy levels in the circuit, and are fully evaluated.

In determining available energy levels, abnormal conditions include opening, shorting, and grounding of wires connected to the enclosures in the intrinsically safe portion of the system. In North America, two "reasonable" simultaneous faults are considered in assessing available electrical and thermal energy. Industry standards give detailed criteria for determining reasonable failure modes. Evaluations usually involve an in-depth circuit analysis, supplemented by actual ignition testing.

Intrinsically safe systems and portable equipment must be listed or labeled by an independent, third-party certification organization. This provides assurance that the system will not have sufficient energy in the intrinsically safe portion to cause ignition, even with an interconnecting cable failure and failures in the energy limiting circuitry.

Safety also depends on proper installation. It is necessary to ensure that the system is connected correctly and that unsafe energy levels are not imposed upon intrinsically safe circuits by nearby non-intrinsically safe circuits. The manufacturer's installation instructions must always be followed.

For low power applications, intrinsically safe systems offer advantages over "add-on" protection, such as explosion-proof and purged and pressurized enclosures. Intrinsic safety is not jeopardized by a missing or loose bolt, a scratched flange, an unpoured cable seal, a stuck interlock, or mechanical damage. The intrinsically safe circuit is less maintenance dependent and provides a lifetime of protection with relatively little care.

## Summary

Nonincendive systems are not a source of ignition under normal conditions and are permitted in Division 2 locations. Intrinsically safe systems are not a source of ignition under normal and abnormal conditions and are permitted in all classified locations. With the technological advances in electronics, low energy equipment is available to monitor and control most functions that could be expected to be located in a hazardous location on a vessel or mobile offshore drilling unit. Most of these can be designed to be nonincendive or intrinsically safe.

The material presented in this article has been condensed and simplified. Should the reader desire more information, there are many standards and other publications available on intrinsically safe and nonincendive systems. Many of these are published by the Instrument Society of America, the National Fire Protection Association, Underwriters Laboratories, and the Canadian Standards Association.

# Maritime Notes

## Prohibiting Disposal of Plastic Garbage in Ocean Waters

While we may not know how much salt is in the sea, we do know that every year 6.4 million metric tons of trash is dumped in the ocean; 45,000 tons of which is plastic garbage.

Legislation to implement an international agreement to end the practice of throwing plastics overboard was approved by the House Merchant Marine and Fisheries Committee on September 22, 1987.

H.R. 940 implements Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL). The bill prohibits the disposal of plastic garbage by U.S.-flag vessels in all ocean waters and establishes additional restrictions on the dumping of other forms of trash. U.S. public vessels (i.e., Navy) would have 5 years to comply with the prohibition, but this timetable could be extended if necessary.

Plastics degrade slowly because of their light weight and float at or near the surface, posing a fatal hazard for many forms of marine life. Seabird mortality is estimated at 1 million annually and marine mammals at over 100,000 annually.

Four amendments were offered and adopted by the Committee by voice votes: the first a technical amendment; the second allowing the Coast Guard to enforce the bill's provisions against foreign-flag ships within the U.S. 200-mile limit; an amendment calling for an EPA study of plastic pollution problems in the New York Bight; and an amendment requiring studies by EPA on land-based sources of plastic pollution and by NOAA on the effects of plastics on the marine environment.

## Hazardous Materials Transportation Seminar

The U.S. Coast Guard Marine Safety Office, Hampton Roads, Virginia, along with the National Cargo Bureau and the International Thomson Transport Press, will sponsor a Hazardous Materials Transportation Seminar on November 18, 1987, at the Omni International Hotel, Norfolk, VA. The seminar will be from 8:30 a.m. until 4:00 p.m. and will be geared toward the *waterborne* transportation of hazardous materials. Topics to be covered include Title 49 CFR, documenting requirements, stowage, segregation, packaging, marking, labeling, and placarding of hazardous materials.

Mr. Ron Bohn, a nationally recognized expert in the shipment of packaged hazardous materials, will be a guest lecturer as will several other members of the local maritime community and the U.S. Coast Guard.

The cost of the seminar is $10 and seating is limited to the first 100 people. Reservations may be made by contacting Mrs. D. Montague at (804) 441-3299.

Members of the press are invited to interview presenters with prior arrangements. Press inquiries should be made to LT John McCarthy at (804) 441-3306.

# On Ocean Service: Two River Barge Casualties

**LCDR Joe Brusseau**

It can be risky to put river barges in ocean service. In separate, recent incidents, two river barges were destroyed. Each was on its first ocean voyage.

In one case, an administrative error allowed a river barge to gain an oceans route. It was under tow from Houston, Texas, to Tampa, Florida, with a full load of ethyl alcohol. The cargo exploded when the barge broke up crossing the Gulf of Mexico.

In the other case, a river barge was undergoing a change of employment. It was gas-free and unballasted when it left Greenville, Mississippi, under tow to New York. Near Charleston South Carolina, it broke up in 10-foot seas.

There are some lessons to be learned from these casualties. They are worth a closer look.

The alcohol barge was being towed astern across the Gulf of Mexico. It had been a pleasant day, but thunderstorms developed in the evening, kicking up a 5-foot chop. Suddenly, the barge exploded. Hearing the explosion, the tug operator looked back to see the bow of the barge engulfed in flames. About 15 minutes later the fire went out, extinguished by the seas. But the bow rake had disappeared. The tug was able to tow the remaining part of the barge back to port. It was later modified for oceans and put back in service.

The operator believed that lightning had struck the barge and ignited the cargo. An examination of the salvaged stern section showed, however, that the barge had been breaking up before the explosion.

Apparently, a structural failure damaged the bulkhead between the alcohol cargo and the bow rake void. This allowed alcohol to leak into the rake and form explosive vapors. The source of ignition could indeed have been lightning, or it may have been sparks from the progressing structural failure. Whatever finally ignited the explosion, this casualty was caused by a structural failure on a barge that was not designed for ocean conditions.

In the other casualty, a barge was being towed astern on smooth seas east of Charleston, South Carolina. As evening approached, the good weather deteriorated. Seas were up to 10 feet with 25- to 30-knot winds by midnight, when the towline suddenly parted. On board the tug, the operator was able to keep the barge on radar while the crew prepared to take it in tow again. But when the tug came alongside to pass a towline, they found only the stern half of the barge! It was salvaged, and the Coast Guard was able to study it. The bow half eventually drifted aground, but it was damaged too badly to help in reconstructing the casualty.

The bottom plating of the stern half was crumpled and twisted, while the deck was distorted very little. This indicated that the deck was in tension while the bottom was in compression. In other words, the barge was in a hogging mode when it failed. A close look revealed that the steel had failed in a ductile manner; that is, the plate was torn apart in a relatively slow fashion rather than fracturing instantaneously. The bottom shell apparently buckled under compression. Then the barge hinged up and down a few times at this spot before it was torn completely in two. As the barge broke up, there would have been a sudden increase in towing resistance. It is probably at this moment that the towline broke.

These casualties should be looked at together because they have several things in common:

- Both were single skin, longitudinally framed, river tank barges.

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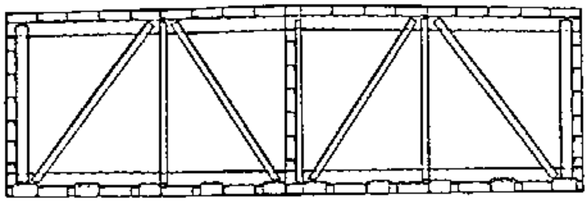


internal stiffening:
midship section of a barge

- Both had been certificated for Lakes, Bays, and Sounds before their final voyage.
- Both had been recently inspected and were in good structural condition.
- Both were on their first sea voyage.
- Both were being towed astern.
- Both met American Bureau of Shipping (ABS) River Rules, but not ABS Rules for Barges in Offshore Service.
- Both had the long, shallow bow rake typical of a river tank barge (sometimes called a spoon-bill barge).
- A strength analysis showed that the longitudinal strength of both was sufficient to withstand the static wave bending moments they encountered.

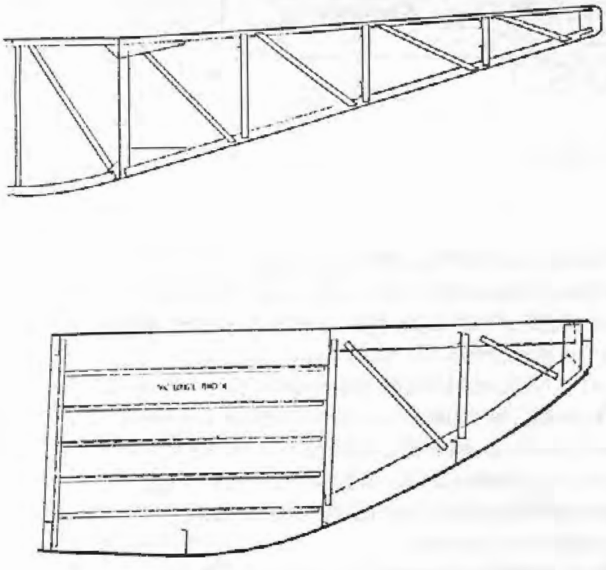
Nobody actually saw these barges break up, so we can never be completely certain about what happened in either of these casualties. But from all the evidence, our best estimate is that the bottom structure was pounded in by the seas until it was no longer effective in compression. Then the barges didn't have enough strength left to keep from bending and eventually breaking.

In the case of the alcohol barge, the rake bottom just forward of the cargo tank bulkhead suffered most of the damage. As the bottom was "set up," it distorted the bulkhead until it eventually leaked. Under continued pounding, a spark from the tortured steel may have touched off the explosion. For this casualty, the spoon-bill bow form is mostly to blame. It is so long, shallow, and flat that pounding is almost guaranteed in a seaway.

For the other barge, the spoon-bill rake was a problem, but this barge had worse problems. Remember that this barge was completely empty, and its draft was only about 18 inches. So when it encountered waves several feet high, it began pitching significantly. By the time it was in 10-foot seas, the forward one-third of the barge was pitching clear of the water on nearly every wave. The wonder is that it endured this punishment for hours before it broke up.

The most important lesson is a reminder: pounding is a dangerous and destructive force that must be avoided. Complete failure of the hull can result from continuous pounding for even a short time. This danger is particularly great for towed barges, since nobody is aboard to feel that the barge is pounding.

- Any vessel is in danger of pounding, even at low speeds, if it is light by the head. For long voyages, or if bad weather can be expected during the voyage, barges should be ballasted to keep the bow from coming out of the water.
- The long, spoon-bill rake has poor seakeeping properties. Although a heavy load or proper ballasting can improve the situation somewhat, there is no way to keep this type of bow from pounding in a seaway. While the spoon-bill is typical and adequate for river service, it is not the best shape for ocean service.



**Inboard profile of a spoon-bill bow (top) and an ocean barge bow (bottom).**

- Most changes of employment are supposed to be made in fair weather only. Fair weather can turn foul in a very short time. Tug operators should be instructed to seek shelter when bad weather is first forecast. If they wait until they are in the middle of it, they may be too late.

- A Change of Employment, the so-called "one way trip," doesn't need to be one way to Davy Jones' locker. But even short sea voyages are much more severe than is normal for a river barge. They should be undertaken very cautiously.

## Explaining Some Basic Principles

Longitudinal strength refers to a vessel's ability to bend without breaking. Bending down in the middle is called sagging. Bending up in the middle is called hogging. A ship or barge is essentially hollow. It is a box with very thin walls relative to its breadth and depth. In fact, if you wanted to make a scale model of a river barge, if it is made 4-1/2 feet long 1 foot wide, and 3 inches deep, the plate thickness would be the thickness of a piece of typing paper! Your intuition is right: that would never be strong enough, unless there were a way to keep the paper (plating) where it all belongs. In fact, barges have an extensive network of stiffeners and trusses inside to do just that.

Buckling happens when a piece of plate bends while its edges are under compression. You can demonstrate this with a piece of paper. Lay a piece of typing paper flat on a table. Pressing down and out on the ends of the paper tends to stretch the paper: it is being stressed in tension. Pressing down and inward on the ends of the paper stresses it in compression. You will quickly see a difference in the way the paper behaves. In tension, no matter how hard you press out on the ends of the paper (even if it rips), it stays flat. In compression, however, no matter how lightly you press in on the ends of the paper, the middle of the sheet wants to buckle upward off the table. The bottom or deck plating of a ship or barge acts exactly the same way. Under tension, it is very strong. But under compression, it tends to buckle, and it takes a lot of stiffening to keep that from happening.

Here is a startling demonstration of failure due to buckling. (Partygoers are probably familiar with this one.) Place an empty beverage can upright on the floor. The can should be in good condition, that is, without dents or creases. Have someone with a good sense of balance gently step up on the can until he or she is standing on one foot on top of the can. If this is done carefully, the can is able to handle a person up to 175 pounds or so. At this point, the sides of the can are under compression. The shape of the can, however, stiffens the sides enough to keep them from failing. Now let's do something to get buckling started. With your acrobat still balanced on the can, have someone else lightly push against the side of the can with the eraser of a pencil. The can will collapse immediately. (You can use a finger instead of a pencil, but a pencil is less painful.)

Barge designers have had this figured out for a long time, so barges are built with enough stiffening to handle the job . . . most of the time. If anything happens to get buckling started in spite of the stiffening, then disaster usually follows quickly. This is where pounding becomes important. Under normal conditions, the bottom plating has only about 5 psi tending to buckle it out of line. But pounding pressures can be 5 to 10 times as great. The barge simply can't stand that much, and the bottom will buckle. ▮

# Grounding of the Tankship Mobiloil

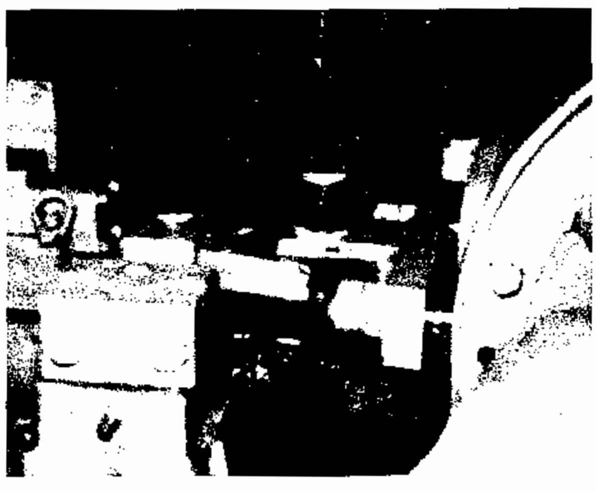
Thomas J. Pettin

Sometimes it's the little things that wreak havoc. In the case of the tankship **Mobiloil**, that little thing was a small cotter pin in the steering system, and the accident that followed the loss of this pin resulted in substantial pollution of U.S. waters and the total loss of a multimillion-dollar vessel.

At approximately 6 minutes past midnight on March 19, 1984, the **Mobiloil**, a 618-foot American oil tanker, enroute from Anacortes, Washington, to the Mobil Oil Facility in Portland, Oregon, loaded with 200,442 barrels of cargo oil, ran around near Warrior Rock in the Columbia River. On the day of the casualty, the sky was overcast, visibility was 10 miles, and there was no measurable wind. The **Mobiloil** went aground in 29 feet of water, 900 feet from the Oregon shoreline. Due to the rocky bottom, the vessel suffered severe damage to the forepeak and five cargo tanks. The federal On-Scene Coordinator determined that the amount of oil spilled into the Columbia River was about 4,000 barrels of various grades of No. 6 oil. Temporary repairs were made to the **Mobiloil**, and it was refloated. On March 26, 1984, the vessel proceeded to Portland Ship Repair Yard for survey. Due to the extensive damage and age of the vessel, the **Mobiloil** was determined to be a constructive total loss. No one was injured in the casualty.

The primary steering equipment on board the **Mobiloil** was an electrohydraulic unit manufactured by American Engineering Company. The steering equipment was tested by the watch officer just prior to the vessel entering the Columbia River, using first the hand electric controls and then the hydropilot system. Just prior to the casualty, the helmsman was ordered by the pilot to change course. The helmsman reported that the rudder was jammed hard right and that the steering gear was not responding. The pilot ordered "all stop," "full astern," and then ordered both anchors dropped. Before the anchors could be let go, the **Mobiloil** ran aground.

Immediately following the grounding the Chief Engineer, First Officer, and Third Engineer went to the steering gear room. While examining the gear, the First Engineer noted that the starboard crosshead link pin had risen up out of position. The starboard crosshead link pin is part of the pump's follow-up control linkage (part of the shaft connection). After taking several pictures showing the pin out of position, the First Engineer returned the crosshead link pin to its proper position. When this was done, the steering gear was tested and found to be operating properly. A piece of wire was used as a "keeper" pin to prevent the crosshead link pin from working free again. The steering gear room was thoroughly searched for the missing cotter pin, but it was not found. Minutes before the casualty occurred, the steering gear had been examined by the relieving oiler, and nothing unusual was noted.



**Starboard steering pump with crosshead link clevis pin raised. This picture was taken immediately after the casualty, before any remedial action occurred.**

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*Mr. Pettin is a Program Analyst in the Coast Guard's Marine Safety Evaluation Branch, Office of Marine Safety, Security, and Environmental Protection.*

## Analysis

During the Coast Guard investigation, it was determined that the proximate cause of the grounding of the **Mobiloil** was a loss of steering control due to the starboard crosshead link clevis pin coming out of its fitting while both pumps were supplying hydraulic power to the rams. The linkage from which the pin shifted was located on the follow-up system. This system connects the output shaft from the motion transmitter to the pump control lever. The starboard crosshead link pin came free because of heavy vibrations in the steering room and vibrated free because the cotter pin intended to keep it in place was missing. The reason the cotter pin was missing cannot be determined; however, the most probable cause was that it had not been replaced after the steering gear had been worked on during an overhaul 9 months previously. It is also conceivable that an undersized cotter pin could have vibrated out of the clevis pin hole over time.

## The Coast Guard Is Trying To Reduce Steering Casualties

President Carter's initiative of 1977 called for higher tanker safety standards that included proposals for steering gear improvements. At that time, U.S. statistics included 87 casualties involving failure of the steering gear or steering gear control systems to oil tankers of 20,000 gross tons and upwards during the period 1963 to 1976: 40 of these casualties occurred on non-U.S. tankers operating in U.S. waters.

Historically, requirements for steering gear on U.S.-flag vessels have been found in Title 46, Code of Federal Regulations (46 CFR). Requirements for steering gear were not changed much prior to 1978. Following the numerous tanker steering casualties, the Coast Guard introduced new steering gear regulations (33 CFR Part 164), which stipulate that before a vessel of 1,600 or more gross tons can enter or get underway on any navigable waters of the United States, the vessel's primary and secondary steering gear has to be tested. This testing must occur no more than 12 hours before the vessel enters U.S. waters or gets underway.

The reader should note in table 1 the sharp decline in vessel casualties after 1979. This sharp decline followed the Coast Guard's introduction of the regulations that are now found in Title 33 CFR Subpart 164.25. While it is acknowledged that the number of vessels has decreased, it is believed that regulatory

Table 1:

Vessels Exceeding 1000 Gross Tons Sustaining a Steering Casualty

| | Pass Ship | Freight Ship | Tank Ship | MODU | Towboat | Research | Dredge | Fishing | Ferry | Other | Total Vessels |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1972 | 0 | 17 | 7 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 26 |
| 1973 | 3 | 28 | 14 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 46 |
| 1974 | 3 | 21 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 39 |
| 1975 | 1 | 26 | 6 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 37 |
| 1976 | 0 | 29 | 9 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 40 |
| 1977 | 0 | 28 | 17 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 48 |
| 1978 | 2 | 47 | 24 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 76 |
| 1979 | 2 | 52 | 17 | 1 | 4 | 0 | 0 | 0 | 2 | 1 | 79 |
| 1980 | 2 | 27 | 14 | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 48 |
| 1981 | 4 | 17 | 17 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 42 |
| 1982 | 5 | 26 | 12 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 47 |
| 1983 | 7 | 28 | 14 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 52 |
| 1984 | 5 | 19 | 11 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 38 |
| 1985 | 4 | 28 | 14 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 48 |
| TOTAL | 38 | 393 | 190 | 3 | 22 | 2 | 2 | 2 | 8 | 6 | 666 |

Note: barges not included

enforcement has had a significant impact. The decline in vessel casualties can also be attributed to the fact that many older ships were scrapped when the bottom fell out of the oil market in 1980.

A final rule published in the Federal Register in October 1984 (Vol. 48, No. 20, 29) became effective on November 28, 1984, and stated with regard to 33 CFR 164.25(a)(1) that the test procedures for primary and secondary steering gear include a visual inspection of the steering gear. There has been much discussion and deliberation on the topic of manned steering rooms. The National Transportation Safety Board has promoted this requirement in its investigation of the **Sea Witch-Esso Brussels** collision (June 2, 1973), the **Pola de Lena** steering failure/collision with Mississippi River ferries (February 3, 1979), and most recently in its report of the **Amstelvoorn** steering failure/dock collision (September 26, 1982). The NTSB is also promoting this requirement on this particular casualty. That such a requirement would promote safety and reduce casualties has been and, in consideration of this casualty, remains questionable.

## Steering Gear Requirements Do Make a Difference

The owner or master of a vessel operating in U.S. waters must report to the Coast Guard any failure or loss of a vessel's primary steering or main propulsion. This includes the failure or loss of any associated component or control system of the vessel. Such occurrences are separate reporting criteria of the Coast Guard. This requirement makes it possible for the Coast Guard to maintain a history and analyze the frequency of such occurrences. The Coast Guard's Marine Safety Information System(MSIS) now allows for the comparison of steering casualties to vessel histories and vessel classes, and even manufacturers. This capability can highlight trends or pinpoint a steering gear system component that might be more prone to break down. The Coast Guard can then address the matter if warranted.

Rewards for safety! Steering casualties to tankers exceeding 1,000 gross tons declined from a high of 24 in 1978 to 14 in 1985 (table 1). Freight ships fared even better. Steering casualties to freight ships exceeding 1,000 gross tons declined from a high of 52 in 1978 to 28 steering casualties in 1985. Overall, the annual steering casualties for all vessels over 1,000 gross tons declined from a high of 79 in 1979 to just 48 in 1985.

Using analytical procedures, it is estimated that the freight ship population experienced an 11.5-percent decline during the period between 1978 and 1985. This corresponds to a 46.2-percent decrease in accidents. During the same period, it is estimated that tank ships decreased in population by 16.2 percent while the number of accidents declined 41.7 percent.

Reliable steering systems aboard vessels are absolutely fundamental to the safety of the vessel and its crew. Regulations will probably never prevent steering casualties from completely occurring, but we've seen how steering systems aboard vessels have been made safer by regulations. Such regulations have to be necessarily detailed because there is no guarantee they would be observed in spirit if they are written too generally. A wise man might say that the lives of those who go to sea depend on just how well these regulations are observed.

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This article was based on the investigation of a vessel casualty filed by the Investigating Officer, U.S. Coast Guard, Marine Safety Office, Portland, Oregon, case number 0196POR84, dated January 17, 1986. ▮

# Environmental and Health Issues Top the Agenda for CTAC

LCDR R. Fitch and LT J. Ocken

The Chemical Transportation Advisory Committee (CTAC), first organized in 1949, was recently reformed in April 1987. An article by Robert Trainor in the September 1987 issue of *Proceedings* described this organization which has played an active role in the Coast Guard's development of transportation regulations for hazardous materials.

Two newly organized subcommittees of CTAC were established on August 25 to address environmental and health-related issues which are seen as high priority items for both the Coast Guard and CTAC.

To meet national ambient air quality standards for ozone, some state and local air quality control boards are considering the control of hydrocarbon vapors given off while loading and ballasting tank vessels. Where these controls are imposed, facilities would be required to use vapor control systems when tank vessels are loaded or ballasted. Vapor control systems could also be used to reduce the exposure of marine chemical workers to toxic chemicals. The Coast Guard is concerned about the safety of vapor control systems in the absence of safety standards, and has requested that CTAC advise the Coast Guard on the development of safety standards for these systems. In response to this request, the Subcommittee on Vapor Control was formed. During the Subcommittee's first meeting, the scope and basic premises on which to base recommendations for the design of safe vapor control systems were discussed. Mr. Robert H. Conn, a transportation specialist with the Marine Department of Shell Oil Company, was elected chairman. The next subcommittee meeting was held on the 8th and 9th of October At that meeting, technical papers were presented relating to vapor control systems. For further information on this subcommittee, contact Lieutenant Commander Fitch at (202) 267-1217.

Through a variety of activities and regulatory responsibilities, the Coast Guard has a longstanding interest in protecting the safety and health of vessel crews. In 1972, Congress passed the Occupational Safety and Health (OSH) Act and since that time, the health risks associated with occupational exposures to chemical vapors, dusts, noise, and other related health hazards have taken on a particular importance for all workers in this country. In the late 1970s, the Coast Guard began an investigation of occupational exposures in the marine community looking toward the development of improved occupational safety and health programs appropriate for the marine hazardous chemical workers who are outside the jurisdiction of the OSH Act. Recommendations for a comprehensive program are expected in the early summer of 1988, and the implementation of these recommendations is considered a high priority by CTAC. In response to Coast Guard requests, CTAC has formed a new Subcommittee on Marine Occupational Health and Safety (MOSH). Dr. Geraldine Cox, Technical Director to the Chemical Manufacturer's Association, was elected to chair the subcommittee. Dr. Cox has a professional background in environmental health and science, and also in occupational safety and health. During their August meeting, the MOSH Subcommittee began a review of the issues which are likely to impact on program implementation, such as OSHA's jurisdiction, and voluntary versus mandatory standards. The Subcommittee Chairwoman plans to continue preparation for the 1988 final report by having a meeting on November 4 to present a summary of research findings to date, and to provide an opportunity for members to review earlier study reports. For further information on this subcommittee, contact Lieutenant Ocken at (202) 267-1217.∎

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*LCDR Fitch is a Naval Architect / Marine Engineer, and LT Ocken an industrial hygienist. Both are assigned to the Marine Technical and Hazardous Materials Division, Office of Marine Safety, Security, and Environmental Protection.*

## Chemical of the Month

David R. Perault

# Hydrogen Fluoride

Hydrogen fluoride is a colorless, corrosive liquid or gas that fumes quite strongly when coming in contact with air. It is formed naturally by active volcanoes and synthetically by many industries. These industries (aluminum or fertilizer manufacturing, petroleum, or those industries making glass pottery, brick, or ceramics) release hydrogen fluoride into their surroundings as a byproduct. Hydrogen fluoride is also released into the environment from the burning coal.

The chemical was first manufactured in the late 1800s, but commercial production did not begin until the 20th century. The current method of production is a reaction of calcium fluoride with sulfuric acid. The two are fed into a heated horizontal reactor and mixed between 200° - 250°C, resulting in the formation of hydrogen fluoride gas. This gas is then scrubbed and cleaned of sulfur acid fumes and dust. it is then condensed into a 99-percent hydrogen fluoride acid which is distilled to give a 99.9-percent pure hydrogen fluoride. Anhydrous hydrogen fluoride is one of the purest chemicals in regular commercial distribution today.

Uses for hydrogen fluoride have increased over the years. The chemical originally was used in glass works as an etcher and polisher. Then in the mid-1920s, as the need for aluminum increased, hydrogen fluoride came into demand for aluminum refining. It was further used in making fluorinated organics for refrigerating fluids, aerosol propellants, and aviation gasoline. It is also used in stainless steel pickling and as an additive in rocket propellants.

From its very beginning, hydrogen fluoride was known to be toxic. Laboratory tests have supported this fact even more. When test animals inhaled air containing 1500 mg/m$^3$, they died within 5 minutes. A smaller concentration of 1000 mg/m$^3$, while not causing any deaths, damaged internal tissues. Even at lesser concentrations of 50 mg/m$^3$, coughing and sneezing resulted after short periods of time. In tests conducted with human volunteers, small exposure with hydrogen fluoride caused irritations around the eyes and on the skin. Difficulty in breathing was also a result. Repeated long-term exposure resulted in problems with the bones and the respiratory system.

Although hydrogen fluoride is dangerous as a gas, most injuries result from contact with the liquid. Skin contact, usually due to a ruptured chemical container, causes severe burns or, if the solution is dilute, creates ulcers which develop at a later date. Any direct contact with the eyes may result in severe vision problems and even blindness. In some instances, individuals have died from heart or breathing problems after coming into direct contact with the chemical.

Immediate aid can help to reduce damage to internal organs and external tissues. Breathing pure oxygen reduces the damage from gas exposure, and skin damage can be lessened by first applying water and then a solution containing a small percentage of ammonia. If hydrogen fluoride is swallowed, the victim should drink large amounts of water to dilute the substance. *Vomiting should not be induced.* In all these cases, medical assistance should be sought at once.

Hydrogen fluoride can be dangerous in the environment, and if a spill occurs, the National Response Center (800-424-8802) should be called immediately. A spill entering any body of water can be lethal to fish and other aquatic life. In this situation, local health and wildlife officials and those in charge of any nearby water facilities should also be notified.

In its Hazardous Chemical Data Handbook, the U.S. Coast Guard lists hydrogen fluoride as a corrosive material. It is shipped mainly by tank cars or in steel cylinders, usually at about 70-percent pure. Bulk shipment of hydrogen fluoride is not permitted except over this 70-percent level. All of its shipments must carry the Corrosive Liquid label. Hydrogen fluoride is available at 48-, 60-, and 70-percent acid in polyethylene bottles for laboratory use, but even at these strengths, hydrogen fluoride, being as toxic as it is, should be handled with care.

**Chemical Name**
Hydrogen Fluoride

**Formula**
HF

**Synonyms**
Anhydrous hydrofluoric acid

**Physical Properties**
boiling point: 19.5°C (67.1°F)
melting point: -92.2°C (-134°F)
vapor pressure: 17.8 psia

**Threshold Limit Value**
time weighted average: 1.5 mg/m³
short-term exposure limit: 5 min - 60 mg/m³

**Flammability Limits in Air**
nonflammable

**Combustion Properties**
nonflammable

**Densities**
liquid (at 25°C): 0.9576 mg/cm³
saturated vapor (at 25°C): 3.553 mg/cm³

**U.N. Number:** 1790

**CHRIS Code:** HFA

**Cargo Compatibility Group:** 1
(Non-oxidizing mineral acids)

# Nautical Queries

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

## Engineer

1. If the excitation of an alternator operating in parallel is decreased below normal, its ______.

A. power factor will change in the lagging direction
B. power factor will change in the leading direction
C. ampere load will be greatly decreased
D. kilowatt load will be greatly decreased

**Reference:** Hubert, *Preventive Maintenance of Electrical Equipment*

2. What can cause below normal air pressure in the intake manifold of a turbocharged diesel engine?

A. Excessive piston blowby to the manifold
B. Insufficient cooling water flow
C. Water accumulation in the air boxes
D. Clogged air intake filters

**Reference:** Stinson, *Diesel Engineering Handbook;* Maleev, *Diesel Engine Operation and Maintenance*

3. A thermostatic expansion valve is designed to respond to ______.

A. refrigerated space temperature
B. compressor suction pressure
C. vapor discharge pressure in the cooling coils
D. superheat in the tail coil

**Reference:** Nelson, *Commercial and Industrial Refrigeration*

4. At which interval must a foam fire extinguisher be recharged if the vessel's Certificate of Inspection is issued for 2-year periods?

A. Quarterly
B. Semiannually
C. Biennially
D. Annually

**Reference:** 46 CFR 97.15-60

5. Coast Guard regulations require that new fuel oil service piping between pumps and burners be subjected to ______.

A. a hydrostatic test of 1.5 times the maximum allowable pressure but not less than 500 psi
B. a hydrostatic test of 1.25 times the maximum allowable pressure with the relief valves closed
C. spot radiographic examination of portions of the finished weld joints
D. a hydrostatic leak test to the design pressure specified by the Coast Guard

**Reference:** 46 CFR 56.97-4(a)(2)

## Deck

1. The place where a channel moves from along one bank of the river over to the other bank of the river is called a ______.

A. draft
B. cutoff
C. draw
D. crossing

**Reference:** Lower Mississippi River Maps

2. A small, light tackle with blocks of steel or wood that is used for miscellaneous small jobs is called a

A. snatch block.
B. three-fold purchase.
C. handy-billy.
D. chockablock.

**Reference:** Cornell and Hoffman, *American Merchant Seaman's Manual*

3. When using a stabilogauge, you assume the center of gravity of a loaded compartment is

A. on the deck of the compartment.
B. one-third the height of the compartment.
C. at the geometric center of the compartment.
D. one-half the height of the compartment.

**Reference:** Ladage, *Stability and Trim for the Ship's Officer*

4. The wind speed and direction observed from a moving vessel is known as

A. coordinate wind.
B. true wind.
C. apparent wind.
D. anemometer wind.

**Reference:** Chapman, *Navigation, Seamanship, and Small Boat Handling*

5. Which vessel may exhibit identifying lights when not actually engaged in her occupation?

A. A trawler
B. A fishing vessel
C. A tug
D. None of the above

**Reference:** International Rules (various); COMDTINST M16672.2A

## Answers

**Engineer**
1-B; 2-D; 3-D; 4-D; 5-A
**Deck**
1-D; 2-C; 3-C; 4-C; 5-D

*If you have any questions concerning "Nautical Queries," please contact Commanding Officer, U.S. Coast Guard Institute (mvp), P.O. Substation 18, Oklahoma City, Oklahoma 73169; telephone (405) 686-4417.*

# Keynotes

## Notice of Proposed Rulemaking

*CGD 87-016, Emergency Position Indicating Radio Beacons for Uninspected Fishing, Fish Processing, and Fish Tending Vessels (September 3)*

The Coast Guard is proposing to amend the uninspected vessel regulations by requiring emergency position indicating radio beacons (EPIRBs) to be carried on uninspected fishing, fish processing, and fish tender vessels operating on the high seas. Congress amended the shipping laws of the United States by requiring those vessels to have the number and type of EPIRBs prescribed by regulation. By implementing the law, the regulations will ensure rapid and effective search and rescue during emergency situations.

The closing date for comments is October 19, 1987. For further information, contact LCDR William M. Riley, Survival Systems Branch, Room 1404, U.S. Coast Guard Headquarters, 2100 Second St., SW, Washington, DC 20593-0001.

*CGD 85-061, Intervals for Required Internal Examination and Hydrostatic Testing of Pressure Vessel Type Cargo Tanks on Barges (September 8)*

The Coast Guard is proposing to amend the regulations that govern internal inspection and hydrostatic test intervals for pressure vessel cargo tanks on barges that transport liquefied gaseous cargoes and Grade A flammable liquids. This proposal originated from industry requests that the Coast Guard review and amend existing inspection requirements. If this proposal is adopted, industry's compliance costs would decease due to the lengthening of inspection intervals. The present level of safety is maintained by the incorporation into the standards of more sophisticated examination technologies.

Comments must be received on or before December 7, 1987 at the Marine Safety Council (G-CMC/21), U.S.Coast Guard Headquarters, 2100 Second St., SW, Washington, DC 20593-0001. For further information, contact LCDR Powers, telephone (202) 267-1045.

*CGD 82-042, Hand Held Flashlights (September 25)*

This proposed rulemaking would delete 46 CFR 161.008 and incorporate by reference the American Society for Testing and Materials standard ASTM F1014-1986, Standard Specification for Flashlights on Vessels in the specific vessel regulations. The intended effect of this proposal is to incorporate this industry standard by reference in the regulations which require flashlights on lifeboats and liferafts and flashlights suitable for use in hazardous atmospheres in emergency lockers and firemen's outfits, and as part of the safety equipment on self-propelled vessels carrying bulk liquefied gases. The present regulations for flashlights do not reflect the recent advances in technology. The proposed regulations will incorporate an up to date standard which will allow a wider variety of flashlights to be used, without jeopardizing the safety of either the vessel or personnel.

The closing date for comments is November 9, 1987. For further information, contact Mr. Thomas Nolan, telephone (202) 267-2206.

## Request for Applications

*CGD 87-063, Chemical Transportation Advisory Committee; Request for Applications (September 3)*

The U.S. Coast Guard is seeking applications for appointment to membership on the Chemical Transportation Advisory Committee (CTAC). This committee advises the Chief, Office of Marine Safety, Security, and Environmental Protection on regulatory requirements for promoting safety in the transportation of hazardous materials on vessels and the transfer of these materials between vessels and waterfront facilities. Applications will be considered for eight expiring terms and any other existing vacancies. To achieve the balance of membership required by the Federal Advisory Committee Act, the Coast Guard is especially interested in applications from minorities and women. The Committee usually meets at least once a year in Washington, DC, with subcommittee meetings for specific problems on an as-required basis.

Requests for applications should be received no later than December 1, 1987. Requests should be addressed to Commandant (G-MTH-1), U.S. Coast Guard Headquarters, 2100 Second St., SW, Washington, DC 20593-0001. For further information, contact CDR Ronald W. Tanner at the above address, or telephone (202) 267-1217.

## Notice of Availability of FONSI (Finding of No Significant Impact)

*CGD 87-060, Consolidation of Atlantic and Gulf Strike Teams (September 3)*

The Coast Guard is in the process of consolidating the Atlantic Strike Team (AST) located at Elizabeth City, North Carolina, with the Gulf Strike Team (GST) located at Mobile, Alabama. The Pacific Strike Team located at Hamilton AFB near San Francisco will not be affected by this consolidation. The consolidated unit will be located at Mobile and will serve the Coast Guard Atlantic Area, which includes the states, territories, and U.S. possessions east of the Rocky Mountains. This notice announces the public availability of the Environmental Assessment and FONSI prepared for this action.

The FONSI and Environmental Assessment will be available for inspection and copying at the Marine Safety Council (G-CMC/21) Room 2110, U.S. Coast Guard Headquarters, 2100 Second St., SW, Washington, DC 20593-0001, between the hours of 8:00 a.m. and 3:00 p.m. For further information, contact Mr. Allen R. Thuring, (202) 267-0426.

## Final Rule

*CGD 86-082, Identification of the Horizontal Datum Referenced in the Coast Guard Regulations (September 8)*

The purpose of this final rule is to inform the public that due to the ability to establish global reference systems that provide more accurate geographic positions (latitude and longitude), the horizontal datums referenced on maps and charts are being revised and during the interim, various horizontal datums may be encountered. The geographic positions listed in the regulations in Title 33, Parts 1-999 are referenced to various horizontal datums such as the North American Datum of 1927, U.S. Standard Datum, Old Hawaiian Datum, Puerto Rican Datum, Local Astronomic Datum, and others; however, the datum is not identified. The National Oceanic and Atmospheric Administration (NOAA) has identified the North American Datum of 1983 (NAD 83) to replace the various horizontal datums currently in use. The rulemaking inserts cautionary reminders that during the conversion there may be discrepancies between the positions described in the existing regulations and the charted positions.

The effective date of this Final Rule is September 8, 1987. For further information, contact Mr. Frank Parker, (202) 267-0357.

*Requests for copies of Notices of Proposed Rulemaking (NPRMs) should be directed to Commandant (G-CMC/21), U.S. Coast Guard, 2100 Second St., SW, Washington, DC 20593; telephone (202) 267-1477. The office, located in Room 2110, is open between the hours of 8:00 a.m. and 3:00 p.m. Monday through Friday, excluding federal holidays. Comments are available for inspection or copying during those hours.*

U.S. Department
of Transportation

**United States
Coast Guard**

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