Proceedings

of the Marine Safety Council

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Proceedings
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The U.S. Coast Guard is actively involved in certifying vessels to incinerate hazardous wastes at sea. The **Apollo One**, *pictured on our cover, was the first incinerator ship to be built in the United States. Story by LCDR David B. Crawford begins on page 1. Photo courtesty of At-Sea Incineration, Inc.*

The U.S. Coast Guard Incinerator Ship Program

LCDR David B. Crawford

Ocean incineration of hazardous waste originated in Europe in the late 1960s. It was 1974, however, before U.S. wastes were incinerated at sea. This burn, which occurred in the Gulf of Mexico, was conducted aboard a foreign-flag incinerator ship. Recognizing that incineration would help address the growing hazardous waste disposal problem, government agencies began to take action. This article provides an overview of the Coast Guard's program for incinerator ship design and equipment requirements, including initial Coast Guard involvement, responsibility, concept review, and regulations for the carriage and incineration of hazardous chemical wastes at sea. Operational controls are also discussed briefly.

Initial Coast Guard Involvement With Incinerator Ships

The first incineration at sea of U.S. hazardous wastes occurred in 1974, when the owners of the foreign-flag ship **Vulcanus** (now **Vulcanus** I) requested authorization to load hazardous chemical waste from the Shell Company in Deer Park, Texas, and burn it in the Gulf of Mexico. The owners also proposed loading "herbicide orange" owned by the U.S. Air Force to burn off Johnston Island in the Pacific. Because a foreign vessel involving a novel feature of design or construction or which involves potential unusual operating risks is subject to inspection to the extent necessary to safeguard life and property in U.S. ports, the Coast Guard decided to regulate **Vulcanus** as a chemical tanker under the Letter of Compliance program. Under this program, the Coast Guard regulates the carriage of commercial chemicals on all foreign-flag chemical tankers which operate in the United States. A Letter of Compliance, issued in accordance with the Code of Federal Regulations (CFR) Title 46, Part 153, grants authority to carry chemicals listed in Table 1 of Part 153. Due to the wide variance in composition of waste to be burned, **Vulcanus'** Letter of Compliance included a provision requiring a waste analysis for each loading.

In 1980, the Environmental Protection Agency (EPA) and the Maritime Administration (MARAD) cochaired an Interagency Ad Hoc Work Group to study the possible development of a U.S. ocean incineration capability. This interagency work group also had representatives of the National Bureau of Standards (NBS) and the Coast Guard. The 1980 Report of the Interagency Ad Hoc Work Group for the Chemical Waste Incinerator Ship Program endorsed at-sea incineration of chemical waste on board specially designed ships as a technically and environmentally acceptable technology. This report further recommended assigning a high priority to U.S. development of this capability.[1] The report was approved by the EPA Administrator and the Assistant Secretary of Commerce for Maritime Affairs. (At that time, MARAD was part of the Department of Commerce.) After agency approval of these recommendations was obtained, coordinated legislative, regulatory,

LCDR David B. Crawford is a Chemical Engineer in the Coast Guard's Hazardous Materials Branch, Marine Technical and Hazardous Materials Division, Office of Marine Safety, Security and Environmental Protection.

[1] "Report of the Ad Hoc Work Group for the Chemical Waste Incinerator Ship Program," U.S. Environmental Protection Agency, U.S. Department of Commerce/Maritime Administration, U.S. Department of Transportation/Coast Guard, U.S. Department of Commerce/National Bureau of Standards, September 1980.

The foreign-flag vessel Vulcanus II was the first vessel to be certified by the Coast Guard as an incinerator ship under Public Law 97-389. *(Photo courtesy of Chemical Waste Management, Inc.)*

and incinerator ship construction initiatives began.

One report recommendation culminated in the passage of Public Law 97-389. This legislation made ocean incineration a coastwise trade, meaning that U.S.-generated hazardous wastes could be transported and incinerated only on U.S.-flag ships. Foreign vessels are prohibited from loading bulk hazardous wastes from U.S. ports for the purpose of incineration at sea. This law grandfathered foreign vessels owned or under construction on May 1, 1982, by a corporation wholly owned by a citizen of the United States (i.e., **Vulcanus I** and **Vulcanus II**), provided the vessels met applicable Coast Guard regulations. Specifically, the law requires that these ships be inspected (including drydock inspections and internal examinations of the tanks and void spaces) to the same standards as U.S. vessels before loading and burning U.S.-generated hazardous waste.

Congressman John B. Breaux (D-LA), a sponsor of this law, clearly indicated the intent of Congress when imposing this inspection requirement. In a joint oversight hearing of the House Subcommittee on Fisheries and Wildlife Conservation and the Environment and the House Subcommittee on Oceanography, he said, directing his remarks to the Coast Guard, "...We want those foreign-built ships to be properly inspected according to Public Law 97-389...We do not want a letter of compliance...That is not enough."[2]

What are the U.S. standards to which Congress referred? This question is answered by first looking at development of international standards.

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[2]"An Oversight Regarding the Incineration of Hazardous Waste at Sea as Part of the Overall Efforts of Congress To Confront the Problem of Managing Hazardous Waste," Hearing before the Subcommittee on Fisheries and Wildlife Conservation and the Environment and the Subcommittee on Oceanography of the Committee on Mechant Marine and Fisheries, House of Representatives, 98th Congress, 1st. Sess., Serial No. 98-31, December 7, 1983.

International Standards

As stated earlier, incinerator ships were regulated internationally as chemical tankers. Based on the Coast Guard's Letter of Compliance program, a recommended international standard for all chemical tank vessels, the Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (Bulk Chemical Code), was adopted in 1971. The Coast Guard incorporated the Bulk Chemical Code into U.S. regulations (46 CFR Part 153) in 1977. The Bulk Chemical Code has been updated, expanded, and made mandatory as the International Bulk Chemical Code (IBC) for ships built after July 1, 1986. The Bulk Chemical Code still will apply to all ships built prior to that date. As part of the update, the International Maritime Organization (IMO) developed a set of comprehensive incinerator vessel requirements which have been included in Chapter 19 of the IBC. (The Coast Guard actively participated in the development of these requirements.) Chapter 19 contains detailed requirements that specifically address hazards associated with incinerators and incinerator spaces, the sources of ignition in these spaces, and the potential for release of hazardous wastes in these spaces during transfer from vessel cargo tanks to an incinerator. Examples of areas addressed include automatic shutdown systems, electrical equipment requirements for equipment located in compartments containing cargo piping, ventilation requirements for spaces surrounding the incinerators, and special pumproom requirements. Chapter 19 also incorporates requirements of Chapters 1-16 of the IBC that apply generally to all chemical tank vessels.

Concept Review -- Development of U.S. Standards

The 1980 interagency report included a recommendation that the Coast Guard develop design requirements for incinerator ships.

Unsafe hazardous waste disposal sites prompted the Unit[redacted]onsider alternative disposal methods, such as ocean incineration.

The Apollo One was the first incinerator ship to be constructed in the United States. *(Photo courtesy of At-Sea Incineration, Inc.)*

Based on the positive signs of the 1980 report and legislative initiatives, MARAD guaranteed loans for the construction of the first U.S.-flag incinerator ships. Since incinerator ships were a relatively new technology, the Coast Guard required that such vessels undergo conceptual plan review on a case-by-case basis before certification as ocean incinerator vessels. Concept review is a process to determine if a design proposal is rational, if it is capable of meeting U.S. standards for its intended operation, and most important, that it has no "fatal flaws" which violate basic naval architecture or marine engineering principles. This process usually consists of meetings and correspondence between the vessel owner/naval architect and the Coast Guard to clearly communicate the concept and identify the requirements that the vessel would be expected to meet. This is followed by submission of vessel plans to the Coast Guard. Once the Coast Guard determines that the concept is suitable and meets the criteria discussed above, the Coast Guard issues a letter approving the concept to the prospective shipowner. The letter also includes any specific restrictions or conditions of approval. Concept review of incinerator vessels is managed by the Hazardous Materials Branch of the Marine Technical and Hazardous Materials Division, Office of Marine Safety, Security and Environmental Protection, U.S. Coast Guard Headquarters.

Concept review of the **Apollo** ships (the first U.S-flag incinerator ships to be constructed) provided the Coast Guard with the first opportunity to enumerate what design standards would apply. First, the Coast Guard looked at the "big picture" of incinerator vessel operation. In a typical disposal operation, a tank vessel which has one or more specially designed incinerators receives hazardous waste at a port, transports it to a designated burn site, burns the waste at the site, and then returns. Thus, incinerator vessels have two primary functions. First, an incinerator ship transports hazardous waste to an ocean incineration site. This aspect of the operation is similar to that of any other tank vessel. The second function is the actual process of incineration. In this respect, incinerators pose hazards similar to other fired units onboard ship, such as marine boilers. On the other hand, the Coast Guard viewed the operation of transferring hazardous waste which may be flammable and toxic from the incinerator vessel's cargo tanks to an incinerator as an operation unique to incinerator vessels.

For shipboard transportation of hazardous waste to an incineration site, the Coast Guard applied the existing requirements for chemical tank vessels that carry hazardous materials in bulk. This was done based on the Coast Guard's experience with the **Vulcanus** under the Letter of Compliance program. The standards necessary to safely transport hazardous waste materials are essentially the same as those applied to the carriage of hazardous materials as cargo in bulk.

The principal safety regulations for all tank vessels are in Subchapter D of Title 46, Code of Federal Regulations. Examples of areas these requirements address are firefighting systems, structural fire protection, lifesaving equipment, cargo venting systems, and ventilation systems. For chemical tank vessels, the principal safety regulations are in Subchapter O of Title 46, Code of Federal Regulations. Examples of areas these requirements address are vessel arrangements, cargo containment systems, cargo tank gauging, cargo pumps and pumprooms, monitors, alarms, and control systems, toxic vapor protection, emergency shutdown, and various operational procedures and controls.

One area that has resulted in some confusion is the assignment of tanker type to incinerator ships. Chemical tanker type indicates certain requirements for a tanker's cargo containment system. Requirements for cargo containment systems are applied on the basis of the hazard a chemical poses. A cargo containment system type is assigned for each chemical shipped in a chemical tanker. Regulations for chemical tankers in 46 CFR Part 153 include three levels of cargo containment systems: type I, II, and III. Applying a cargo containment type requirement to a chemical specifies the extent to which a ship carrying the chemical must survive damage conditions given in Table 172.135 of 46 CFR Part 172 and specifies the location of the tank carrying the chemical with respect to the ship's shell plating. This damage stability criteria for chemical tankers evolved from international standards.[3] The Coast Guard does not prohibit shipowners from exceeding the cargo containment system type that is required for a cargo.

Chemicals assigned a type I cargo containment system (a type I tanker) must be carried in a type I hull. A type I hull must be capable of surviving specified damage to any location along the vessel's length. Tanks for these chemicals must be at least 76 centimeters inboard from the ship's shell and outside the damage penetration distances specified for collisions and groundings in 46 CFR Section 153.230 and Table 172.135. It should be noted that a type I system is applied only to a few chemicals, such as phosphorus and chlorosulfonic acid, which pose extreme flammability and reactivity hazards with water upon release.

Chemicals assigned a type II cargo containment system (a type II tanker) must be carried in a type I or type II hull. There is no difference between a type I or type II hull except for ships less than 150 meters in length. For ships less than 150 meters, a type I hull still must survive damage to any location, but a type II hull does not have to survive damage to a main transverse bulkhead bounding an aft machinery space. Tanks containing type II chemicals must meet the same tank location requirements as a type I system except that, as allowed in 46 CFR Section 153.231, they do not have to be outside the damage penetration distance specified for high-energy collisions.

Chemicals assigned a type III cargo containment system (a type III tanker) must be carried in a type I, II, or III hull. For ships greater than 125 meters, a type III hull must

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[3] *J.W. Kime, R.E. Johnson, and W.D. Rabe, "Damage Stability Requirements for Tankships, Chemical Ships, and Gas Ships,"* Marine Technology, *Vol. 13, April 1976.*

survive damage to any location except that it does not have to survive damage to a main transverse bulkhead bounding an aft machinery space. For ships less than 125 meters, a type III hull must survive damage to any location except an aft machinery space. Chemicals assigned a type III cargo containment system may be carried in wing tanks, i.e., tanks bounded by the ship's shell.

Incinerator ships require a type II cargo containment system. This stems from IMO regulations which mandate type II double-hulled construction. The Coast Guard anticipates that the wastes to be carried on incinerator vessels will be a mixture of chemicals, which when shipped commercially must be carried in a type II or type III cargo containment system. Depending on the hazards associated with individual wastes, various operational limitations and controls would also be imposed.

It is important to note that type type II cargo containment system requirement precludes carriage of cargo in an incinerator vessel's wing tanks (i.e., the wing tanks will be empty and gas-free or ballasted) whereas on a type II chemical tanker the wing tanks could contain flammable chemicals. This feature improves survival after collisions by lowering the fire risk. Therefore, a type II incinerator vessel can give better protection than a type II chemical tanker.

In addition to the existing requirements in Subchapters D and O, specific requirements were necessary to address construction and arrangement features concerning incinerators and incinerator spaces. These additional requirements were taken from Chapter 19 of the IMO IBC Code. The Coast Guard applied requirements from 46 CFR Part 63 which relate to large water heating equipment and other large fired units on board ship. The hazards involved in using this equipment are essentially the same as those associated with shipboard incinerators. The principal purposes of these requirements were to prevent introduction of fuel or hazardous waste into an incinerator in the absence of an ignition source and to prevent the ignition of flammable vapor in amounts that would damage an incinerator or cause an explosion. The design and operating features necessary to meet environmentally acceptable emission standards for incinerators are the responsibility of EPA. In February 1985, EPA published proposed rules governing the issuance of ocean incineration permits and the designation and management of incineration sites.

Conclusion

At present, there is one U.S.-flag incinerator vessel, the **Apollo I**, nearing completion. Construction has begun on another **Apollo II**. (At the time this article was written, construction had been halted on both vessels due to the owner's filing for bankruptcy.) The plans for both of these vessels have been approved by the Coast Guard. The Coast Guard has also evaluated the design of **Vulcanus I** and **Vulcanus II**. The Vulcanus II was certified by the Coast Guard in accordance with Public Law 97-389. As part of the initial concept review process, the Coast Guard has received several inquiries from other prospective builders of incinerator vessels.

To streamline its regulations for the design of incinerator vessels, the Coast Guard developed a proposed rule (see 51 Federal Register 30241, dated August 25, 1986) to consolidate existing rules from various sources that the Coast Guard has applied to incinerator vessel design, construction, and equipment. Compliance with these requirements would be a prerequisite for an incinerator vessel to carry and burn bulk hazardous wastes at sea.

To provide additional protection beyond the safety features of the Coast Guard's design requirements, the Coast Guard can impose specific operational restrictions during port transit depending on the hazard of the cargo being carried and taking into account local port conditions. As provided in EPA's proposed regulations, proposed 40 CFR Section 234.52, the ocean incineration permit issued to an incinerator vessel would be conditional upon limitations and controls determined to be necessary after consultation with the Coast Guard. Examples of port transit restrictions may include, where appropriate, establishment of a moving safety zone, requirements for Coast Guard escort vessels, restriction of operations to daylight hours, weather and visibility restrictions, requirements for tug assistance,

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Personnel Protective Equipment

Fashions may come and go, but one type of attire will never be out of style.

(Reprinted with permission from Chevron Shipping Company's **Safety Bulletin**, *Vol. 48, No. 7, July 1986.)*

The human body is amazing in its ability to protect itself from sources and substances that may cause harm. Your eyelashes and eyelids protect eyes from particles and light. Nose and ear hairs protect from airborne particles, and your skin and skeletal system protect your vital organs. Think also how miraculously your body can repair itself if it is cut or if a bone is broken. But no matter how amazing this all seems, sometimes it's not enough.

This is what personnel protective equipment is for: to put an extra layer of protection between you and conditions that may cause you harm.

Senior officers must ensure that officers and crew members are instructed in the proper use of protective equipment and then check that it is used correctly. Every seaman is responsible for wearing the required protective equipment.

Personnel protective equipment supplied to the vessel should be inspected regularly. Equipment must be maintained and, if in questionable condition, it should be replaced. Never alter protective equipment. Its effectiveness could be reduced. Know the correct personnel protective equipment to wear before starting a job.

Eye Protection

Every 2 minutes, someone's eyes are injured in an industrial injury. Accidents to the eyes happen most often when flying or falling objects strike the eye (69%) or from contact with liquids or chemicals (21%).*

Safety glasses are required by anyone on board who wears glasses. They are designed to prevent eye injury should the glasses break while being worn. Safety glasses, with or without side shields, must never be used as a substitute for goggles as they do not provide complete eye protection.

Chemical goggles protect against liquid splashes, fumes, and vapors. Some styles have top or side ventilators to prevent fogging. Ventilator-type goggles must never be worn where there are heavy gas or vapor concentrations.

Chipping goggles provide protection against medium to heavy impact. They should be used for concrete or metal chipping, metal hammering, riveting, and similar work. Chipping goggles should also be worn when using heavy-duty, rotating-type shop machinery such as a grinder and when letting go the anchor. Never substitute chemical goggles for chipping goggles.

Welding goggles/mask must be worn during oxyacetylene welding, arc welding, burning, brazing, or soldering to protect your eyes from ultraviolet rays. In order to prevent eye damage to others, helpers and observers are also required to wear the same protection as the welders.

Face shields should be used to protect the face and neck from flying particles, sprays of hazardous liquids, splashes of molten metal, and from hot solutions. Face shields should never be worn as the sole eye protection. The proper goggles should always be worn in conjunction with face shields.

Hard Hat

Six percent of on-the-job injuries are to the head. A hard hat is a necessary piece of safety equipment that will help protect you from head injuries that can range from bruises to death. It is required when you are at risk from falling objects, when working in close quarters, or when working near high voltage equipment.

**Source: U.S. Labor Department*

Never modify your hard hat. If it doesn't feel right, tell the officer in charge.

Hearing Protection

If the ear is subjected to high levels of noise for a sufficient period of time, loss of hearing may occur. Engine room spaces are generally high-noise areas. The use of hearing protective devices effectively controls excessive exposure. There are three types of hearing protective devices: ear muffs, permanent ear plugs (stiff rubber) and disposable ear plugs (foam rubber). Choose the type that is most comfortable and wear it.

Gloves

Nineteen percent of all industrial injuries involve the hands. Use safe working procedures and wear the correct gloves.

Rubber gloves protect against moisture, acids, chemicals, and electric shock. During loading or deck operations and during welding and power tool operation, **leather gloves** will provide protection and enable you to maintain a firm grip. Operations not involving direct contact with heat but posing a risk to the skin of the hand should be performed with leather gloves.

Heat resistant gloves protect from sparks, flame, and heat. Always wear them when working with boilers or hot gases and fluids.

Metal reinforced gloves should be used when working with objects that could easily cut the hand. Work with knives, sheet metal and cutting tools should be done with metal reinforced gloves.

After determining the correct gloves for the job, make sure of the fit. The wrong size will reduce the glove's effectiveness, and you'll risk a chance of "losing your grip."

Safety Shoes

Safety shoes should be worn while on duty. They provide protection from falling objects and from punctures when stepping on a sharp object. They are also water and chemical resistant. The rubber soles ensure good traction on slippery surfaces. Keep them maintained, and they will keep you walking.

Aprons

Your boiler suit and clothing do not protect you adequately from chemicals. Make sure that splashes will not reach your skin by wearing a **rubber or plastic apron.**

When welding, protect your clothing and skin from sparks by wearing a **leather apron.**

Other items necessary for special jobs include a safety harness and life line for working aloft or when rigging ladders and gangways, asbestos removal suits for working with asbestos and other fibrous materials, and respirators and a breathing apparatus to protect from harmful smoke, fumes, gases, and dust.

Personnel protective equipment is designed to protect your body. Never hesitate to wear additional equipment should you feel the need. Don't be injured because you didn't take the time to dress smart.

Incinerator Ships

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and a requirement to provide at least 24 hours notice before transferring hazardous waste to an incinerator vessel. (In May 1986, the EPA decided that no research or operational permits would be issued until its proposed rules are finalized sometime in the spring of 1987.)

The approach to establishing design requirements for incinerator ships, as well as the operational restrictions that may be needed with respect to vessel loading and port transit of bulk hazardous wastes are similar to the Coast Guard's regulatory program for liquefied natural gas (LNG) ships. (See LT Kevin Cook's article on LNG ships in the September 1986 issue of *Proceedings*.) The excellent safety record of LNG ships reflects the Coast Guard's success in its LNG ship program. The Coast Guard is confident that its incinerator ship program is the best available to ensure the safety of vessels, crew, and port and the protection of the marine environment.

Letters to the Editor...

Dear Editor:

For the past several months I have been researching background information on the history of navigation sidelights. I have been trying to find answers to why the different colors were chosen, why they were placed on their respective sides, who made these determinations, and when.

Information on this subject is scarce at best. I have written to the National Maritime Museum located in Greenwich, England, and received my most informative reply to date. From their reply I have determined that the present color and positioning of sidelights was already in place by the mid-1800s. The horizontal arc requirements were incorporated into the navigation rules at about the same time. However, exactly who, what, and when these determinations were made has yet to surface.

If any of your readers has information on this subject, please send it to LTJG E.D. Zacharias, U.S. Coast Guard Headquarters (G-NSS-2), 2100 Second Street, SW, Washington, DC 20593. Hopefully, with the information I receive, I will be able to provide an article for your publication in the near future.

Sincerely,

E.D. Zacharias
LTJG, USCG

Dear Mrs. Chapman:

We have been reading *Proceedings* for some years now, and we particularly liked your article "The 'A Boats'" (July 1986). The article read well and made its point without becoming hysterical.

The U.S. Coast Guard should know that while the cost of fishing boats has risen dramatically over the years (a new "A boat" would cost $4 million), the price of a stability test has not. The cost of a test itself conducted in non-shipyard working hours (so no construction time is lost) would be $20,000 to $40,000 including the preparation of a complete trim and stability book. A loading computer would cost a bit more, but with crew training would be more accurate and easier to use.

We would like to offer our support of the recommendation in the article that complete stability information be made available to fishing captains. For what we spend in other areas to preserve life, the fishing community could be made a lot safer and, hopefully, the cost of search and rescue could be cut.

Sincerely,

John W. Boylston
Vice President
Seaworthy Systems, Inc.

...and from the Editor

Dear Readers:

Well, after 6 weeks of training, experimenting, and all-around hair-pulling, I've finally gotten the hang of my desktop publishing system. This issue of *Proceedings* is the result.

In the next year, I will be making gradual changes to the magazine's appearance. Some portions of the layout will be eliminated; other portions will be modified so that *Proceedings* is easier to read.

I have long been anticipating the chance to give *Proceedings* a much-needed facelift, and I would welcome comments from you about the "new" magazine. Please drop me a line at the address below and let me know what you think. I'm interested in your comments and criticism alike.

Editor, *Proceedings* Magazine
U.S. Coast Guard (G-CMC)
2100 Second Street, SW
Washington, DC 20593

Index of 1986 Proceedings Articles

Articles

Articles are listed by **main subject** (in boldface). Categories within main subjects are indicated by *italics*.

Authors

Vessels

Chemical of the Month

Douglas Winton Anderson

Propylene Oxide

Propylene oxide, also known as 1,2-expoxypropane, methyl oxirane, propene oxide, and methyloxidrane, is a colorless, extremely flammable liquid with an ethereal (etherlike) odor. It boils at 34.3°C (93.7°F). Structurally it consists of a three-carbon chain with a single oxygen bonded to two of the carbons (CH_3CHOCH_2). It is highly reactive, being intermediate between ethylene oxide and butylene oxide. In the presence of catalysts such as acids, alkalies, and certain salts, its liquid form may react violently with hydrogen. It may polymerize and give off heat when placed in contact with highly active catalytic surfaces, i.e., anhydrous chloride or iron, tin, and aluminum, peroxides of iron and aluminum, and alkali metal hydroxide. Also, propylene oxide should not be placed in contact with acetylide-forming metals, such as copper or its alloys.

Propylene oxide is primarily used in the production of propylene glycol and its derivatives, i.e., propylene glycols, mixed polyglycols, and various propylene glycol ethers and esters. It is also used in the preparation of hydroxypropylcelluloses and sugars, isopropanolamine, surfacants (surface-active agents) and detergents, oil demulsifiers, and as a chemical intermediate in preparing polyethers to form polyurethanes, and also in the preparation of lubricants. Propylene oxide is further used as a preservative, herbicide, fumigant, and as a solvent.

Propylene oxide is considered moderately toxic and an irritant. Its primary acute toxic effect is an irritation of the eyes, breathing passages, and lungs. Early symptoms include tears, nasal discharge, salivation, and labored breathing. At higher concentrations, severe lung irritation may result in pneumonia. At even higher concentrations (4,000 parts per million (ppm)) it has an anesthetic effect. It also will irritate the skin, and prolonged contact may cause delayed burns. It has a detectable concentration, i.e., odor threshold, of 200 ppm. Neither odor nor irritation should be used as a basis to warn of its presence because such conditions usually indicate the presence of acutely dangerous concentrations. The following guidelines may be used for "safe" exposure, although individuals must still use extreme caution:

- Concentrations less than or equal to 150 ppm for up to 7 hours in duration and no more than 5 times a week.
- Concentrations less than or equal to 200 ppm for up to 4 hours in duration and no more than 5 times a week.
- Concentrations less than or equal to 400 ppm for up to 1 hour in duration and no more than 5 times a week.
- Concentrations less than or equal to 400 ppm for up to 7 hours in duration and no more than once a week.
- Concentrations less than or equal to 1,000 ppm for up to 10 minutes in duration and no more than 5 times a week.
- Concentrations less than or equal to 1,000 ppm for up to 1 hour in duration and no more than once a week.

According to the current OSHA standards, the permissible TWA (time-weighted average) exposure limit is 100 parts of propylene

Douglas Winton Anderson was a Third-Class Cadet at the Coast Guard Academy when this article was written. It was written under the direction of LCDR J.J. Kichner for a class in hazardous materials transportation.

oxide to one million parts of air averaged over and 8-hour work day for a 40-hour work week.

When exposed to propylene oxide vapor, one should

- Move to fresh air.
- Give oxygen if breathing is difficult.
- Give artificial respiration if breathing has stopped.

When exposed to propylene oxide liquid:

- Remove contaminated clothing and shoes.
- Flush the affected areas with plenty of water.
- Hold eyelids open and wash with plenty of water if eyes have been contaminated.
- Have the victim drink water or milk if the chemical has been swallowed and the victim is conscious.

In the event of a spill or leak the following steps should be taken:

- Remove all ignition sources.
- Use water spray to disperse the vapors and dilute the spill to a nonflammable mixture.
- Ventilate the areas thoroughly.
- Issue a high flammability warning.
- Restrict access to the area.
- Evacuate the area.

In case of fire, fight from a safe and protected location and use dry chemical, "alcohol" foam, or carbon dioxide.

Propylene oxide is shipped in glass bottles, cans, metal drums, tank trucks, and tank barges. Usually propylene oxide is "blanketed" with a layer of nitrogen.

Propylene oxide is regulated by the following organizations:

- The International Maritime Organization, under Chapter 6 of its Chemical Code,
- The Coast Guard, under Title 46, Subchapter O of the Code of Federal Regulations, and
- The Department of Transportation, under Title 49, Subchapter C of the Code of Federal Regulations.

It is also regulated as a hazardous waste by the United States Enviromental Protection Agency under Title 40, Subchapter D of its regulations.

Chemical Name
Propylene Oxide

Formula
CH_3CHOCH_2

Synonyms
1,2 epoxypropane
methyl oxirane
propene oxide
methyloxidrane

Physical Properties
boiling point: 34.3°C (93.7°F)
freezing pont: -111.9°C (-169.4°F)
vapor pressure
17.8°C (64°F) 400 mmHg
20°C (68°F) 442 mmHg

Threshold Limit Values
time-weighted average: 100 ppm; 240 mg/m3
immediately dangerous to life or health (IDLH): 2,000 ppm

Flammability Limits in Air
lower flammability limit: 2.1% vol.
upper flammability limit: 38.5% vol.

Combustion Properties
flash point (c.c./o.c.): -37.2°C (-35°F)/-28.9°C (<-20°F)
autoignition temperature: 465°C (869°F)

Densities
liquid (water = 1): 0.830 at 20°C
vapor (air-1): 2.0

U.N. Number: 1280
CHRIS Code: POX
Cargo Compatibility Group: 16 (Alkylene Oxide)

Next Month's Chemical: Cashew Nutshell Liquid

Nautical Queries

Engineer

1. Which component of a hydraulic system would enable the pump to be temporarily shut down, and yet still provide an instantaneous source of hydraulic oil?

A. Modulator
B. Pressure compensator valve
C. Accumulator
D. Sump actuator

Reference: Harrington, *Marine Engineering*

2. In a diesel engine, blow-by ____________.

A. increases exhaust back pressure
B. causes excessive crankscase pressure
C. can only be detected by a compression check
D. decreases fuel consumption

Reference: Maleev, *Diesel Engine Operation and Maintenance*

3. Most pump manufacturers recommend that the discharge piping for centrifugal pumps be one size larger than the pump discharge nozzle to ____________.

A. reduce the pump discharge pressure
B. reduce the discharge friction losses
C. increase the pump discharge pressure
D. allow rapid venting of entrained air

Reference: Hicks, *Pump Operation and Maintenance*

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

A. slide block
B. tilting box
C. pintle
D. reaction ring

Reference: McNickle, *Simplified Hydraulics*

5. AC circuits contain resistance, inductance, and capacitance. The inductive reactance of circuit is expressed in ____________

A. ohms
B. mhos
C. henrys
D. farads

Reference: *Principles of Naval Engineering*, NAVPERS 10788-B

Deck

1. A coastwise vessel is not required to carry an Emergency Position Indicating Radio Beacon (EPIRB) when

A. its route does not extend more than 25 miles from the nearest land.
B. it carries an FCC-approved VHF radiotelephone.
C. at least one lifeboat on each side of the vessel is fitted with a fixed radio installation.
D. a self-activating smoke signal is mounted at each bridge wing.

Reference: 46 CFR 33.60-1(b)(1)

2. During twilight on 28 December 1981, about GMT 1800, in DR position LAT 4°00'N, LONG 0°06'W, the sextant altitude (hs) of Venus was 30°46.8'. The height of eye was 36 feet, and the index error was 2.0' on the arc. The temperature was 68°F. The barometer read 1030 mb. Calculate the observed altitude (Ho).

A. Ho 30°35.2'
B. Ho 30°37.1'
C. Ho 30°38.1'
D. Ho 30°40.3'

Reference: *Nautical Almanac*

3. A stretch where the channel changes from one side of the river to the other is called a

A. passing.
B. transit.
C. crossing.
D. transfer.

Reference: Chapman, *Piloting*

4. A tonnage tax is levied according to the

A. deadweight cargo tonnage aboard.
B. displacement tonnage of vessel.
C. gross tonnage of vessel.
D. net tonnage of vessel.

Reference: Turpin, MacEwen, *Merchant Marine Officers Handbook*

5. Working lights shall be used to illuminate the decks of a vessel

A. over 100 meters at anchor.
B. not under command.
C. constrained by her draft.
D. any of the above.

Reference: COMDTINST M16672.2A

~~Answers~~

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

New Publications

Shipwrecks on the Virginia Coast and the Men of the Life-Saving Service, *by Richard A. Pouliot and Julie Pouliot. Tidewater Publishers, P.O. Box 456 Centreville, MD 20617. Price: $16.95.*

From its establishment in the early 1870s until it was merged with the Revenue Cutter Service in 1915 to form the U.S. Coast Guard, the United States Life-Saving Service was the guardian of the Atlantic coast from Maine to North Carolina. Well trained and well equipped (though primitively by today's standards), the men of the Service patrolled the beaches day and night to warn ships in danger of running aground and to alert their liefesaving stations in the event of disaster.

Shipwrecks, of course, occurred more frequently at night than during the day, and when weather conditions were at their worst. Men of the Life-Saving Service were thus called out under the most adverse circumstances imaginable.

The coast of Virginia is scarcely a hundred miles long, yet from 1874 to 1915 there were more than 600 incidents there in which the Life-Saving Service was involved. Nearly 7,000 lives were imperiled in the stranding of vessels. Of these, only 102 lives were lost; only 220 vessels were wrecked beyond hope.

This book is the story of these incidents and of the incredibly stalwart men of the Service. The episodes are made more graphic by the use of contemporary illustrations and annotated maps. Appended to the narrative are lists of all known wrecks on the Virginia coast during this period, arranged both chronologically and by vessel.

How To Navigate Today, 6th ed., *by Leonard Gray (based on the original edition by M. R. Hart). Cornell Maritime Press, P.O. Box 456, Centreville, MD 21617. Price: $5.50.*

How To Navigate Today sets out for the reader exactly what is needed for beginning navigators to learn the subject themselves. It explains what is being done and why, without getting into mathematics beyond adding and subtracting, and occasional multiplying and dividing. With this book, one can be navigating almost from the beginning, and advanced theory can be learned later.

The method taught is Pub. No. 249 (H.O. 249) because it's simple, inexpensive, and accurate. Sight reduction procedures are given for all celestial bodies: sun moon, stars, and planets. Forms are included for the reader to copy and use. They are logically arranged and have an accompanying guide for their use.

This small volume is the direct descendant of the first edition, published in 1943. *How To Navigate Today* continues, after more than four decades, to be an extremely popular beginner's book.

MARAD Reports

The Maritime Administration has released two updated reports, *Relative Cost of Shipbuilding* and *Inventory of American Intermodal Equipment 1986*. The first report is required by law under section 213(c) of the Merchant Marine Act, 1936, as amended. The second report records the intermodal equipment of all U.S.-flag marine carriers and the major U.S. leasing companies at the close of 1985.

Limited copies are available from MARAD, Room 7219, 400 Seventh St., SW, Washington, DC 20590.

Maritime Notes

Honoring a Skilled Shipmaster

The 1986 winner of the American Merchant Marine Seamanship Trophy, CAPT James Edward Bise (third from left) receives his award at recent ceremonies at the U.S. Merchant Marine Academy in Kings Point, NY. As skipper of the integrated tug-barge **Baltimore**, CAPT Bise skillfully maneuvered his vessel in heavy seas to rescue the crews of two yachts which had foundered in Hurricane Kate in 1985 (see *Proceedings*, September 1986, p. 217). The Seamanship Trophy award is administered by the Academy and sponsored by the Maritime Administration. To the right of CAPT Bise, a 1973 Academy graduate, is Maritime Administrator John Gaughan. On his left are Academy Superintendent RADM Thomas A.King and Mrs. Bise.

Coast Guard Cutter Taney Finds Home in Baltimore

The last active duty vessel to have survived Pearl Harbor will be transferred to the City of Baltimore (Maryland) under the terms of H.R. 5598, introduced by Barbara Mikulski (D-MD), Chairman of the Oceanography Committee.

The U.S. Coast Guard cutter Taney was commissioned in 1936 and was decommissioned on December 7, 1986. It was transferred to the City of Baltimore at that time. Costs of the transfer were borne by Baltimore.

Port Economic Impact Kit

The Maritime Administration has released its revised version of "Port Economic Impact Kit." The Kit, originally published in 1979, now provides an automated as well as a manual methodology to determine port economic impacts for small- and medium-sized ports. As designed, it allows pubic ports to demonstrate their significance to local communities in support of continued port development.

Basically, the Kit quantifies the importance of a port in terms of purchases, income, employment, and taxes generated. This is accomplished by examining the impacts of the local port industry, the local port user industries, and port capital spending. For each type of port activity identified above, the economic effect of impacts can be separated into the direct, indirect, and induced categories.

The automated methodology, which is designed for microcomputers, contains a 30-sector matrix for the determination of secondary impacts.

Copies of the Kit and diskettes (2) are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. The order numbers and prices of the Kit and diskettes are listed below:

Kit and Diskettes	PB86-225539/AS	$90.00
Kit	PB86216959/AS	$16.95

Limited copies of the Kit are available from MARAD's Office of Port and Intermodal Development, Room 7201, 400 Seventh Street, SW, Washington, DC 20590.

Keynotes

Final Rules

CGD 5-002, Boating Safety; Certification and Safe Powering Standards (October 23)

This rule amends the Certification regulations in Subpart B of Part 181 and the Safe Powering Standard in Subpart D of Part 183 of Title 33, Code of Federal Regulations. The purpose of these amendments is to give those boats which can clearly operate safely with more horsepower than they currently rate under the Coast Guard Safe Powering Standard, more reasonable maximum horsepower capacities. In order to allow greater flexibility in the manner in which the maximum horsepower capacity of the boats is determined, the amendments establish an optional performance test method as an alternative to the existing calculation method. An additional editorial change to Subpart A of Part 181 reflects changes in the applicability of the part.

CGD 85-059, Boating Safety; Ventilation Standard (October 23)

This rule amends the Ventilation Standard in Subpart K of Part 183 of Title 33, Code of Federal Regulations. The Coast Guard undertook a review of its regulations governing construction standards which apply to the manufacture of recreational boats in an effort to reduce the burden of existing regulations, while ensuring that boats are built to an adequate level of safety. Based upon the review effort, it has been determined that two of the requirements for natural ventilation do not contribute to improved boating safety. The intended effect of the amendments is to relieve the regulatory burden upon recreation boat manufacturers. The effective date of this rule is August 1, 1987.

Notice of Availability of Publications

CGD 86-007, Voluntary Uninspected U.S. Commercial Fishing Vessel Safety Program (October 30)

The U.S. Coast Guard's Fishing Vessel Safety Task Force has competed its work in developing a voluntary vessel standards program and a safety awareness and education program. The vessel standards have been consolidated in navigation and Vessel Inspection Circular (NVIC) 5-86. The safety awareness and education program has been included in the U.S. Coast Guard/North Pacific Fishing Vessel Owners' Association (NPFVOA) "Vessel Safety Manual." This notice provides information on how these publications may be purchased.

CGD 86-065, Rules of the Road Advisory Council; Membership Applications

The U.S. Coast Guard is seeking applications for appointment to membership on the Rules of the Road Advisory Council. This Council was established under the Inland Navigational Rules Act of 1980 (33 U.S.C. 2073) to advise, consult with, and make recommendations to the Secretary of Transportation on matters relating to the Inland Navigation Rules and the International Regulations for Preventing Collisions at Sea (72 COLREGS). Applications must be completed and returned to the Coast Guard no later than February 15, 1987. Persons interested in applying should write to Commandant (G-NSS-2), U.S. Coast Guard Headquarters, 2100 Second St., SW, Washington , DC 20593-0001, or call (202) 267-0366.