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Tsunami of March 27, 1964, Seward Alaska. North end of Resurrection Bay. Overturned ship, demolished Texaco chemical truck, and torn-up dock strewn with logs and scrap metal. Picture taken in April 1964. (U.S. Department of the Interior photo)

Tales of Shores, Ships, and Tsunamis

Patricia A. Lockridge

The *Badger* and The Wave at Lituya Bay

On July 9, 1958, the Swansons entered Lituya Bay, Alaska, on the launch **Badger** and cast anchor near the bay entrance. A little after 10:15 p.m., violent rocking of the **Badger** aroused Mr. Swanson. He went on deck, and in the evening light saw the mountains heaving and shaking. An earthquake was in progress! At the head of the bay, the movement dislodged a large section of rock that avalanched into the water below. The resulting explosive splash heralded the birth of a tsunami. Swanson saw the wave rise and thunder toward his launch. As the wave passed Cenotaph Island in the center of the bay, it had a height of about 50 feet.

The wave reached the launch in 4 minutes and lifted it toward the crest of the wave. With the stern forward and sinking, the launch sailed across LaChausse Spit at the mouth of Lituya Bay. Swanson looked down on the trees growing on the spit and saw that his craft was about 2 boat lengths (more than 80 feet) above their tops. The flight over the treetops was short-lived. Immediately behind the spit, the crest collapsed in open sea, and the launch hit bottom and sank. The Swansons were able to transfer to a skiff and were soon picked up by a fishing vessel. Aerial photographs showing LaChausse Spit devoid of its former tree cover corroborated Swanson's account.

Tsunamis: Definition and Cause

Tsunamis, incorrectly called tidal waves, have been responsible for millions of dollars in property damage in the United States and its territories. They present a special hazard to the shipping industry, the fishing industry, and small recreational craft.

Patricia Lockridge is the Tsunami Data Base Manager for the National Geophysical Data Center, Boulder, Colorado.

"Tsunami" is a Japanese word meaning "harbor wave." As the name suggests, these waves, although formed in the open sea, confine their effects to coastal areas. A large mass of earth on the bottom of the ocean drops or rises in an earthquake, explosion, landslide, or volcanic eruption. The movement of the ocean floor displaces the column of water directly above it. The resulting wave or series of waves travel through the water at speeds up to 600 miles per hour. These tsunamis are nearly undetectable far out from land, but as they approach shallower water, tsunamis trade speed for height. Heights may reach 100 or more feet as waves crest onshore. Some tsunamis, on the other hand, are barely measurable.

The *Alaska Standard* and the Prince William Sound Tsunami

On March 27, 1964, Ted Pederson stood on the dock to which his oil tanker, the **Alaska Standard**, was tethered. He was on hose watch when he felt a tremor transmitted from shore to dock. He realized an earthquake was occurring. Thirty seconds after the initial jolt, the shaking became very violent along the waterfront. Pederson saw his oil tanker buck and slam against the dock. Turning, he began to sprint along the dock toward the shore and safety. He had traveled about 100 feet when all the pipelines leading from the beach to the dock broke, causing oil to geyser into the air. As the oil company facilities exploded in a ball of fire, the **Alaska Standard** flew 25 feet into the air and fell back on the dock.

The collapse of the dock threw Pederson into the turbulent water about 20 feet below the deck of his ship. He struggled to remain afloat in the water where seconds earlier the oil company dock had been. He looked over his shoulder in time to see a huge wave filled with debris engulf him. Something struck him on the back of the head and knocked him unconscious.

When he regained consciousness, he found that the wave had plucked him out of the water

Earthquake of July 9, 1958. Aerial view of head of Lituya Bay, Alaska. Large rockslide plunged into Gilbert Inlet at lower left, shearing off part of Lituya Glacier and seind a wave over the opposite spur. *(Photo credit: NOAA/EDIS)*

and deposited him back on his ship. Pederson was 8 feet above the deck on the **Alaska Standard's** catwalk, wet but safe.

The *Wateree* and the Tsunami at Arica

In August of 1868, the U.S. Navy ship **Wateree** anchored about a quarter mile from the shore of Arica, Peru. At about 4:00 p.m., Rear Admiral Billings felt the ship tremble violently. On deck, Billings and the crew discovered that the shaking was due to an earthquake. As they watched, the town of Arica crumbled to dust in a matter of seconds.

Seeing a few survivors crawling out of the ruins, the **Wateree** dispatched a landing party to supply aid. Unfortunately, the incoming ocean swells dashed the launch to pieces against rocks in the harbor, killing one man.

Following another earth tremor, the water rapidly withdrew from the harbor, leaving the flat-bottomed **Wateree** high and dry. The returning sea lifted the **Wateree** from the sandy sea floor. The keel-bottom boats in the harbor, however, were capsized and destroyed as the incoming waves tumbled them about. Four hours later, in early evening, the crew noticed a thin line of phosphorescent light sweeping toward them from the sea. As the light grew rapidly closer, the men realized that a tsunami was about to engulf them.

The wave surged on the coast, submerging the U.S. ship. Miraculously, the flat bottom of the ship allowed it to fight back to the surface and ride the wave inland. After a time, movement ceased. The light of dawn revealed that the **Wateree** was 2 miles inland at the foot of the Andes. If the wall of water had carried them a couple of hundred feet farther, the ship would have smashed against a mountainside.

The U.S.S. Monongahela and the Tsunami at St. Croix

Although most tsunamis occur in the Pacific Basin, they can occur elsewhere with equal devastation. The **U.S.S. Monongahela** was anchored in the harbor of Frederiksted on the west coast of St. Croix, Virgin Islands, on November 29, 1967. The first indication of danger was a violent trembling of the ship in completely calm weather. The water receded rapidly from the shore. The current changed almost immediately and drove the ship toward the beach with a force that drew the bolts from the kelson. Within a few yards of the beach, the reflux of tide and a light breeze appeared to offer a reprieve to the shore-bound ship. However, the returning wave was 25 to 30 feet high. It picked up the **Monongahela** and carried it over the warehouse into the first street fronting the bay. The reflux of this wave carried the ship back toward the beach, leaving it keeled over at an angle of 15 degrees.

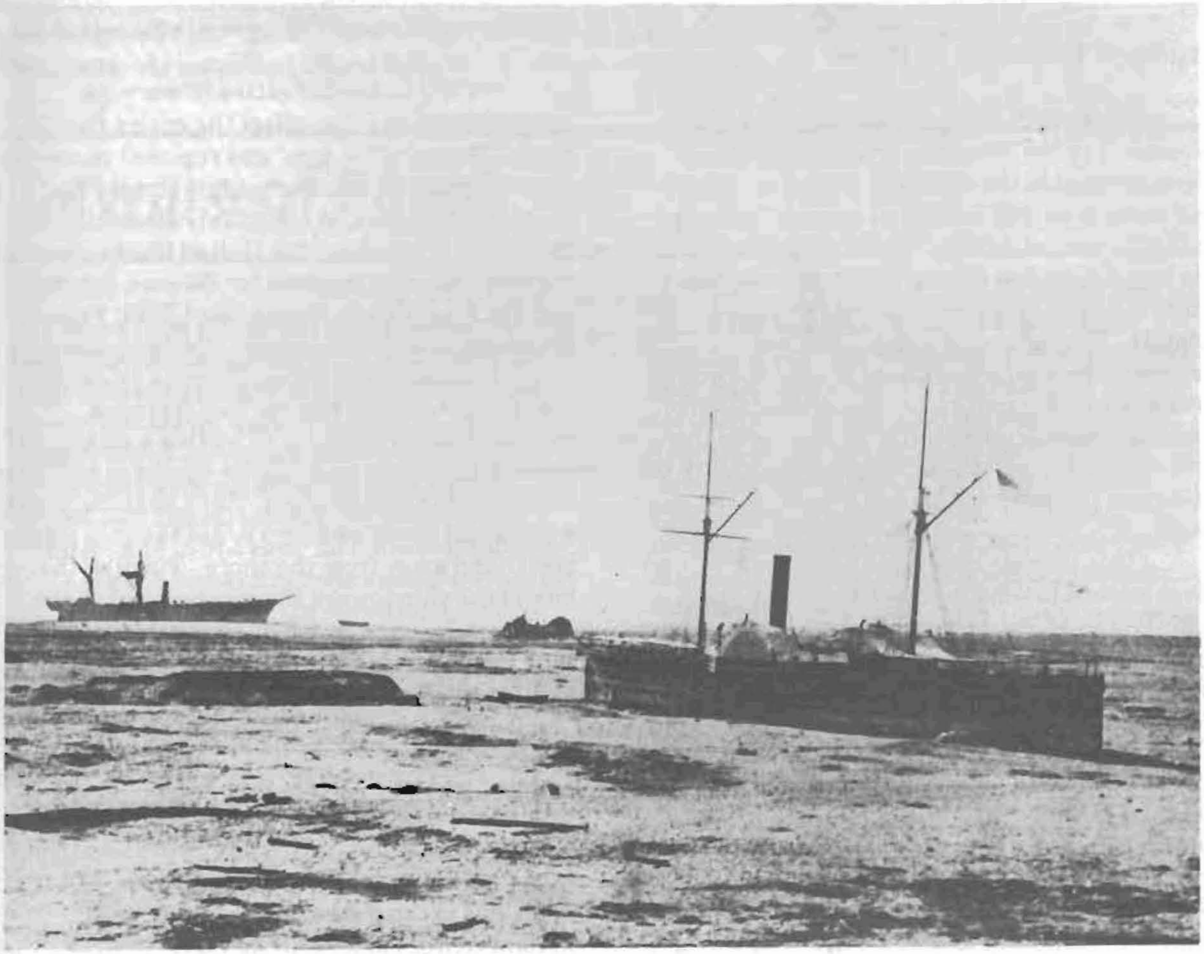
Commodore Bissel reported that the hull of the ship had not sustained injury. Although there was damage to the keel, the propeller, shaft, and rudder, he believed that the ship could be refloated. The task was completed in about 6 months, and the **Monongahela** left Frederiksted on May 20, 1968.

Sea Craft and Tsunamis

In November 1935, a tsunami in Hawaii ran many fishing vessels and yachts onto dry land at Hilo. In November 1952, a tsunami threw boats onto the land all throughout the islands.

In October 1883 at Port Graham, Alaska, all the fishing boats were beached, carried out to sea, and finally run aground. The March 1964 tsunami in Valdez, Alaska, demolished the waterfront facilities and destroyed the entire fishing fleet that was in the harbor.

However, ships and boats at sea or away from harbor areas escape damage. Perhaps the most dramatic example of this occurred in Japan



The America, Peruvian man of war, and the Wateree 2 miles inland after the tsunami of August 8, 1868, Arica, Chile. *(Photo by Rear Admiral Billings, USN)* in June 1896. In this event, the fishermen who had gone to sea were among the few survivors of the tsunami that took more than 27,000 lives. When they returned on the following morning, the fishermen saw a sea strewn with corpses and the debris of homes. Heaps of ruins or bare expanses were all that remained where coastal villages and cities had been. The tsunami had passed beneath the fishing boats undetected but had devastated the coastal areas.

This event illustrates the best defense for boats and ships anchored in harbors when a large earthquake occurs. Ships should attempt to leave the harbor area and leave the open seas. The amount of time elapsing before the arrival of the tsunami is dependent on the distance to the tsunami-generating area (earthquake epicenter). Areas prone to tsunami damage have established local and regional tsunami warning systems to warn ships and coastal areas of the impending dangers.

Tsunami Warning Systems

On April 1, 1946, a tsunami was generated in the Aleutian Islands that caused some damage in the sparsely settled Aleutians and more than $26 million in property damage in the Hawaiian Islands. Following this event, the U.S. Coast and Geodetic Survey provided a tsunami warning system for the Hawaiian Islands. The following capabilities are necessary to such a warning system: the ability to detect rapidly and accurately the location of each earthquake, the ability to determine the actual existence of a tsunami, and the ability to calculate the expected time of arrival of the tsunami.

This process requires an hour or less, and gives adequate time to warn of tsunamis that require 4 to 15 hours to reach the Islands. The system begins to function only when an earthquake of magnitude 6.5 or larger anywhere in the Pacific Basin triggers the earthquake alarm.

In 1965, the United States, in cooperation with the United Nations Educational, Scientific, and Cultural Organization's (UNESCO) Intergovernmental Oceanographic Commission (IOC), expanded its existing Tsunami Warning Center in Honolulu to become the headquarters of the International Pacific Tsunami Warning System. Today the Pacific Tsunami Warning Center (PTWC) at Ewa Beach near Honolulu is operated by the U.S. National Weather Service. Twenty-three nations in the Pacific now cooperate in the warning system. The system makes use of 69 seismic stations, 65 tide stations, and 101 dissemination points scattered through the Pacific Basin.

PTWC requests data from observatories in the system to determine the epicenter and magnitude of the earthquake. If the earthquake has a magnitude of 7.5 or larger (7.0 or larger in the Aleutians), and is located where a tsunami could be generated, PTWC issues a tsunami watch. It requests participating tide stations in the area of the earthquake to monitor their gauges. If one of the tide stations in the area reports unusual tidal activity, the tsunami watch is upgraded to a tsunami warning. PTWC calculates the travel times and transmits the warning to the disseminating agencies that relay the message to the public. If reports from tide stations show that the tsunami is too small to cause problems, PTWC cancels the watch or warning.

PTWC is most effective in warning against tsunamis that affect the entire Pacific Basin. Warning for local and regional tsunamis occurring within 45 minutes to 1 hour of the earthquake cannot be effectively disseminated by PTWC. Therefore, the United States operates regional warning systems for Hawaii, Alaska, and the West Coast. Japan, the USSR, France, Polynesia, and Chile operate similar systems.

In areas near the earthquake epicenter, the earthquake itself is the best warning. Strong shaking of the earth lasting a minute or more is an urgent warning for people to evacuate coastal areas immediately. Such shaking is also a signal for ships' captains to get the ship under power and away from the shore. Turning the bow of the ship toward the wave may save the ship from being capsized by the tsunami. In such instances, education is the best defense against the tsunami threat.

However, new technology continues to improve the warning system process. An updated warning system is being implemented that transmits real-time data to PTWC from shore-based seismic and tsunami sensors using synchronous meteorological satellites. Future additions to the PTWC may include ocean bottom sensors placed in the travel path of tsunamis to confirm that an earthquake has generated a tsunami. Use of these sensors should help to eliminate unnecessary warnings.

They will provide scientists with critical data about the wave when it is undisturbed by shoaling processes.

Tsunami Data Bases

Computer systems are constantly being upgraded to handle data quickly and efficiently Refined historical data are also increasingly useful in predicting future events. The U.S. National Geophysical Data Center/World Data Center A for Solid Earth Geophysics has developed data bases to further tsunami research. These sets of data include marigrams (tide gauge records), wave damage photographs, source data, descriptive material, and a tsunami wall map. A digital file contains information on methods of tsunami generation, location and magnitude of generating earthquakes, tsunami size, event validity, and references. The data can be used to describe areas most likely to spawn tsunamis and the locations along shores that experience amplified effects from tsunamis.

For more information, write National Geophysical Data Center, E/GC1, 325 Broadway, Boulder, Colorado 80303, or call (303) 497-6337.

The combination of shores, ships, and tsunamis can be deadly. However, better tsunami warning systems and increased tsunami awareness by navigators can mitigate the effects of this hazard.

(Ed. Note: A unique set of twenty 35-mm slides has been selected from NGDC's photograph collection. Slides in this set depict advancing waves, harbor damage, and before-and-after scenes of structural damage; they also show views of the extent of inundation along the shores. Because photographs show clear-cut evidence of the destructive force of tsunami waves, they provide a unique and affordable educational tool for presentation to both technical and nontechnical audiences. Please call (303) 497-6277 or write to the address above for more information.) ▮

Beware of Rags!

More than one vessel has suffered reduction in maneuverability as a result of rags becoming caught in equipment. In two recent instances, rags carelessly left inside ship systems during periodic overhaul eventually became so lodged that critical machinery failed, leaving the vessel with limited, and in one case, no maneuverability.

One one vessel a rag worked its way up the steering system from the sump tank until it eventually became lodged in the suction side of a non-return valve leading to the port steering gear pump. As a result, the steering gear failed causing total loss of maneuverability! The lodged rag was finally found after numerous lengthy investigations to determine the source of the failure.

In the second case, the low pressure turbine pinion bearing in the main reduction gear began overheating as a result of reduced oil flow from the bearing. Several hours of investigation revealed that a rag was obstructing the outlet lubricating port. The rag had apparently been left unnoticed in the equipment when reduction gears were renewed 3 years previously during periodic overhaul.

Fortunately, in both these cases the ships were in open seas at the time of failure, and no casualty occurred. However, such oversights can easily place the vessel at risk of grounding or collision, and invariably result in costly repairs and delays.

(Reprinted from Chevron Shipping Company's Safety Bulletin, *April 1988.)* ▮

Underrecognized Hazards, Asphyxiation, and Toxic Vapor

Thomas J. Pettin

The vast majority of asphyxiation and toxic vapor casualties occur in confined spaces. When entering a confined space, an individual is faced with three primary hazards: the confined space may not contain enough oxygen, the space may contain toxic vapors, or the space may contain cargo vapors within the explosive range. The profile indicates that commercial fishermen are at the highest risk where death is involved, while seamen who work on tank ships appear to have the highest injury rate.

Marine transport personnel who handle toxic cargoes and U.S. Coast Guard personnel involved in inspection of marine transportation activities are potentially at risk to toxic substance exposures in performance of their normal work. Tank ships and tank barges continually transport chemicals, gasoline, crude oil, and other common chemical and petrochemical products. These products have toxicities which range from substances with negligible toxicity to those that are highly toxic. Cargoes can present significant respiratory hazards. Vapors absorbed through mucous membranes in the lungs can get into the bloodstream and cause injury and sometimes fatal damage to the brain.

The pie chart (table 1) shows tank ships involved in the most casualties. Note the majority of these personnel cases involved only injuries. On the other hand, the vast majority of commercial fishing vessel cases involved death. It is generally acknowledged that commercial fishermen are engaged in one of the more hazardous occupations in the United States. This perception is reinforced after examining casualty data files that have been compiled from reports of personnel accidents and vessel casualties submitted to the Coast Guard by vessel owners and operators (as required by 46 Code of Federal Regulations Part 4).

Since 1981, there have been 50 maritime asphyxiation and toxic vapor cases reported to the Coast Guard. From 1981 through 1986, asphyxiation and toxic vapors caused 11 deaths and 5 injuries aboard fishing vessels alone. These 16 cases represent 32 percent of all asphyxiation and toxic vapor cases reported. While these numbers are not alarmingly high, the Coast Guard feels the majority of these tragedies could have been prevented. Human error was the primary cause of 72 percent of all cases reported, while machinery and equipment failures accounted for the remaining 28 percent.

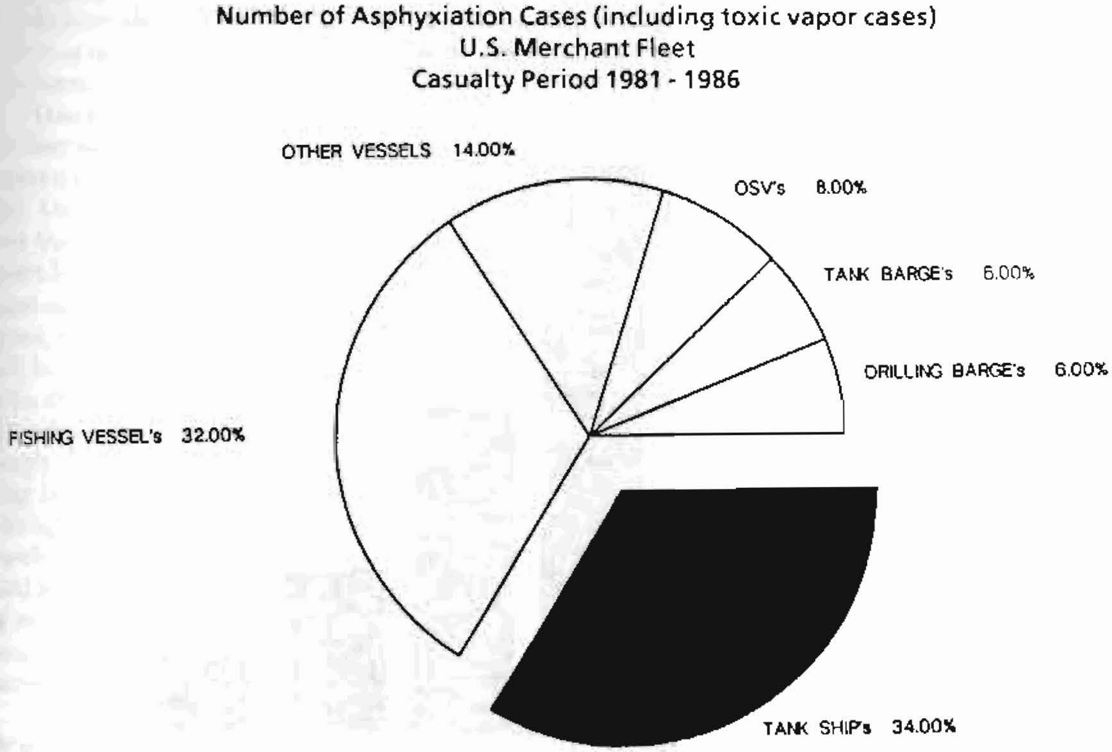
There doesn't appear to be any one particular vapor causing asphyxiation or toxic vapor casualties, although vapors from gasoline and Malithion accounted for the highest number of casualties from those vapors that could be identified. The trend (table 2) indicates that these types of cases are declining. The number of cases reached an all-time high of 21 in 1983. In 1984, this declined to 12 cases, and to 6 cases in 1985. The encouraging news is that the Coast Guard only recorded 3 asphyxiation cases for 1986.

I have examined some of the more frequent causes for asphyxiation and toxic vapor casualties. Some of the more common gases and compounds that have caused injuries and deaths over the last 6 years are described below:

Hydrogen sulfide. Hydrogen sulfide is a poisonous, colorless gas with a rotten-egg odor. Many persons are congenitally unable to smell the noxious odor. Oddly, in large concentrations the gas quickly desensitizes the nostrils and becomes odorless. This gas is found in many mineral waters and in putrefying matter (e.g.,

Mr. Pettin is a Program Analyst in the Coast Guard's Marine Investigation Division. This article was adapted from a paper Mr. Pettin presented to the 1987 National Safety Council Congress and Exposition.

Table 1



decaying fish and sewage), and can cause immediate coma, convulsions, and ultimately death due to respiratory failure.

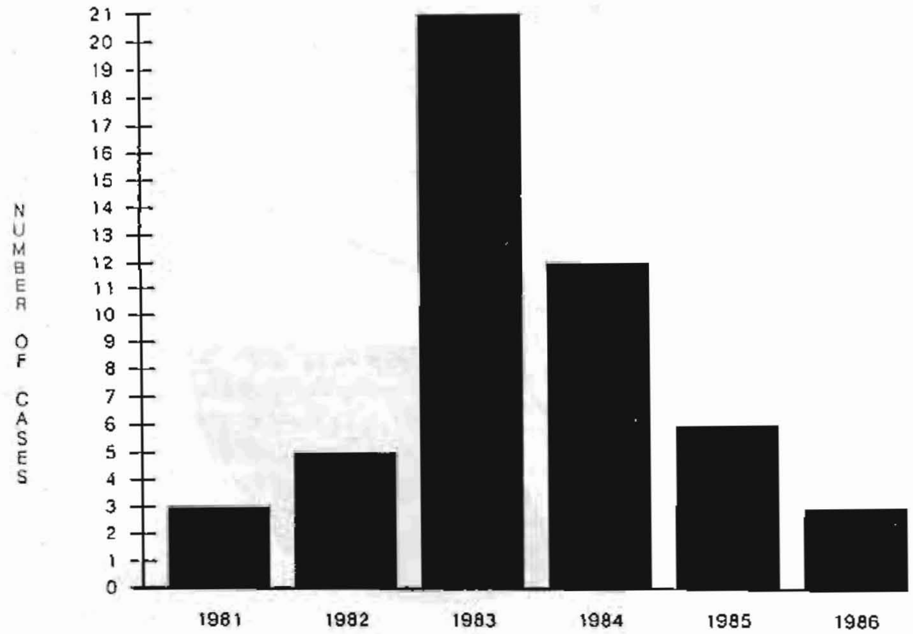
Freon. Freon is widely used as a refrigerant and a propellant in aerosol cans. It is nonflammable in gas or liquid form. It is *not* commonly known that freon can displace fresh air and become lethal in a closed space. Proper refrigeration maintenance should prevent most serious accidents caused by freon leaks. Because freon is heavier than air, a person who suspects a freon leak should remember to exit a space in an upright position rather than in a crawling position.

Carbon Monoxide. This dangerous gas is colorless, odorless, tasteless, and deadly. If inhaled in concentrated amounts within a closed space, death will result in a short period of time. Carbon monoxide thwarts the oxygen-carrying capacity in the blood. The effect is an abnormal condition resulting from a decrease in the oxygen supplied to, or used by, body tissue. Symptoms of exposure to carbon monoxide include headaches, dizziness, drowsiness, nausea, vomiting, collapse, coma, and death. This dangerous gas is produced by the incomplete combustion of carbon, most commonly from gasoline or diesel engines.

Ammonia. Ammonia is a pungent, colorless, gaseous, and alkaline compound of nitrogen and hydrogen. It is water-soluble and can be condensed to a liquid by pressure and cold temperatures. It irritates the eyes, nose, and moist skin. Ammonia can produce headaches, excessive salivation, burning in the throat, amnesia, nausea, and vomiting. If exposure is extensive or prolonged, severe irritation of the respiratory tract can result in respiratory arrest and death. Survivors of severe exposure often suffer from bronchitis and pneumonia. Since it is easily recognized by its obnoxious odor, ammonia should be easily detected. Ammonia can be deadly within a relatively short period of

Table 2

Toxic Vapor Cases and Asphyxiation Cases Reported to U.S. Coast Guard
Casualty Period 1981 - 1986



time, thus one should not discount their vulnerability to it.

Carbon Dioxide. Carbon dioxide is a heavy, colorless, odorless, noncombustible gas which is formed in large volumes in the decay or decomposition of animal or vegetable matter. Carbon dioxide is a major problem to the fishing industry since fish begin to decay shortly after they expire. Decaying fish produce carbon dioxide, thus this killer has been responsible for many a fisherman's demise. Carbon dioxide is a simple asphyxiant that interferes with the oxidation of body tissue. When 10 percent of the air volume contains carbon dioxide, unconsciousness and death can result due to oxygen deficiency. This gas has the potential of being doubly dangerous to cardiovascular and pulmonary disease victims. Since carbon dioxide is heavier than air, concentrations of carbon dioxide in a hold or in other unventilated area will be greater at the bottom than at the top.

There is only one sure way to determine if the space is safe and contains sufficient oxygen to support life, and that is to *test* it with the appropriate instrument. Maritime personnel cannot rely on the sense of smell to detect vapors. Some chemical vapors deaden the sense of smell. There are chemical vapors that cannot be detected by smell even at hazardous concentrations; examples are hydrogen sulfide and propylene oxide. Smoking or the consumption of alcoholic beverages can accelerate toxic effects or make an individual susceptible to lower concentrations of chemical vapors.

We must remember most lethal gases work silently and quickly. The air that we breathe normally contains a 21-percent oxygen level. An atmosphere containing less that 16 percent oxygen is considered to be immediately dangerous to life. The exact amount required to sustain a human life varies from individual to individual; however, marine chemists generally regard 19.5 percent as minimally acceptable.

An atmosphere containing less than 16 percent oxygen cannot be relied upon to sustain life without proper respiratory equipment. There is only one sure way to determine if a space is safe, and that is to test it with the appropriate instrument.

One should take note that a confined space can sometimes become oxygen deficient if oxidation (rusting) is taking place within that space. Oxidation can remove oxygen to the point where there may not be sufficient oxygen to support life. Fatalities have resulted from oxygen-deficient atmospheres caused by certain cargoes, such as fresh fruit, scrap iron, or wood, which have slowly used up the oxygen. Oxygen may be displaced in an area if welding equipment is not properly secured when work is through. Enough argon or helium may leak during the night or weekend to displace oxygen to a dangerous level, therefore spaces in which gas welding equipment has remained overnight should be tested to ensure a safe oxygen content. If we adhere to the following safety principles, we can reduce this type of casualty from occurring in the first place:

a. Of paramount importance is the emphasis that should be placed on training crew members of onboard hazards. Maritime personnel should also be instructed in the use and limitations of all safety equipment, and it is important for safety equipment to be maintained in good working order.

b. Crew members must be instructed never to enter a hold or any other space that has been closed for an extended period of time before testing the atmosphere for the presence of lethal gas or for the absence of sufficient oxygen. Atmospheric testing devices specifically designed for that purpose should be located where they are readily accessible. Spaces found to be oxygen deficient should be ventilated.

c. Crew members should be further instructed never to enter a confined space without making sure another person is stationed outside the area.

d. Unventilated areas aboard vessels may contain explosive vapors. Signs reminding crew members not to smoke should be posted in these spaces.

e. Holds on fishing vessels should be cleaned with clean water as soon as possible after off-loading to prevent gas formation from decaying matter.

f. When a portable gasoline engine is used in a confined space, exhaust fumes should be vented to the outside. Exhaust pipes and cooling systems should be inspected for leaks on a regular basis.

g. Finally, crew members should be drilled for actual emergencies and regularly instructed on the dangers aboard vessels.

Conclusion

The concept of an asphyxiation or toxic vapor casualty as an unforeseen or chance event must be replaced by the concept that this type of casualty is a complex event involving a system of human and environmental factors. These casualties don't happen by chance. These casualties occur because people don't respond properly to the situation at hand. Their particular situation may not be perceived accurately, or there may be distractions or other "interference." Nevertheless, a human failure has occurred. A clear element of negligence or misjudgment may also be involved. The more loaded a situation is with such characteristics, the more likely it is that improper actions will lead to a personnel casualty.

The extent of marine deaths and injuries, and the probability of higher statistics in the future, demand immediate action. Personnel injuries are the most numerous and cumulatively the most costly type of casualty faced by the industry. Benjamin Franklin summed it up 200 years ago when he said that a voyage at sea had many things to recommend it, but safety wasn't one of them.

To minimize this class of personnel casualty, the Coast Guard continually strives to "raise the consciousness" of the maritime community. The Coast Guard invites all maritime organizations and associations to encourage continued safety and to publicize the aforementioned safety recommendations to all their memberships. ∎

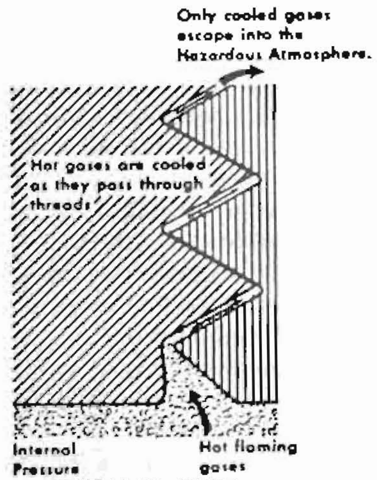
Explosionproof Equipment

Randall N. Crenwelge

This article is the third in a series on Electrical Installations in Hazardous Locations. It follows the "Intrinsically Safe and Nonincendive Systems" and "Purged and Pressurized Enclosures" articles published in the November 1987 and the August-September 1988 issues of Proceedings, *respectively. These articles discussed classification of hazardous locations and the proper application of low energy circuits and purged and pressurized enclosures.*

When electrical equipment is installed where flammable gases and vapors may be present, an "explosionproof" enclosure may be used to allow the equipment to operate safely. The explosionproof enclosure concept recognizes that flammable gases and vapors may enter the enclosure and assumes that a source of ignition will create an internal explosion. The enclosure is designed to withstand the explosion and prevent it from propagating to the hazardous area surrounding the enclosure. Locations where explosive vapors or gases can exist include battery rooms, paint lockers, tank vessel pump rooms, and mud pit rooms and on the drill floor of a mobile offshore drilling unit.

Explosionproof enclosures usually have covers which can be removed or opened for making connections and adjustments, and for maintenance. The dimension of the gap between an enclosure's flanges and metal-to-metal joints determines its effectiveness. An explosion will propagate through this gap if the gap's width is greater than the maximum experimental safe gap (MESG). If the gap is less than the MESG, the velocity of the emerging jet and the velocity of the external gases mixing with the jet are so great that cooling takes place, and ignition cannot occur. When the hot gas or vapor from an explosion passes through this region, some energy is absorbed by the flanges, some energy is absorbed by the expansion of gases (refrigeration effect), and some energy is absorbed by hot gases mixing with cool gases outside of the enclosure. A sufficient amount of energy must be transferred from the hot gases to the surrounding air or enclosure, otherwise an explosion will occur. The MESG is determined experimentally for each gas or vapor using a special apparatus and test chamber, and specific gases and vapors are divided into groups based on their MESGs (i.e., Groups A through D).



THREADED JOINT

FIGURE 1

Several types of explosionproof covers are used depending on their application. The most simple and effective cover is a threaded joint (see figure 1) which is often used for watertight applications. When an explosion occurs, the cover threads are forced tight against the body threads. Hot gases are cooled as they spiral along these threads. A gasket under the cover's flange is located outside of the cooling region and does not interfere with the metal-to-metal contact of the threads. Other types of enclosure

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Mr. Crenwelge is a Staff Engineer assigned to the Electrical Engineering Section, Marine Technical and Hazardous Materials Division, U.S. Coast Guard.

openings or accesses include flanged covers (see figure 2) and cylindrically shaped openings. These enclosures use precision-machined, metal-to-metal joints which provide a straight path from the enclosure's inside to the outside atmosphere. During an explosion, numerous cover screws prevent flange and enclosure distortion.

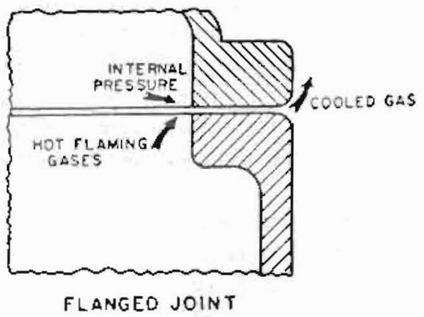


FIGURE 2

When a flame ignites a gas, it is compressed, and the resulting explosion causes a large increase in pressure. Due to the rapid increase in pressure, less energy is required for further ignition and flame propagation. An explosion occurs rapidly, causing a front between burned and unburned compressed gas. If the expanding gas is restricted, channeled, or impeded, pressure piling will occur. Pressures can occur which are ten times higher than pressures which occur when there is no impediment to expansion. Pressure piling is particularly serious in pipes and conduit. To reduce the effects of pressure piling, cable seal fittings are installed within 18 inches of enclosures.

Explosionproof equipment is evaluated and labeled by an independent product certification agency. Typically, the enclosure is placed in a test chamber which has explosion pressure-recording devices attached to it. Both the enclosure and the chamber are charged with a specified gas. The gas inside the enclosure is ignited, and the resulting explosion is observed for propagation to the surrounding chamber's atmosphere. The explosion tests are repeated over the entire explosive range of the gas or vapor's fuel-air mixture. The enclosure must withstand the internal pressure from the explosion without bursting or loosening its joints. Explosion damage to equipment inside the enclosure must not occur during testing unless the damaged equipment can readily be replaced. All tests are conducted using maximum loads, short circuit, or worst case conditions. Typically, ten tests are conducted over the entire flammable range for each device. Enclosures are usually tested for a period of 1 minute using a hydrostatic pressure based on the maximum observed internal explosion pressure. Seals must withstand for 1 minute a hydrostatic test pressure of four times the maximum explosion pressure. Additionally, equipment which generates heat is evaluated to ensure that its surface temperature is not high enough to cause ignition of the surrounding hazardous atmosphere.

Specific Types of Explosionproof Enclosures and Fittings

Flame arresters are sometimes used in explosionproof enclosures to reduce maximum explosion pressure and to protect any incoming air lines. Types of flame arresters include porous metal plugs made on sintered metal, a baffle-type breather similar to an automobile muffler, a special fitting with a loosely fitted thread, and a spiral-wound, corrugated metal fitting. The spiral-wound fitting causes the flame to spread through paths which cool the gases by heat transfer to the metal from the atmosphere. The others make the escaping explosion's hot gases turn sharp corners, thus allowing them to cool.

Explosionproof receptacles and plugs are designed as a pair. Mechanical interlocking is used between the plug and receptacle. When a plug is inserted, electrical contact cannot be made until the mated plug and receptacle assembly has established its explosionproof integrity. To prevent explosions from propagating, many threads are usually engaged before electrical contact is made or broken.

An explosionproof enclosure is not effective without sealed cable entrances. Seal fittings allow an explosion to be contained within an enclosure, prevent pressure piling, and prevent the transmission of gases or vapors between enclosed electrical systems installed in

Division 1, Division 2, and ordinary locations. Seal fittings are usually attached by a short piece of rigid conduit to an enclosure for switches, circuit breakers, fuses, relays, resistors, or other apparatus which may produce arcs, sparks, or a high temperature. Not more than 18 inches of pipe or rigid conduit may be used, and at least five full nipple threads must be engaged at each end. Explosionproof unions, couplings, elbows, capped elbows, and conduit bodies are the only permitted fittings between the sealing fitting and the enclosure. Two types of seal fittings are commonly used. A cable gland is shown in figure 3, and a "poured" seal is shown in figure 4. Use of a cable gland allows for a cable to be assembled in a clean shop environment and for simple field connection and installation. The compound is applied to a portion of the fitting which is later inserted into the enclosure. The "poured" seal is completed by potting it with an approved compound after the conductors have been brought into the enclosure.

Maintenance

Equipment which is certified for a hazardous location should usually be repaired by a qualified facility. Product certification agencies usually qualify repair facilities that have demonstrated their knowledge, expertise, and capability to repair explosionproof equipment. Each facility is qualified to repair specific types of equipment such as motors, generators, telephones, etc. When the explosionproof equipment is repaired, a label is usually affixed to indicate that the equipment conforms to the same rules which applied when it was new. The following guidelines can be used to maintain explosionproof equipment:

1. All cover screws and bolts must always be tight while circuits are alive. Leaving one screw or bolt loose can render equipment unsafe. Bolts or screw types other than those provided with the equipment should not be used.

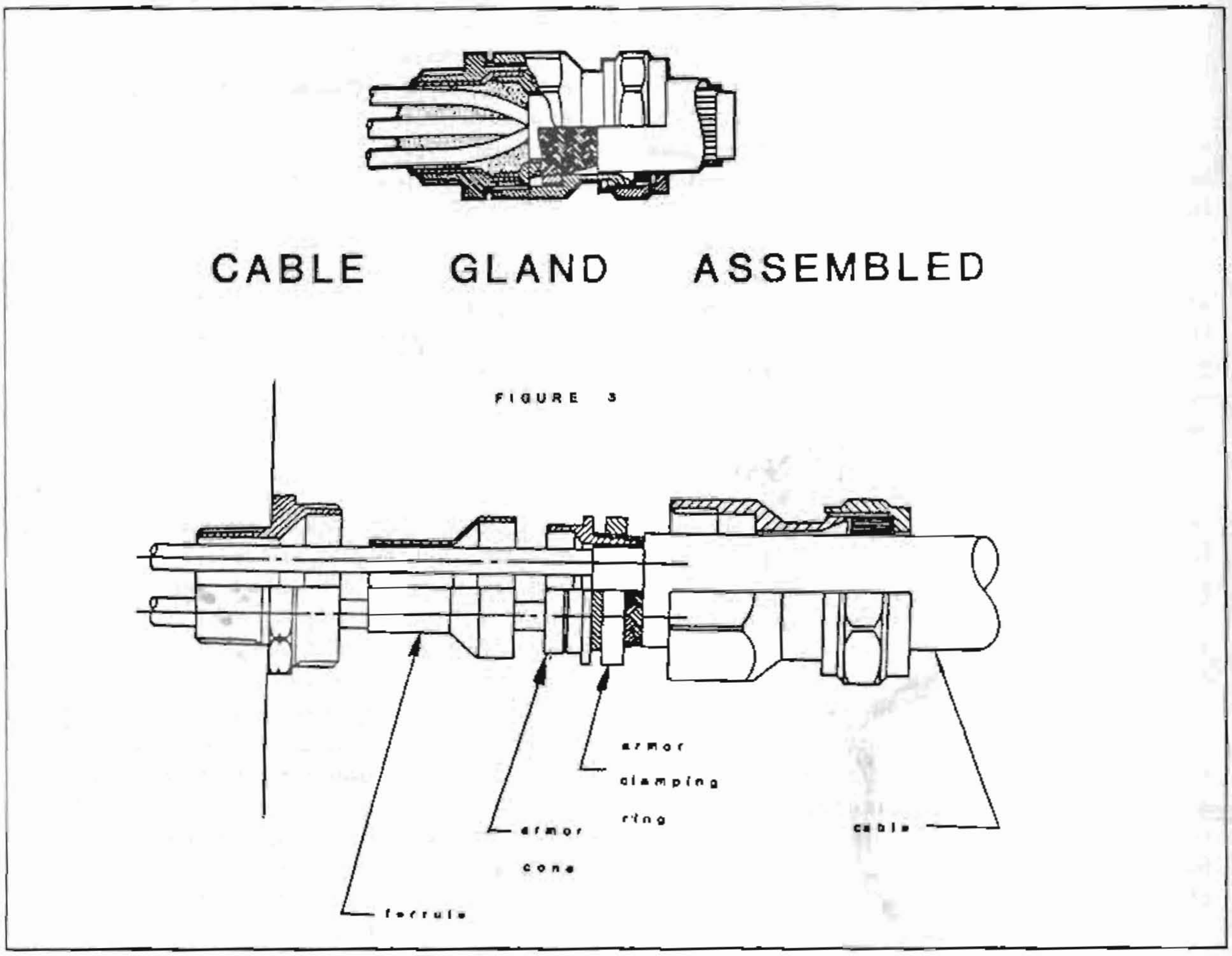


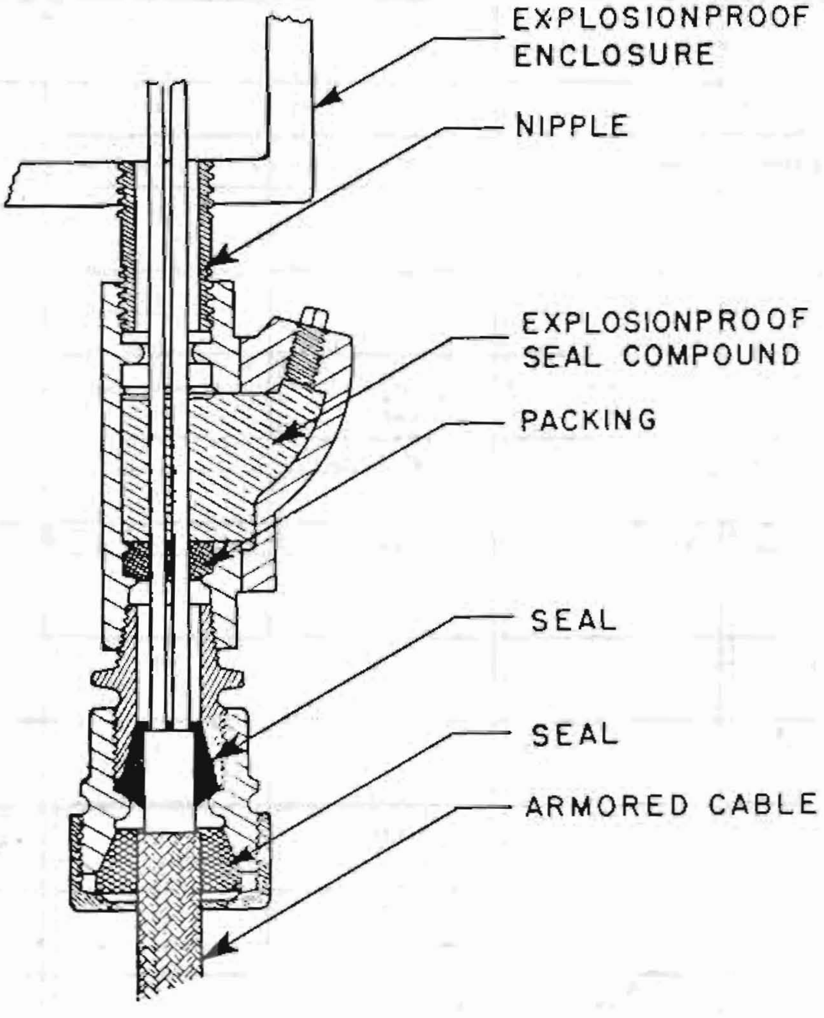
FIGURE 3

2. Hammers and other tools must not be allowed to damage threaded joints or flat machined surfaces of flanged joints. All surfaces that form part of a flame path must be protected from scratches and other mechanical defects.

3. Flange surfaces and threaded joints should be cleaned free of old grease and other foreign materials. A light oil film or lubricant should be applied to both sides of the joint immediately before assembly. When reassembling, there should be no foreign particles on joint surfaces.

4. Threaded covers, flat joints, surfaces, rotating shafts, bearings, and operating shafts should be lubricated for protection against corrosion. Never use abrasives or files to remove corrosion products from threaded or flanged joints. Equipment which is corroded should be replaced.

5. Explosionproof equipment should not be modified, and the equipment nameplate should not be obscured. ∎



Explosionproof Cable Installation (the type of cable termination has no particular significance).

FIGURE 4

1987 Merchant Marine Officer Licenses Issued

New license regulations became effective on December 1, 1987. At that time, 29 new licenses were established. These licenses are listed separately for identification purposes. Both the Summary and Comparison charts for 1987 reflect these new license figures.

Deck

	Issues	Endorsements	Failures	Renewals
Master, Any Gross Tons, Ocean	181	31	3	648
Master, Great Lakes	12	5	1	60
Master, Coastwise	11	3	1	33
Master, Lakes, Bays, Sounds/Rivers	350	44	3	279
Master, Uninspected Vessels	59	58	2	166
Master, Fishing Vessels	9	9	1	34
Master, Ferry Vessels or MODUs*	35	5	1	26
Master, Freight and Towing Vessels & M.O.	741	448	25	736
Chief Mate, Any Gross Tons, Oceans	161	85	9	226
Chief Mate, Limited Tonnage, Oceans	67	9	3	19
Second Mate, Any Gross Tons, Oceans	155	39	11	247
Third Mate, Any Gross Tons, Ocean	420	25	3	437
Mate, Uninspected Vessels	14	10	0	40
Mate, Fishing Vessels	0	0	1	3

* MODU - Mobile Offshore Drilling Unit
** M.O. - Mineral & Oil

Deck - Continued

	Issues	Endorsements	Failures	Renewals
Mate, Ferry Vessels or MODUs	7	1	0	4
Mate, Freight and Towing Vessels & M O	215	55	25	82
First Class Pilot	122	553	5	1050
Operator, Uninspected Towing Vessels	361	116	50	1521
2/C Class Operator, Uninspected Towing Vessels	70	10	13	26

Engineer

	Issues	Endorsements	Failures	Renewals
Chief Engineer, Motor	72	87	4	108
First Assistant, Motor	56	73	0	53
Second Assistant, Motor	109	52	2	73
Third Assistant, Motor	146	23	1	522
Chief Engineer, Steam	68	12	6	422
First Assistant, Steam	113	11	0	223
Second Assistant, Steam	108	18	7	377
Third Assistant, Steam	97	11	1	173
Chief Engineer, Steam & Motor	15	22	2	248
First Assistant, Steam & Motor	15	7	1	50

Engineer - Continued

	Issues	Endorsements	Failures	Renewals
Second Assistant, Steam & Motor	41	10	2	91
Third Assistant, Steam & Motor	494	5	1	680
Chief Engineer, Uninspected Vessels	92	57	3	181
Assistant Engineer, Uninspected Vessels	54	4	3	47
Chief Engineer, Fishing Vessels	18	4	0	20
Assistant Engineer, Fishing Vessels	2	0	0	3
Chief Engineer, Ferry Vessels or MODUs	15	8	3	34
Assistant Engineer, Ferry Vessels or MODUs	0	0	0	0
Chief Engineer, Mineral & Oil Vessels	131	65	3	129
Assistant Engineer, Mineral & Oil Vessels	14	2	1	6

Staff Officer Certificates of Registry Issued

Surgeon	10	Purser	10	Senior Asst Purser/HM	1
Professional Nurse	6	Purser/PYA	0	Junior Asst. Purser	20
Chief Purser	12	Purser/HM	0	Junior Asst Purser/PYA	1
Chief Purser/PYA*	1	Senior Asst. Purser	2	Junior Asst. Purser/HM	2
Chief Purser/HM**	3	Senior Asst. Purser/PYA	1		

*** PYA - Physician's Assistant**
**** HM - Hospital Corpsman**

Operator Licenses

	Issues	Endorsements	Failures	Renewals
Small Passenger Vessels (Ocean)	4630	958	168	2244
Small Passenger Vessels (Inland)	3528	275	302	998
Uninspected Passenger Vessels	3655	165	415	1747

Radio Officer License

	Issues	Endorsements	Failures	Renewals
Radio Officer	37	1	0	240

Summary of All License Transactions

	Issues	Endorsements	Failures	Renewals
Deck (Less OUTV & 2/C OUTV*)	3586	1615	116	4519
OUTV & 2/C OUTV	432	126	63	1572
Engineer	1723	494	41	3490
Staff Officer	69	n/a	n/a	n/a
Operator (SPV & UPV**)	11,813	1398	885	4989
Radio Officer	37	1	0	240
Radar Observer	n/a	3336	n/a	n/a
TOTALS	17,660	6860	1105	14,810
TOTAL ALL TRANSACTIONS	40,435			

* OUTV & 2/C OUTV - Operator, Uninspected Towing Vessels and Second Class Operator, Uninspected Towing Vessels
** SPV & UPV - Small Passenger Vessels and Uninspected Passenger Vessels

Comparison

	1984	1985	1986	1987
Licenses Issued/Renewed	25,314	29,980	32,527	32,470
Endorsements	2589	3331	3752	3634
Failures	6981	523	1238	1105
Radar Observer	3064	8291	3513	3226
TOTAL TRANSACTIONS	37,948	42,125	41,030	40,435

New Licenses Established as of December 1, 1987 -- Deck

	Issues	Endorsements	Failure	Renewal
Master, Near Coastal	3	1	0	4
Chief Mate, Near Coastal	0	0	0	0
Second Mate, Near Coastal	1	0	0	0
Third Mate, Near Coastal	0	0	0	1
Master, Ocean or Near Coastal NMT 1600 GT	29	75	1	50
Mate, Ocean or Near Coastal NMT 1600 GT	11	8	0	2
Master, Ocean or Near Coastal NMT 500 GT	139	92	10	139
Mate, Ocean or Near Coastal NMT 500 GT	32	15	9	24
Master, Ocean or Near Coastal NMT 200 GT	32	6	[illegible]	4
Mate, Near Coastal NMT 200 GT	0	0	0	0

New Licenses Established as of December 1, 1987 -- Deck (continued)

	Issues	Endorsements	Failures	Renewals
Master, Near Coastal NMT 100 GT	453	27	0	98
Master, Great Lakes & Inland Any GT	0	0	0	2
Mate, Great Lakes & Inland Any GT	0	0	0	0
Master, Inland Any GT	3	4	0	12
Master, Great Lakes & Inland NMT 1600 GT	0	0	0	1
Mate, Great Lakes & Inland NMT 1600 GT	2	0	0	1
Master, Great Lakes & Inland NMT 200 GT	0	0	0	0
Mate, Great Lakes & Inland NMT 200 GT	0	0	0	0
Master, Inland NMT 100 GT	310	6	2	39
Limited Master, Great Lakes & Inland NMT 100 GT	12	1	0	2
Operator Uninspected Towing Vessels Great Lakes & Inland	1	0	0	26
2/C Operator Uninspected Towing Vessels Great Lakes & Inland	0	0	0	0

New Licenses Established as of December 1, 1987 -- Engineer

	Issues	Endorsements	Failures	Renewals
Chief Engineer (Limited Oceans)	17	11	0	19
Chief Engineer (Limited Near Coastal)	4	3	0	0
Assistant Engineer (Limited)	21	4	1	8
Designated Duty Engineer	1	1	0	0
Chief Engineer, Fishing Industry Vessels	18	4	0	20
Assistant Engineer, Fishing Industry Vessels	2	0	0	3

1986 Merchant Marine Officer Licenses Issued

Statistics for calendar year 1986 were not previously published and are included at this time for comparison purposes.

Deck

	Issues	Endorsements	Failures	Renewals
Master, Any Gross Tons, Oceans	173	46	10	769
Master, Great Lakes	18	8	5	57
Master, Coastwise	5	1	0	43
Master, Lakes, Bays, Sounds/Rivers	40	29	0	314
Master, Uninspected Vessels	56	48	0	211

Deck - Continued

	Issues	Endorsements	Failures	Renewals
Master, Fishing Vessels	9	3	1	38
Master, Ferry Vessels or MODUs*	60	5	2	33
Master, Freight & Towing Vessels & M.O.**	1196	679	12	825
Chief Mate, Any Gross Tons, Oceans	129	89	13	199
Chief Mate, Limited Tonnage, Oceans	74	15	5	36
Second Mate, Any Gross Tons, Oceans	177	48	7	275
Third Mate, Any Gross Tons, Oceans	511	14	9	416
Mate, Uninspected Vessels	9	15	0	44
Mate, Fishing Vessels	1	0	0	6
Mate, Ferry Vessels or MODUs	8	0	0	4
Mate, Freight & Towing Vessels & M.O.	425	85	21	88
First Class Pilot	162	579	23	1212
Operator, Uninspected Towing Vessels	432	143	52	1608
2/C Operator, Uninspected Towing Vessels	71	16	8	17

* MODU - Mobile Offshore Drilling Unit
** M.O. - Mineral & Oil

Engineer

	Issues	Endorsements	Failures	Renewals
Chief Engineer, Motor	114	106	2	124
First Assistant, Motor	69	73	1	54
Second Assistant, Motor	101	74	3	61
Third Assistant, Motor	178	28	3	572
Chief Engineer, Steam	91	10	9	522
First Assistant, Steam	137	18	1	257
Second Assistant, Steam	99	18	13	457
Third Assistant, Steam	126	5	2	213
Chief Engineer, Steam & Motor	19	10	2	306
First Assistant, Steam & Motor	19	5	1	605
Second Assistant, Steam & Motor	49	6	2	73
Third Assistant, Steam & Motor	569	7	0	684
Chief Engineer, Uninspected Vessels	171	74	8	271
Assistant Engineer, Uninspected Vessels	56	11	7	87
Chief Engineer, Fishing Vessels	9	4	3	26
Assistant Engineer, Fishing Vessels	1	0	0	11
Chief Engineer, Ferry Vessels or MODUs	26	8	3	34

Engineer - Continued

	Issues	Endorsements	Failures	Renewals
Assistant Engineer, Ferry Vessels or MODUs	7	2	1	2
Chief Engineer, Mineral & Oil Vessels	177	112	2	99
Assistant Engineer, Mineral & Oil Vessels	20	5	3	5

Staff Officer Certificates of Registry

Surgeon	10	Purser	6	Senior Assistant Purser/HM	1
Professional Nurse	8	Purser/PYA	0	Junior Assistant Purser	18
Chief Purser	8	Purser/HM	0	Junior Assistant Purser/PYA	0
Chief Purser/PYA*	1	Senior Assistant Purser	0	Junior Assistant Purser/HM	6
Chief Purser/HM**	0	Senior Assistant Purser/PYA	0		

*** PYA - Physician's Assistant**
**** HM - Hospital Corpsman**

Operator Licenses

	Issues	Endorsements	Failures	Renewals
Small Passenger Vessels (Ocean)	5139	983	231	2504
Small Passenger Vessels (Inland)	2945	205	337	1038
Uninspected Passenger Vessels	3147	153	436	1685

Radio Officer License

	Issues	Endorsements	Failures	Renewals
Radio Officer	30	12	no number given	265

Summary of All License Transactions

	Issues	Endorsements	Failures	Renewals
Deck (Less OUTV & 2/C OUTV*)	3053	1664	108	4570
OUTV & 2/C OUTV	503	159	60	1625
Engineer	2038	576	66	3923
Staff Officer	62	n/a	n/a	n/a
Operator (SPV & UPV**)	11,231	1341	1004	5227
Radio Officer	30	12	n/a	265
Radar Observer	n/a	3513	n/a	n/a
TOTALS	16,917	7265	1238	15,610

TOTAL ALL TRANSACTIONS 41,030

* OUTV & 2/C OUTV - Operator, Uninspected Towing Vessels and Second Class Operator, Uninspected Towing Vessels

** SPV & UPV - Small Passenger Vessels and Uninspected Passenger Vessels

Comparison

	1983	1984	1985	1986
Licenses Issued/Renewed	32,337	25,314	29,980	32,527
Endorsements	2767	2589	3331	3752
Failures	9980	6981	523	1238
Radar Observer	3552	3064	8291	3513
TOTAL TRANSACTIONS	48,636	37,948	42,125	41,030

Navigation and Vessel Inspection Circulars

The following Navigation and Vessel Inspection Circulars (NVICs) issued prior to January 1, 1988, are in effect:

#7-56, Manned LSTs; Structural Reinforcement and Drydocking; Hull Inspection Requirements ($2.50)

#10-60, Placards, Forms, and Instructions Required to be Posted Aboard Vessels; Alternate Materials and Methods ($1.75)

#12-61, Inspection Procedures for Approved Inflatable Life Rafts Held in Storage ($1.75)

#2-62, Watertight Bulkheads in All Inspected Vessels -- Maintenance of Watertight Integrity ($1.75)

#9-62, Liquefied Compressed Gas Cargo Hose ($1.75)

#1-63, Notes on Inspection and Repair of Wooden Hulls ($4.75)

#2-63, Guide for Inspection and Repair of Lifesaving Equipment ($4.75)

#11-63, LSTs as Unmanned Barges; Structural Reinforcement and Drydocking; Hull Inspection Requirements ($2.50)

#1-65, 24.0' 70 8.0' 70 3.58' Steel Lifeboats with Removable Interiors, Oar-Propelled (App. No. 160.035/398/0), Hand-Propelled (App. No. 160.035/411/0), and Motor-Propelled (App. No. 160.035/412/0) Manufactured by Welin Davit & Boat, Perth Amboy, New Jersey, Replacement of Short Breast Plates ($2.50)

#10-65, Stability Determination in Capsizing Cases Involving Uninspected Vessels ($1.75)

#1-66, Requirements for Hull Structural Steel -- Structural Continuity ($1.75)

#3-66, Dual Gross Tonnages; Application of ($1.75)

#3-67, Alteration of Ship's Structure Which May Affect the Adequacy of Installed Safety Devices ($1.75)

#4-67, Application of Incombustible Insulation Requirements and Identification of Approved Materials ($2.00)

#3-68, Tensile Fasteners ($2.50)

#4-68, Protective Equipment Required for Firemen's Outfits ($1.75)

#7-68, Notes on Inspection and Repair of Steel Hulls ($4.50)

#8-68, Classification of Vessels as Self-Propelled ($2.00)

#1-69, Automated Main and Auxiliary Machinery ($2.75)

#2-69, Submission of Reports for the Shipment and Discharge of Seamen Not Shipped or Discharged Before a Shipping Commissioner; Information Concerning ($2.25)

#3-69, A Nomograph Method of Calculating Available GM ($2.75)

#4-69, Inclusion of Social Security Numbers on Certificates of Discharge and Discharges for Masters ($1.75)

#8-69, Impulse-Projected Rocket Type Line-Throwing Appliances ($2.00)

#12-69, Special Examination in Lieu of Drydocking for Large Mobile Drilling Units ($2.00)

#4-70, Powder Loads for Lyle Type Line Throwing Guns ($1.75)

#6-70, Fixed Fire Extinguishing Systems for Use in Galley Ventilating Equipment ($1.75)

#7-70, Marine Type Portable Fire Extinguishers ($2.00)

#1-71, Repair of Boiler Safety Valves ($1.75)

#2-71, Pipe Stress Analysis Calculations; Procedure for Submission of ($2.00)

#4-71, Valves Employing Resilient Material ($2.00)

#5-71, Index to 46 CFR Part 151 (Certain Bulk Dangerous Cargoes on Unmanned Tank Barges), Subchapter 0 ($2.75)

#6-71, Monitoring Carbon Monoxide (CO in Ship's Cargo Spaces ($2.00)

#3-72, Portable Radio Apparatus, Training in Use of ($1.75)

#6-72, Guide to Fixed Fire-Fighting Equipment Aboard Merchant Vessels ($5.00)

#6-72, CH-1, Guide to Fixed Fire-Fighting Equipment Aboard Merchant Vessels, ($3.25)

#1-73, Pilot Ladders Used Aboard Merchant Vessels ($2.00)

#3-73, Intact Stability Criteria for Passenger and Cargo Ships Under 100 Meters in Length ($2.75)

#7-73, Main Propulsion Boiler Automation ($1.75)

#8-73, Alternate Means of Determining the Weight of CO_2 in Fire Extinguishing Systems ($1.75)

#4-74, Stability Information Required on Inspected and Uninspected United States Vessels Receiving a Load Line Certificate and Foreign Vessels Receiving Form B Load Line Certificates ($2.00)

#6-74, Elimination of Unsafe Conditions On Board Tank Barges ($1.75)

#7-74, Oil-Water Separators; Acceptance of ($1.75)

#7-74, CH-1, Oil-Water Separators; Acceptance of ($1.75)

#2-75, Alteration of Existing Rafts To Comply with Improved Inflation Standards ($1.75)

#3-75, Bulk Grain Cargoes ($3.25)

#2-76, Damage Stability Calculations for Tank Vessels ($1.75)

#2-77, American Bureau of Shipping Acceptance of Structural Fire Protection Approval ($2.00)

#3-77, Code of Safe Practice for Ships Carrying Timer Deck Cargoes ($3.00)

#4-77, Shifting Weights or Counter Flooding During Emergency Situations ($1.75)

#5-77, Inspection of Hydraulic Starting Systems for Lifeboats and Survival Capsules ($1.75)

#1-78, Automation of Offshore Supply Vessels of 100 Gross Tons and Over ($2.00)

#1-78, CH-1, Automation of Offshore Supply Vessels of 100 Gross Tons and Over ($1.75)

#2-78, Bulk Grain Cargo Regulations, 46 CFR 31.10-33, 46 CFR 74.10-12, and 46 CFR 93.20 ($2.00)

#4-78, Inspection and Certification of Existing Mobile Offshore Drilling Units ($2.25)

#4-78, CH-1, Inspection and Certification of Existing Mobile Offshore Drilling Units ($2.50)

#2-79, Aluminum Bus Bars ($2.00)

#3-79, Lifeboat Capacity on Foreign Flag Passenger Vessels ($2.00)

#5-79, Inerting and Tank Cleaning Procedures for Alkylene Oxide Containment Systems ($2.25)

#5-79, CH-1, Inerting and Tank Cleaning Procedures for Alkylene Oxide Containment Systems ($1.75)

#1-80, Inspection of Viking On-Load Release Gear on Watercraft America Lifeboats ($2.25)

#2-80, Poured Metal Socket Connections for Lifeboat Falls ($1.75)

#6-80, Guide to Structural Fire Protection Aboard Merchant Vessels ($5.50)

#7-80, Use of Fire Detection Systems Which Are Not Approved Under 46 CFR 161.002 ($1.75)

#8-80, Fire Hazard of Polyurethane and Other Organic Foams ($2.00)

#9-80, Servicing Requirements of Inflatable Life Rafts ($1.75)

#11-80, Structural Plan Review Guidelines for Aluminum Small Passenger Vessels ($4.75)

#13-80, Breathing Apparatus for Tank Vessels ($1.75)

#1-81, Guidance for Enforcement of the Requirements of the Port and Tanker Safety Act of 1978 (PTSA) Pertaining to SBT, CBT, COW, IGS, Steering Gear, and Navigation Equipment for Tank Vessels ($5.00)

#1-81, CH-1, Guidance for Enforcement of the Requirements of the Port and Tanker Safety Act of 1978 (PTSA) Pertaining to SBT, CBT, COW, IGS, Steering Gear, and Navigation Equipment for Tank Vessels ($2.00)

#2-81, Coast Guard Inspection Guidance Regarding Integrated Tug Barge Combinations ($2.50)

#2-81, CH-1, Coast Guard Inspection Guidance Regarding Integrated Tug Barge Combinations ($2.50)

#5-81, Literature Concerning Hazardous Cargoes ($2.50)

#6-81, Lifeboat Weight Tests ($2.00)

#8-81, Initial and Subsequent Inspection of Uncertificated Existing Offshore Supply Vessels Under P. L. 96-378 ($2.50)

#9-81, Coast Guard Guidance Regarding Shipboard Helicopter Facilities ($2.25)

#10-81, Coast Guard Certification and Inspection of Certain Categories of Existing Vessels ($4.75)

#10-81, CH-1, Coast Guard Certification and Inspection of Certain Categories of Existing Vessels ($1.75)

#14-81, Stability Tests; Waiving of For "Sister Vessels" ($2.25)

#15-81, Guidelines for Conducting Stability Tests ($4.75)

#2-82, Letter Form Temporary Certificate of Identification/Service (N/C)

#4-82, Uninspected Commercial Vessel Safety ($2.25)

#5-82, Fixed Ballast ($2.25)

#6-82, Servicing and Inspection of Inflatable Life Rafts Utilizing Voluntary Third Party Inspection Originations ($1.75)

#7-82, Sample Format of Vessel or Facility Station Bill ($2.25)

#8-82, Load Line Certificates ($1.75)

#9-82, MSD Certification ($2.25)

#10-82, Acceptance of Plan Review and Inspection Tasks Performed By the American Bureau of Shipping for New Construction or Major Modifications of U.S. Flag Vessels ($2.75)

#10-82, CH-1, Acceptance of Plan Review and Inspection Tasks Performed By the American Bureau of Shipping for New Construction or Major Modifications of U.S. Flag Vessels ($1.75)

#11-82, Deck Foam Systems for Polar Solvents ($2.75)

#12-82, Recommendations on Control of Excessive Noise ($3.75)

#13-82, Cross Reference List between the IMO Chemical Code and 46 CFR Part 153 ($3.00)

#14-82, Regional Examination Centers; Administrative Policy for the Issuance of Merchant Marine Licenses and Certificates ($2.25)

#16-82, Appeal of Coast Guard Commercial Vessel Decisions and Actions ($2.00)

#17-82, Intact Stability of Small Vessels; Recommendations ($2.00)

#18-82, Form B Load Lines; Procedures for Issuance of Certificates ($2.50)

#1-83, Painters for Life Floats and Buoyant Apparatus ($2.50)

#2-83, Smith & Wesson Line Throwing Rockets ($1.75)

#3-83, Voluntary Qualifications for U.S. Merchant Marine Entry Ratings ($1.50)

#5-83, Unified Interpretations of the International Convention on Load Lines, 1966 ($3.25)

#6-83, Admeasurement of Vessels in Accordance with the Rules of the International Convention on Tonnage Measurement of Ships, 1969 ($2.25)

#8-83, Guidance for Compliance with Annex I of the International Convention for the Prevention of Pollution from Ships, 1973, as Modified by the Protocol of 1978 Relating Thereto (MARPOL 73/78) ($3.75)

#9-83, Coast Guard Guidance Regarding Requirement for Charts and Publications ($1.00)

#10-83, Stability Approval and the Issuance of Stability Letters ($1.00)

#11-83, Regulations for Very Large 46 CFR Subchapter T Passenger Vessels ($1.25)

#12-83, Intact Stability of Towing and Fishing Vessels; Research Results ($1.25)

#13-83, Coast Guard Retention of Commercial Vessel Plan Review Case Files ($1.00)

#1-84, Lack of Topstitching on Some Type I Personal Flotation Devices (PFDs) ($1.00)

#2-84, Amendments to the 1974 Safety of Life at Sea (SOLAS) Treaty ($1.00)

#3-84, Acceptance of Stability Related Review Performed by the American Bureau of Shipping for New U.S. Flag Vessels ($1.00)

#4-84, Equivalent Determination for Existing, Installed Oil-Water Separators Which Have Not Received U.S. Coast Guard Approval ($1.00)

#5-84, Acceptance of Certificates of Admeasurement Issued by the American Bureau of Shipping ($1.00)

#6-84, Automated Main and Auxiliary Machinery; Supplemental Guidance on ($1.00)

#7-84, Outer Continental Shelf (OCS) Citizenship Requirement; Exemptions from ($1.00)

#8-84, Recommendations for the Submittal of Merchant Vessel Plans and Specifications ($1.00)

#9-84, Electrical Installations in Agricultural Dust Locations ($1.00)

#11-84, Guidelines for New Construction or Major Modification of U.S. Flag Vessels in Foreign Shipyards ($1.00)

#1-85, Fire Safety Standards for Foreign Passenger Vessels ($1.75)

#2-85, Notification to the U.S. Coast Guard for Enforcement of Load Line Requirements ($1.75)

#3-85, Bulk Liquid Cargo Finding Aid ($1.75)

#4-85, Recalls and Other Corrective Measures for Lifesaving Equipment ($1.75)

#4-85, CH-1, Recalls and Other Corrective Measures for Lifesaving Equipment ($2.00)

#4-85, CH-2, Recalls and Other Corrective Measures for Lifesaving Equipment ($2.00)

#10-85, Oversight of Technical and Administrative Aspects of Load Line Assignment ($1.75)

#11-85, Coast Guard Guidance Regarding Requirements for Automatic Radar Plotting Aid (ARPA) and Device to Indicate Speed and Distance (Speed Log) ($1.75)

#1-86, Shipment and Discharge of Seamen ($2.00)

#2-86, Simplified Measurement of Vessels ($2.00)

#3-86, Justification Requirements for Exemption of Water-Ballast Spaces from Inclusion in Vessel Gross Tonnage ($2.00)

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#7-87, Guidance on Waterborne Transport of Oil Field Wastes ($2.00)

#8-87, Notes on Design, Construction, Inspection, and Repair of Fiber Reinforced Plast (FRP) Vessels ($3.50)

COMPLETE SET: $322.25

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Submit requests for back issues of NVICs (1987 and earlier) to the U.S. Coast Guard. Payment for these orders of back issues may be made only by check or money order, in advance in U.S. dollars, payable to "Treasury of the United States." Requests indicating the number(s) of the specific Circular(s) desired should be addressed to (back issues only):

Commanding Officer
Marine Safety Center
2100 Second Street, SW
Washington, DC 20593-0001

Chemical of the Month

Scott Rogerson

Propionic Acid

This month's chemical by itself can be extremely dangerous in all forms. When mixed with calcium or sodium to form the salts of propionic acid, however, it is used to prevent mold in bakery goods and cheese. The salts are part of a group called propionates and have been widely used in the food industry since 1956. They are white, free-flowing, readily soluble powders with a slightly cheesy flavor that blends well with the taste of most foods. Though propionates have little effect on yeasts and most bacteria, they do prevent growth of the bacteria that cause "ropiness" in bread dough.

On the other end of the spectrum are the propionibacteriaceae, or "propionic acid-forming bacteria." Some 11 species are included in this genus. The bacteria form propionate, acetate and carbon dioxide by the fermentation of lactate.

Propionic acid bacteria have been isolated chiefly from cheese, milk, and other dairy products. They are particularly abundant in Swiss (Emmentaler) cheese. The carbon dioxide gas produced in chemical reactions is responsible for the formation of the characteristic holes in the cheese, and the sharp flavor is partially attributable to the presence of propionic acid.

Scott Rogerson was a Third Class Cadet at the Coast Guard Academy when he wrote this article for LCDR J. J. Kichner's hazardous materials transportation class.

The first step in dealing with an accidental discharge of the acid is to shut off or eliminate all possible ignition sources. The next step is to stop the discharge. Anyone working in the area should be wearing a chemical protective suit (including rubber gloves and face shield) and should be using a self-contained breathing apparatus. If possible, large spills should be covered with soda ash or sodium bicarbonate. The National Response Center should be called (800-424-8802), as should the local fire department. Local health and pollution control agencies should be notified, and in the case of a spill in natural waters, wildlife officials and operators of nearby water intakes should also be notified.

For a small spill, mix soda ash and small amounts of water. Cover the spill and scoop up the mixture. The site then should be washed thoroughly with soda ash solution.

In case of exposure to the acid a doctor should be notified. If exposed to the vapor, the victim should be moved to fresh air, and artificial respiration should be applied if breathing stops. If contact is made with the liquid, all contaminated clothing should be removed and the affected area should be gently flushed with water for 15 minutes.

The chemical is regulated by the Coast Guard as a Subchapter 0 commodity for shipment by tank barge and tankship (Parts 151 and 150, respectively, of Title 46 of the

Code of Federal Regulations). The Department of Transportation regulates propionic acid as corrosive and requires that it be labeled as such. It is found on page 8206 of the International Dangerous Good (IMDG) Code and is assigned to Hazard Class 8 by the International Maritime Organization.

Chemical Name: Propionic Acid

Formula: CH_3CH_2COOH

Synonyms: ethyl carbonic acid, metacetonic acid, methylacetic acid, propanoic acid

Physical Properties
- boiling point: 141°C (286°F)
- freezing point: -21°C (-6°F)
- vapor pressure: 20°C (68°F) 2.5mmHg
- vapor density (air = 1): 2.56

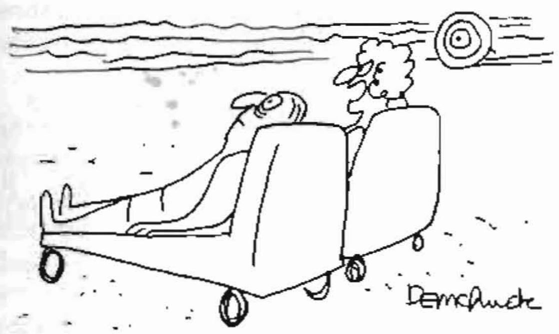
Flammability Limits in Air: 2.9%

Combustion Properties
- flash point: 140°F
- autoignition: 955°F

U.N. Number: 1848

CHRIS Code: PNA

Cargo Compatibility Group: 4 (Organic Acids)



"Can't you just relax on your leave instead of trying to guess how many mistakes your crews are making?"

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. Which statement is true concerning fire hose in the engine room of a tank vessel?

A. It must be painted or branded with the name of the ship.
B. National Standard fire hose coupling threads shall be used having 9 threads per inch for 2-1/2 -inch hose and 7-1/2 threads per inch for 1-1/2-inch hose.
C. In heavy weather, the hose may be removed temporarily from the hydrant.
D. All of the above.

Reference: 46 CFR 32.05-5

2. Dissolved and suspended solids in boiler water are kept at minimum levels by ______.

A. using only volatile chemicals
B. blowing down the boiler frequently
C. treating the boiler water with phosphates
D. introducing oxygen scavenging chemicals into the boiler water

Reference: NAVPERS 10536-D, *Boilerman 1 & C*

3. At high pressures, an O-ring has a tendency to extrude into the clearance space between mating parts of a hydraulic actuator. What component prevents this?

A. Double seal ring
B. Lathe cut ring
C. Back-up ring
D. Static washer

Reference: Oster, *Basic Applied Fluid Power*

4. Which diesel engine cylinder liner has internal cooling water passages?

A. Internally finned liner
B. Externally finned liner
C. Wet liner
D. Integral liner

Reference: Stinson, *Diesel Engineering Handbook*

5. When a fluorescent lamp fails to light the trouble can be in the ______.

A. lamp
B. starter
C. ballast
D. any of the above

Reference: Hubert, *Preventive Maintenance of Electrical Equipment*

Deck

1. The AMVER system requires ______.

A. sailing plans to be sent within 8 hours of departure
B. more frequent reports in heavy weather
C. arrival reports to be sent within 8 hours of arrival
D. a position report within 24 hours of departure

Reference: *Radio Navigational Aids*

2. Which of the following steps should normally be taken first by those who have boarded a lifeboat in an emergency situation?

A. Rationing food and water supplies.
B. Taking anti-seasickness pills.
C. Determining position and closest point of land.
D. Checking pyrotechnic supplies.

Reference: Seaman's International Union, *Water Survival Manual*

3. A patient in shock should be placed in which position?

A. Head up and feet down.
B. Head down and feet up.
C. Flat on back with head and feet at the same level.
D. Arms above the head.

Reference: *Ship's Medical Chest; Medical Aid at Sea*

4. What is the mark on a lead line indicating 3 fathoms?

A. White linen rag.
B. Red woolen rag.
C. Three knots.
D. Three strips of leather.

Reference: Turpin, *Merchant Marine Officer's Handbook*

5. While at your lifeboat station, you hear a signal consisting of one short blast of the whistle. This indicates ______.

A. abandon ship
B. commence lowering boats
C. stop lowering boats
D. secure from boat stations

Reference: 46 CFR 97.13-15

Answers

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

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

Final Rule

CGD 87-031a, Posting Requirement for Placard of Lifesaving Signals and Breeches Buoy Instructions, Form CG-811 (July 22)

The Coast Guard is amending its regulations requiring merchant vessels to post Form CG-811, entitled "Lifesaving Signals, Helicopter Recovery Procedures, and Breeches Buoy Instructions," in the pilothouse and several other locations throughout the vessel. This rule will amend the regulations by removing the requirement that Form CG-811 be posted in various locations throughout the vessel, and require only that it be readily available to the deck officer of the watch. This action reduces the burden on the public of posting and maintaining several copies of Form CG-811 and also reduces Coast Guard operating costs for printing, stocking, distributing, and inspecting the document.

The effective date is July 22, 1988. For further information, contact the Coast Guard's Office of Marine Safety, Security and Environmental Protection, telephone (202) 267-1055.

CGD 88-051, Delegation of Authority Under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as Amended by the Superfund Amendments and Reauthorization Act (August 11)

These rules delegate authority to Coast Guard officials to perform pollution response functions under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). These laws provide authority to respond to releases of hazardous substances, pollutants, and contaminants into the environment. The delegations will allow filed commands to respond rapidly to releases from vessels and facilities in the coastal zone.

The effective date is August 11, 1988. For more information, contact LT Dan R. Williamson, (202) 267-0434.

CGD 87-016, Emergency Position Indicating Radio Beacons for Uninspected Fishing, Fish Processing, and Fish Tending Vessels (August 11)

The Coast Guard is amending 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. The Coast Guard Authorization Act of 1986 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 effective date is October 3, 1988. For further information, contact LCDR Stanford W. Deno, (202) 267-1444.

CGD 84-024, Intervals for Drydocking and Tailshaft Examination on Inspected Vessels (August 24)

The Coast Guard is amending the intervals between drydock and tailshaft examinations by extending them in most cases for certain classes of vessels. These changes will decrease the cost incurred by the marine industry in meeting these examination requirements and align the intervals with those specified by the various classification societies and the intervals currently under consideration internationally.

These rules are effective on September 23,1 988. For more information, contact LCDR Geoffrey D. Powers, (202) 267-1185.

Advance Notice of Proposed Rulemaking

CGD 88-011, Private Electronic Aid to Marine Navigation (July 22)

The Coast Guard is considering amending its regulations to permit private radio aids to marine navigation. Present regulations prohibit all private radio aids, with the exception of radar beacons and shore based radar stations, and may unnecessarily restrict the mariner from making maximum use of available technology. The Coast Guard will also be examining the regulations pertaining to vessels that are required to carry an electronic position fixing device. The Coast Guard is requesting comments in these areas to assist it in drafting new regulations.

Comments must be received on or before December 2, 1988, and should be mailed to Commandant (G-LRA-2/21) (CGD 88-011), U.S. Coast Guard, Washington, DC 20593-0001. For further information, contact LT George H. Self, Jr., (202) 267-0287.

Interim Rule with Requests for Comments

CGD 81-101, Pollution Rules for Ships Carrying Hazardous Liquids; Interim Rule (August 1)

The Coast Guard is making some changes to its regulations that implement Annex II of the 1978 Protocol to the International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL 73/78). These changes correct some errors and discrepancies between the regulations and Annex II of MARPOL 73/78. The changes in this interim rule align the regulations with the convention.

The effective date is August 31, 1988. Comments must be submitted on or before September 15, 1988, to Commandant (G-LRA-2/21) (CGD 81-101), U.S. Coast Guard, Washington, DC 20593-0001. For further information, contact Mr. Robert M. Query, (202) 267-1217.

Request for Applicants/Applications

CGD 88-068, Chemical Transportation Advisory Committee; Request for Applications (August 17)

The 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, 1988. Apply to Commandant (G-MTH-1), U.S. Coast Guard, 2100 Second St., SW, Washington , DC 20593-0001, or call CDR Ronald Tanner, (202) 267-1217.

Interpretation of Rules

CGD 88-062, Ventilation Penetrations of Fire Rated Boundary Bulkheads (August 23)

This notice clarifies existing Coat Guard and international regulations concerning ventilation penetrations in fire rated boundary bulkheads. Various appeals from vessel construction requirements have revealed that the regulations are being misinterpreted by portions of the domestic shipbuilding industry. The intended effect of this Notice is to demonstrate that return air ducts which are not connected to the ventilation system, called balancing or jumper ducts, which penetrate fire rated boundary bulkheads, are prohibited. The result will be a savings in time and costs associated with correcting the impermissible penetrations.

For further information, contact CDR Gordon D. Marsh, Chief, Ship Design Branch, telephone (202) 267-2997.

Check Your Reach Rods

Reach rods allow the manual operation of remote valves that are important for ballast and other ship's systems. In many cases reach rods provide the only means of turning valves that are located in the same compartment they support. It is therefore possible for a tank to be flooded without any discharge capability if these rods part.

Recently, a vessel discovered the importance of maintaining reach rods when it report that four of the rods in the forepeak ballast tank were sheared while the forepeak was open to the sea. The ballast line-up was such that neither the forepeak ballast pump, nor the eductor to the fire main could be used to strip the tank. There was no way to change this line-up since the reach rods had failed. In addition, portable pumps were not adequate to keep up with the ingress of seawater. This allowed the forepeak to flood to the level of the vessel's forward draft.

To solve the problem, the ship was trimmed by the stern, lowering the forepeak innage to a manageable level for tank entry while the vessel was in port. Working in 5 feet of water, a diver bypassed the severed reach rods and lined up the system for discharge so that the tank could be stripped and secured. All reach rods were then inspected and repaired.

Of course, all four reach rods did not shear simultaneously. They undoubtedly failed one at a time until suddenly there was no remaining capability to ballast the forepeak. The situation was further complicated by the fact that the last reach rod failed when the system was lined up for flooding.

This avoidable incident shows what can go wrong when defective equipment is not repaired immediately. A "wait until tomorrow" attitude is extremely dangerous. Forepeak reach rods are exposed to salt water corrosion and significant torquing stresses. Without proper maintenance they will undoubtedly seize or shear again. Every vessel should ensure all reach rods are properly lubricated and maintained to perform as required. Never compromise the vessel because of poor maintenance, and never postpone needed repairs just because it looks like the ship can "do without" for a while.

(Reprinted from Chevron *Safety Bulletin*, June 1988.)∎