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Special issue on hazardous materials

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The Exxon Charleston, a chemical tankship with complex piping systems. *Photo by Michael Morrissette.*

HAZARDOUS MATERIALS
are major Coast Guard responsibilities

By RADM A. E. "Gene" Henn

Progress in the chemical industry mirrors that of the electronics and aerospace industries. While perhaps not as glamorous, the chemical industry has a major impact on the economy of the world, with the United States exporting billions more in chemicals than it imports. In fact, the chemical trade is one of the most important factors in our international trade balance.

Not surprisingly, most chemicals fall into one or more categories of hazardous materials. And the Coast Guard, in partnership with the maritime industry, ensures that these chemicals are transported safely.

Hazardous materials have been with us for centuries. The ancient Greeks carried edible and flammable oils in marine portable tanks of that time, while oil tankers have been in service for more than 100 years.

On occasion, hazardous materials live up to their name. In World War I, the town of Halifax in Nova Scotia was nearly destroyed when a ship carrying ammunition exploded. After World War II, the waterfront area of Texas City, Texas, was almost obliterated when two ships containing ammonium nitrate fertilizer exploded.

The Marine Technical and Hazardous Materials Division of the Office of Marine Safety, Security and Environmental Protection leads the Coast Guard's hazardous materials' safety efforts. Other divisions, however, are concerned with environmental protection, vessel inspection and marine personnel, all of which influence hazardous materials' safety. As a team we work together to protect life and property.

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Advisory committee

Regulations are the foundation upon which the hazardous materials' safety regime is built. The Coast Guard works with industry through the Chemical Transportation Advisory Committee to develop regulations. The committee provides valuable technical knowledge and experience needed to maximize safety at minimal regulatory cost. For more than 20 years, these dedicated advisors have donated their valuable time and expertise toward solving safety problems in the marine industry. They have contributed to virtually all regulations concerning the chemical industry that have been developed during that time.

Another potential threat to safety is the fumigation of edible cargoes. Unless done properly, this can endanger an entire crew.

A third area of concern is the protection of workers from breathing carcinogenic vapors such as benzene.

A new safety issue involves methyl tert-butyl ether (MTBE). It was a low volume chemical until added to gasoline to reduce carbon monoxide. Now MTBE and a related compound, ethyl tert-butyl ether (ETBE), are produced and shipped by water in large quantities. Both of these chemicals are highly flammable.

"The transportation of hazardous materials is an international concern."

IMO

The transportation of hazardous materials is an international concern. A disaster releasing large amounts can affect several countries. However, if every country in the world unilaterally imposed its requirements on visiting ships, there would be chaos. Consequently, the Coast Guard works through the International Maritime Organization (IMO) to develop uniform and consistent regulations applicable to all ships, regardless of their flags.

By harmonizing regulations, a ship owner can satisfy one set rather than one for each country the ship will serve, with some regulations contradicting others. Not only does IMO make this possible, it insures that all ships meet minimum safety and environmental protection standards. The member countries of IMO are dedicated to the common goal of protecting the world from unsafe ships and dangerous operations.

New safety issues

There's more to hazardous materials than ships and barges. One of the newest issues is vapor control. Cargo vapors produced during loading are returned ashore rather than released into the atmosphere. These vapor control systems are mandated by federal, state and local government agencies, but the Coast Guard must ensure their safe operation. As a matter of fact, the Coast Guard has pioneered work on such safety measures as detonation (flame) arresters for vapor control systems.

A liquefied compressed gas, anhydrous ammonia (NH_3) will probably replace ozone-depleting halocarbons in some refrigeration systems. This ammonia is both toxic and corrosive.

The articles in this special hazardous materials' issue of *Proceedings* cover these and other marine safety concerns.

Conclusion

In the future, we can expect only change. New chemical products will produce new and unusual hazards. New vessel and port designs will require new safeguards to prevent hazardous materials' accidents.

With the increase in international trade and in intermodal transportation, the world will be moving toward universal regulations to streamline shipping requirements.

There will be more hazardous materials moving by water. To ensure their safe transportation presents an ever increasing challenge. The Coast Guard, in partnership with the entire maritime community, intends to meet that challenge.

RADM A. E. "Gene" Henn is the chief of the Office of Marine Safety, Security and Environmental Protection.

Telephone: (202) 267-2200.

Vapor control -- systems --

ecological helpers and hazards

By CDR John P. Aherne

Before vapor control ...

Vent stack airs out tanks after cargo discharge.

Photo by Michael Morrissette.

Over the past three years, there has been a radical change in the way oil and chemical tank vessels are loaded and ballasted. In Texas, Louisiana, California, Pennsylvania and New Jersey, environmental laws require that the tons of hydrocarbon vapors previously released into the atmosphere now be sent ashore to be recovered or burned.

This vapor control results in a cleaner workplace and environment, but it also poses fire and explosion hazards, due to long-distance piping of flammable vapors to recovery units, along with the risks of over pressurizing cargo tanks.

To ensure the safety of facilities and vessels engaged in vapor control, the Coast Guard published regulations in June 1990 in the *Federal Register* (33 CFR 154 subpart E and 46 CFR 39). The Chemical Transportation Advisory Committee recommended this action.

Why control vapor?

Pollution is only one reason for vapor control. Cargoes such as propylene oxide are loaded onto vessels with vapor control because of high flammability. Other cargo vapors are controlled due to their pungent odors. Most vessel vapor

Continued on page 4

After vapor control ...

Vapors return ashore to be burned in vapor destruction unit.

Continued from page 3

control, however, is to reduce the amount of volatile organic compounds emitted into the atmosphere. These compounds are precursors of ozone, a principal ingredient of smog.

The Clean Air Act Amendments of 1990 designated the Environmental Protection Agency (EPA) to develop requirements controlling marine volatile organic compound emissions. Consequently, EPA prohibits the release of benzene vapors while the chemical is loaded onto tank vessels. Regulations controlling other chemical vapors also are being developed.

The Clean Air Act also requires the states to reduce air pollution. Because each state has different sources and levels of pollution, it is left to the individual states to determine what sources to control.

What is a vapor control system?

A typical vapor control system that meets Coast Guard regulations is generally used only during vessel loading. As the cargo enters a tank, leftover vapors and those generated by incoming substances are pushed out into a deck manifold. Moved by either the displacement pressure generated from incoming cargo or by shoreside blowers, the vapors leave the vessel through a hose leading to a vapor control system, a complex, expensive engineering unit.

Once ashore, the vapors pass an emergency shutoff valve, pressure sensors (to protect the vessel from being over pressurized), a detonation arrester (to prevent the passage of flames or explosions) and a gas injection system (that combines additional gases to make the vapors nonflammable).

The Exxon Baton Rouge, Louisiana, facility is fully equipped with a vapor control system.

Vessel emissions comprise only a small fraction of the total volatile organic compound discharge nationwide. Yet, in many high pollution areas, air quality is significantly improved by their reduction. Thus, some states focus on tanker loading and ballasting to control vessel emissions. New Jersey, California, Louisiana and Pennsylvania prohibit the release of some or all volatile organic compound discharges from loading, ballasting and lightering of tank vessels. Texas requires marine vapor control for a wide variety of petroleum and chemical cargoes on a facility by facility basis. Other states, such as New York, are considering requirements.

Then the vapors pass oxygen or hydrocarbon sensors (to test for flammability), a blower (to move the vapors through the system) and, if they are to be burned, through two quick-closing valves, another detonation arrester and a liquid seal (to prevent the passage of flames). Finally, the vapors are burned in a vapor destruction unit (flare). In many cases, a vapor recovery unit is used instead. This liquefies the vapors by refrigeration, condensation and/or liquid absorption.

Vapors can also be controlled through balancing, a simple method which returns them to the original liquid cargo tank. Protection in

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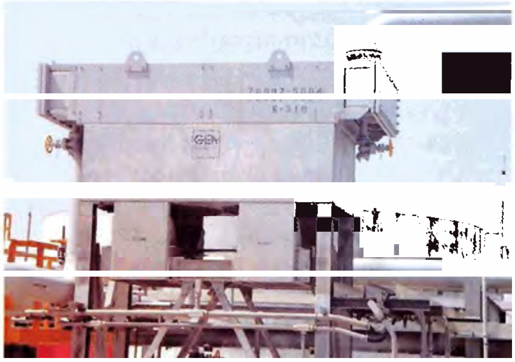
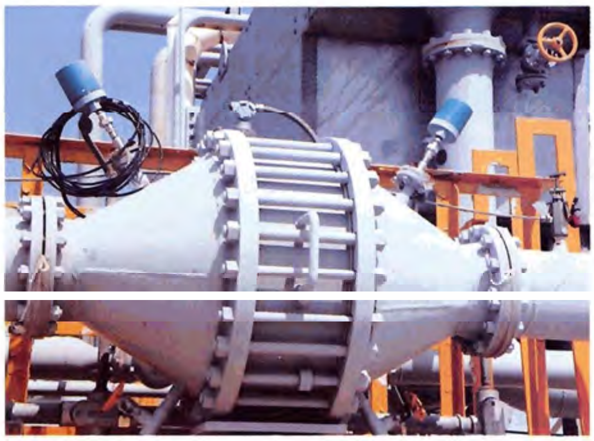
VAPOR CONTROL



(Left) Air-cooled heat exchanger.

(Right) Liquid/vapor phase separator.

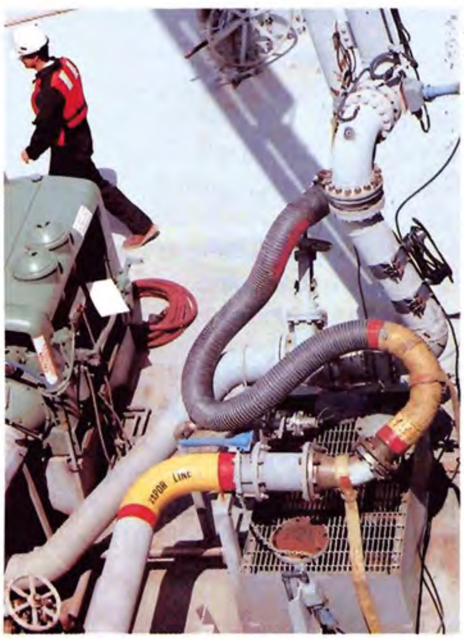
(Above) Most vapor control system components.

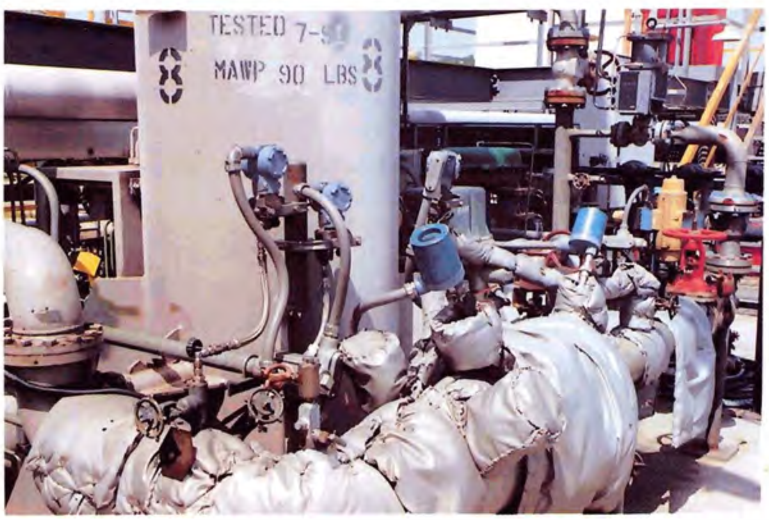


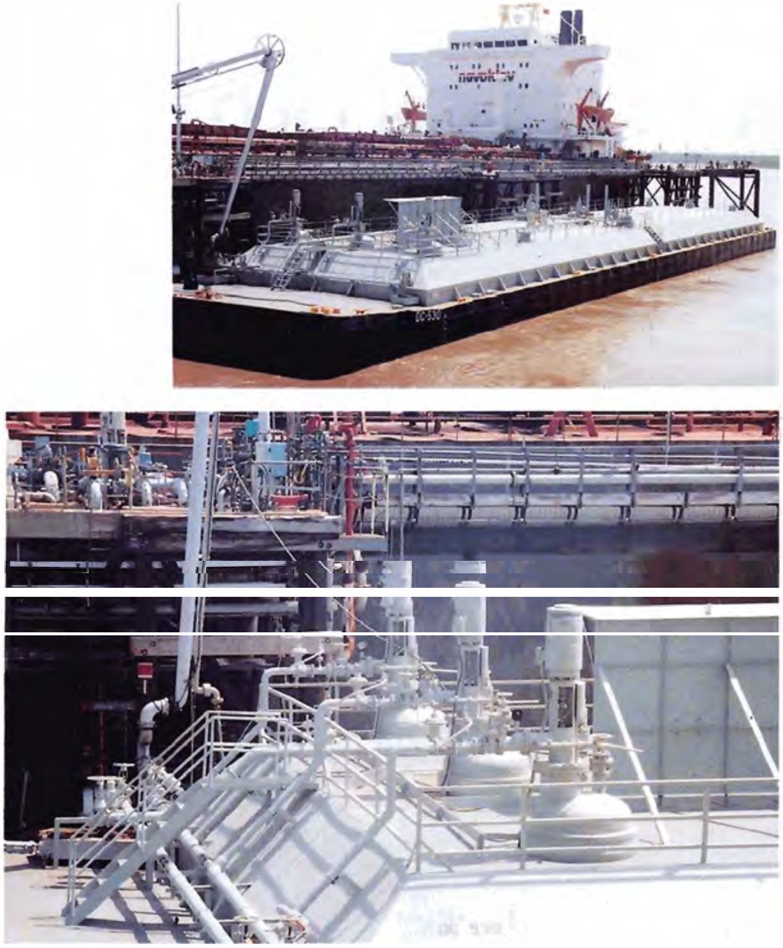
((Right) Detonation arrester.

(Lower left) Vessel-to-shore vapor line connection.

(Lower right) Natural gas enriching system.







(Upper) Propylene oxide barge is connected for vapor recovery.
(Lower) Close-up of barge pressure tank cargo pumps.

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these systems is usually provided by detonation arresters within six meters of the facility vapor connection and at the shoreside tank outlet.

Hazards

Hazards of vapor emission from vessels during loading or ballasting include:

1. **fire, explosion and detonation**
   A primary concern is detonation of the flammable vapors spreading back to the vessel. To eliminate this, the regulations require:

   (a) **detonation arresters**
   At least one should be no more than six meters from the facility vapor connection where the hose connects to the control system. (Only detonation arresters that have been rigorously tested to the standards of 33 CFR 154 appendix A are permitted.)

   (b) **gas injection system**
   The system automatically adds inerting, enriching or diluting gas to keep vapors out of the flammable range. It must also monitor vapors with either oxygen or hydrocarbon analyzers to ensure they are in the nonflammable range.

   (c) **flare isolation**
   The vapor destruction unit or burner must be isolated through two automatic valves, a liquid seal and a detonation arrester. There must also be an automatic system shut-down in the event of a flame out.

2. **over or under pressurization**
   Because vessels loading under vapor control are essentially closed up or airtight, there must be a controlled balance between the cargo loading rate and the vapor flow from the vessel. A disruption of this balance through either loading too quickly or from a blower removing vapors too fast could over or under pressurize a cargo tank. Over pressurization could also occur from liquid overfill or from a faulty facility gas injection system. These are serious concerns because of the many tank vessels with cargo tanks that can only withstand pressures of between +2 and -0.5 pounds per square inch. To prevent this, the following is required:

   (a) **pressure monitoring**
   The facility vapor control system must continually monitor the pressure in the vessel's cargo tanks (taking into account the pressure drop between the tanks and the shoreside sensors), and automatically shut down if a high or low pressure (previously agreed on between tanker and dock personnel) is detected.

   (b) **maximum loading rates**
   The facility must have predetermined maximum allowable liquid cargo loading rates that guarantee that the control system can remove all vapors as fast as they are generated.

(c) **alarms**
Vessels must have cargo tank high level alarms to prevent overfill. Tank barges may install pressure-activated spill valves to ensure overfill does not over pressurize a tank.

(d) **venting system design**
A vessel's tank venting system must be designed for 1.25 times the cargo loading rate to ensure that any pressure buildup from incoming cargo can be relieved through pressure/vacuum relief valves.

Certification

To use a marine vapor control system, both the vessel and the facility must be approved by a Coast Guard Officer in Charge, Marine Inspection (OCMI) or Captain of the Port (COTP), respectively. Also, the system must be certified before receiving Coast Guard approval.

Facility systems

The responsibility for reviewing the design, testing and certifying that a facility vapor control system meets Coast Guard regulations before a final COTP approval rests with a certifying entity, a private engineering firm that has been approved by the Coast Guard. Acting as a third party between the facility operator and the Coast Guard, this entity determines that all requirements of 33 CFR 154 have been met.

The certifying entity reviews the hazard analysis, conducts a plan review, makes on-site inspections and witnesses operational tests to ensure the system will operate properly and safely. Upon completion of this process, the entity issues letters to the facility and the COTP attesting that the system meets all regulations and applicable safety standards. The COTP then endorses the facility's letter of adequacy to permit vapor collection. The COTP conducts annual inspections of facility vapor control systems to ensure continued compliance with regulations.

Vessel systems

The process is similar for vessels, except that their vapor control systems are certified by the Coast Guard Marine Safety Center for United States vessels and classification societies for those under foreign flags. An OCMI reviews the certification and, after inspection, endorses vessel certificates, permitting vapor control.

Unit liquefies vapors for easy recovery.

Conclusion

In many respects, vapor control is just beginning. The EPA is working on new regulations to affect more locations and cargoes. More states are developing their own requirements. However, the ground work is complete.

Regulations accounting for safety hazards are developed and carried out. Certifying entities are appointed and are facility vapor control experts after certifying numerous systems.

The United States tank barge industry understands the requirements and have had many vessels certified for vapor control. Foreign chemical tank vessel operators and their classification societies are also familiar with the regulations and certification process.

The challenge now is to keep certified systems operating as they were designed, to keep personnel properly trained, and to keep loading and vapor control of vessels safe. The hazards of vapor control can never be underestimated nor forgotten.

CDR John P. Aherne was a chemical engineer with the Hazardous Materials Branch of the Marine Technical and Hazardous Materials Division. Recently, he was assigned as chief, Cargo Division, Marine Safety Center, 400 7th Street, S.W., Washington, D.C. 20590-0001.
Telephone: (202) 366-6441.

Coast Guard sets standard for arresting chemical detonations

By Mr. Thomas J. Felleisen

It has been well known since at least 1936 that explosions are not uncommon when a mixture of flammable vapors and oxygen are present in a cargo tank. Although not all such mixtures are dangerous, too frequently, a tank's atmosphere is in an explosive range.

When a tank is "empty," it still may contain vapors and gases from its last cargo and the tank's atmosphere is as likely to be as explosive as when it is partially or completely full. However, as new cargo is loaded into a tank, this atmosphere is pushed out through vents and hatches, and is diluted in the air. This was a normal occurrence before the Clean Air Act.

Clean Air Act

The Clean Air Act, as amended in 1990, requires that the atmosphere in a chemical cargo tank be "returned to shore," so that some of the vapors can be recovered or destroyed instead of being vented in the air. The law prohibits such discharge because vapors can contain chemical compounds which react in sunlight to form smog.

Now, instead of being vented into the air, a chemical cargo tank's atmosphere is passed through a piping system which is connected to air pollution equipment at a facility ashore. Such marine vapor control is mandated by the Clear Air Act.

Pipe hazards

There is a significant difference between the atmosphere in a pipe and in a tank. If a volatile mixture is ignited in a tank, it will simply -- and immediately -- explode. Igniting the same mixture in a vapor control system pipe may cause a flame, which is known as a deflagration.

The same pipe which transmits tank vapors and gases to the shore can also be a conduit for a flame going back to the tank vessel. Moreover, the flame can intensify to a self-propagating explosion or "detonation." This can be described as an exploding ball starting at one end of the pipe, then traveling on through at tremendous speed (up to 5,800 miles per hour) constantly exploding.

Flame arresters

In the mid 1970s, the Coast Guard began investigating the safety of marine vapor control systems, including devices to stop the transmission of a flame or detonation down a pipe.

Other industries, such as paper pulp, had been using such devices for years. Some were failures in that they would stop a severe detonation, but a flame would pass through and explode when it reached a tank.

The Coast Guard researched and tested many of the existing devices or "flame arresters," which, simply described, are pipes or pressure vessels with a blocker with narrow openings through which gases and vapors pass. The principle is that a flame is cooled, and thereby extinguished, as it goes through a narrow passage. Because they have no moving parts, they are called "passive" arresters.

Standards

In the early 1980s, efforts in the United States to control tank vessel emissions were curtailed. However, international interest remained strong and the IMO Fire Protection Committee began developing standards for "detonation" flame arresters. These standards were based largely on testing procedures conducted in former West Germany.

Meanwhile, here in the United States, local initiatives to control vapors emitted during tank vessel loadings were taking place. A lawsuit against the state of New Jersey sought to force regulation of such emissions. Acting in the interest of uniform emission control, in 1988, the secretary of the Department of Transportation directed the Coast Guard to develop standards for vapor control, including flame arresters.

The Coast Guard augmented the IMO standard by including testing under the most severe conditions of detonation and in the deflagration range with a restriction on the outlet of the test apparatus. Test results presented to the American Petroleum Institute showed that a deflagration could pass through an arrester if there was a sharp decrease in pipe diameter on the opposite side of the device.

Detonation arrester is successfully tested in Alberta, Canada. (Front-end loader at right deflects combustion gases.)

The additions to the IMO standards required increased safety testing for the devices, which have to be very robust to withstand the shock of a detonation.

Testing the standard

The United States standard for flame arresters (published in appendix A of 33 CFR part 154) has one drawback. The Coast Guard specified a device for the vapor control safety systems, but no such devices were on the market.

Deadlines, particularly in New Jersey, were fast approaching to install the systems. Compounding this problem, was an assertion by an oil company consultant that given a long enough pipe, any flame arresting device could be made to fail.

To verify the consultant's theory, the American Petroleum Institute contracted for two different tests. There was one in the United Kingdom to see if any devices could pass the new Coast Guard standard. There was another in Texas to verify the consultant's theory.

The first test results in the United Kingdom were not promising. Arrester designs then on the market could not pass the new testing standard. (One blew apart on the first test. Another could stop detonations, but was so damaged that it could not stop a subsequent deflagration.)

Ultimately, devices were designed which passed the test, but the deadline for carrying out the emission controls had to be extended in order to obtain them.

Although the Texas studies are not yet finalized, preliminary results dispel any doubts raised about the standard's validity, regardless of the length of pipe.

The challenges pointed out that the IMO standard was unacceptable to American industry and reinforced the validity of the Coast Guard's augmentation.

Active devices

An "active" flame arrester device,which relies on fast-acting valves is now being considered. Flame sensors activate an explosive charge to close a 24-inch valve, similar to a gate preventing the passage of flames. Such a system may be used at the Alaska' pipeline facility in Valdez.

Given the crude oil characteristics in that area, the severe environment and the tremendous production rate, such a device might be more suitable than a passive arrester that requires considerable cleaning and maintenance.

Current status

Overall, the Coast Guard's flame arrester standard has proven to be the most effective. It has been adopted widely by the petroleum refinery and petrochemical industries. And some two dozen passive arresters have met requirements under appendix A to 33 CFR part 154.

In addition, manufacturers are specifying that arresters have Coast Guard approval for vapor control systems for road and rail vehicles. In short, the Coast Guard has developed new safety standards for a technology, which extends beyond its traditional marine customers.

Mr. Thomas J. Felleisen is a chemical engineer with the Bulk Cargo Section of the Hazardous Materials Branch.

Telephone: (202) 267-1577.

Choosing the right detonation arrester

By Dr. Alan L. Schneider

When several state and local governments passed laws requiring vapor control systems to reduce air pollution during vessel loading, they inadvertently created a potential monumental safety hazard -- one that could turn a small shore or vessel fire into a major conflagration that could destroy lives and property.

The problem

Small flames at one end of a long vapor recovery pipe can pick up speed and become violent as they run through the pipe, resulting in a huge explosion when they reach the end.

It would seem that a detonation arrester could easily prevent this from occurring. However, different chemicals require different types of arresters. (For example, stopping an acetaldehyde/air explosion is much harder and requires more complicated techniques than a gasoline/air detonation.

Here is where the major problems lie. Both industrial and Coast Guard chemical engineers have grappled with matching arresters to detonations with varying degrees of success. Finally, an electrical engineering method paved the way toward some practical solutions. Here's how it happened.

Background

Starting in the late 1980s, many states began requiring vapor control systems. Before this time, there were very few detonation arresters on the market. Coast Guard regulations introduced a detonation arrester test standard emphasizing the chemicals involved. In some cases, one arrester had to be able to prevent many chemicals from detonating. (At one terminal, there were more than 200 chemicals that had to be protected by one detonation arrester.)

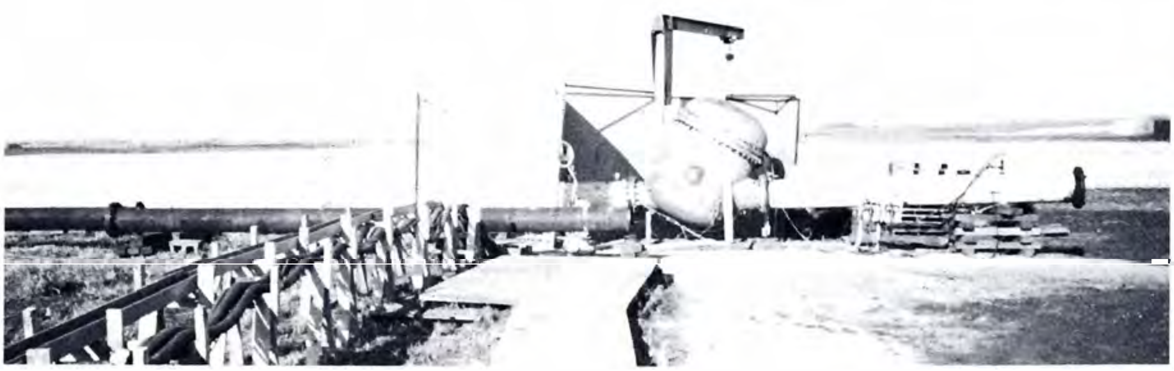
Detonation arresters are similar to flame arresters, except that they can stop high speed, pressurized flames called, "detonations." Conventional flame arresters are not usually effective against fires that accelerate to high speeds and pressures in long pipe runs.

There have been different types of detonation arresters developed for various sizes of pipes, but they have to be tested to prove their effectiveness for the chemicals involved.

Testing

Both IMO and the Coast Guard require detonation arrester testing. The Coast Guard's test series is long and costly, which might not be a problem if one series would determine that an arrester worked for all chemicals. This is not so.

One type of detonation arrester being tested.

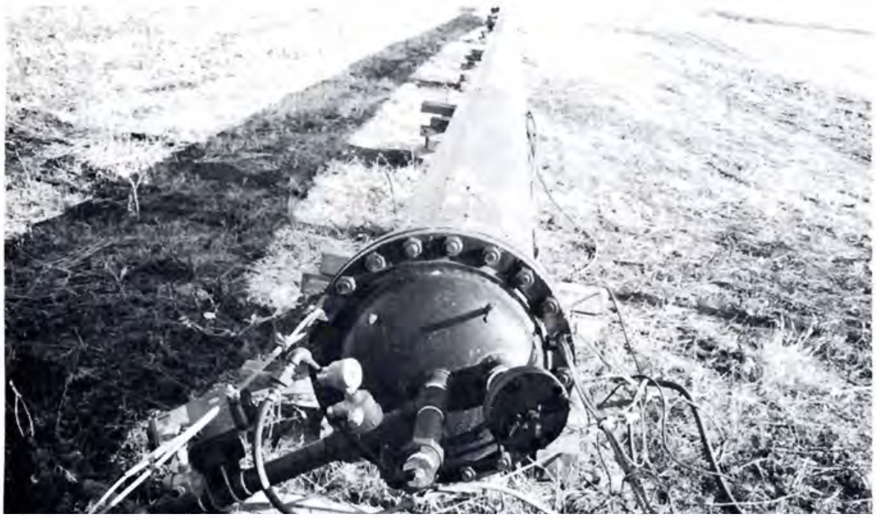


In principle, each arrester should be tested for all the chemicals with which it is to work. However, this would cost in the neighborhood of $50,000 and entail several weeks of hard work for each chemical.

What is needed is a method to relate the detonation properties among chemicals. This way, if a detonation arrester worked with one chemical, it would be effective with a group of chemicals with similar properties.

parts, the plate has an adjustable gap creating a thin passageway between the two parts. An electrical spark ignites the flammable mixture on one side of the plate. If the flame passes through, the gap is greater than the MESG. If it doesn't, it is less than the MESG.

Therefore, the widest gap which prevents flame passage is the MESG. Because MESGs vary with temperature and pressure changes, it is usually tested at one atmosphere and 20°C.



As far as the eye can see -- detonation arrester test piping can stretch a thousand feet.

Potential solution

Electrical engineers have successfully dealt with a similar problem in relating explosion-proof equipment to different chemicals. Electrical junction boxes and other equipment are designed to prevent flames and detonations from escaping from inside an enclosure. Since all explosion-proof equipment comes in two or more parts, there are small gaps through which flames might pass. To minimize chances of sparks inside the box from igniting outside gases, the enclosure has small gaps that quench the fire, much like flame and detonation arresters.

Testing each chemical in each piece of explosion-proof equipment would be too expensive. Instead, electrical engineers measure the maximum gap that will stop a flame between two metal plates. This is called a maximum experimental safe gap (MESG). The greater the MESG, the greater the permissible gaps in explosion-proof equipment.

MESGs are measured by placing a metal plate inside a test chamber filled with the most easily ignited flammable mixture of air and the test chemical. Dividing the chamber into two

Electrical engineers test a piece of equipment with one chemical having a known MESG. If the flame does not pass through the gap. that equipment may be used with all chemicals having MESGs greater or equal to the test chemical.

For example, the MESG for propane is 0.90 mm. Therefore, any piece of explosion-proof equipment tested successfully with propane can be used with any gas having a greater MESG than 0.90 mm.

Another dilemma

Both IMO and the Coast Guard recognize that each arrester type cannot be tested with each chemical. They use MESGs to relate chemicals to one another. If an arrester works for one, it will work for others with greater MESGs.

A list of MESGs for use with certain detonation arresters is provided in 33 CFR 154 appendix B. It would seem that all that would be necessary is to determine the MESGs of cargoes being shipped, and link up the appropriate detonation arrester to the cargoes with less than or equal MESGs.

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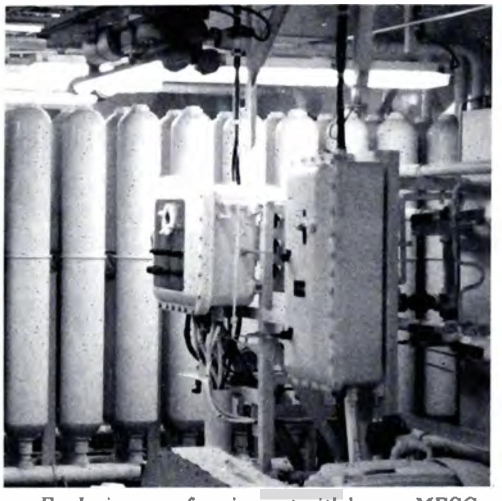

Explosion-proof equipment with known MESG.

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However, problems arise when there are 200 different chemical cargoes being shipped from one terminal. It would cost approximately $15,000 per chemical and several weeks' time to determine the individual MESGs. This would amount to about $3 million and a few years.

Practically speaking, the Coast Guard had to find the MESGs or ban the use of detonation arresters in most large marine terminals. To do this, would effectively shut down many facilities.

Another solution

Even today, there are few MESG values known. Also, the two recognized test standards differ. The International Standards Association and the Underwriters Laboratory use different experimental techniques, therefore producing diverse results for the same chemicals.

Electrical engineers in the United States, however, categorize flammable and combustible chemicals into four groups:

Group A - tested with acetylene,
Group B - tested with hydrogen,
Group C - tested with ethylene and
Group D - tested with propane or gasoline.

To date, all arresters have been tested with either ethylene or propane, so they are either Group C or D. It is believed that no detonation arresters will be tested for use with Group A or B chemicals. However, there are relatively few chemicals in either Group A or B, and they are not usually shipped in bulk.

In almost all cases, the International Standards Association and the Underwriters Laboratory agree on these chemical groupings.

Additional roadblock

Unfortunately, there are many chemical cargoes without known MESGs or groups. There are no methods to calculate MESGs, and, while chemicals with similar structures have similar MESGs, there are many discrepancies. However, the known MESG values for isomers are close, so if we know the group for one chemical, we can assign the same group to the chemical's isomers.

A way around

In the late 1970s, the Coast Guard asked the National Academy of Sciences to determine the group rating for a large number of chemical cargoes for use in explosion-proof equipment. This was done by analyzing the structures of chemicals and comparing them to those with known MESGs. Electrical engineers used these ratings with good results, so the Coast Guard decided to do likewise.

Progress to date

Today, pure chemical cargoes can usually be assigned to electrical groups. This is not true for many cargoes of mixtures of numerous hydrocarbons, some of which are not identified. Compounding this problem is the fact that vapor concentration is different from that of liquid, and the vapor changes somewhat during transfer.

There are still cases involving large numbers of unidentified components and many components with unknown MESGs, where the groups have to be determined on a costly individual basis.

Nevertheless, the Coast Guard has succeeded in saving industry several million dollars and a number of years of work by adapting electrical engineering practice to determine appropriate detonation arresters. A high level of safety has been achieved in the balance. However, there is much work still to be done.

Dr. Alan L. Schneider is a chemical engineer with the Hazard Evaluation Section of the Hazardous Materials Branch.
Telephone: (202) 267-1577.

Evaluating CHEMICAL CARGO HAZARDS

Coast Guard personnel check transfer hoses.

By Mr. Michael Morrissette

Since the early 1960s, shipping of chemicals by tankers has increased dramatically. Today, a large portion of the chemical trade around the world moves by tankship.

In 1967, the Maritime Safety Committee of the Intergovernmental Maritime Consultative Organization, now the International Maritime Organization (IMO), formed the Subcommittee on Ship Design and Equipment. Several years later, the subcommittee established the "*Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk*" (BCH Code). In 1983, this code was supplemented by the "*International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk*" (IBC Code).

Setting international standards for the safe carriage of bulk chemicals, these two codes provide the minimum requirements (i.e., ship and tank types, venting and gauging) for the transport of each cargo presenting serious risks.

Chemical hazards

Developing guidelines for evaluating chemicals is a two part process. First, the inherent hazards of a chemical when it is released are investigated. Secondly, these hazards are related to specific shipboard requirements.

There are three general categories of safety hazards from bulk chemical cargoes: human health, flammability and reactivity. (Marine pollution hazards are covered by MARPOL 73/78.)

Human health

Exposure to chemical products through inhalation, ingestion and skin absorption can lead to poisoning. The chances of exposure by inhalation of vapors during routine operations, such as gauging and tank cleaning, as well as in accidents involving spills, is far higher than exposure by skin absorption or ingestion.

The poison hazard from inhalation is evaluated in several ways, the most common being the "lethal concentration fifty" (LC_{50}). This concentration or dose, usually stated in parts per million (ppm), kills 50 percent of a group of test animals. The LC_{50} does not address nonlethal effects such as headache, nausea or dizziness, although they are important relative to a tanker operator's performance or ability to escape a toxic gas cloud. Nevertheless, this method seems to be the best parameter for comparing inhalation hazards among chemicals. It is used by IMO, along with the volatility of the product, to judge the severity of inhalation hazards. (If two chemicals have the same LC_{50}, but one is more volatile, it presents a greater risk.)

Detrimental effects from intermittent exposure to chemical vapors over a number of years are also considered in the inhalation criteria. Tanker operators who work for years amid vapors from various cargoes require protection. Safety equipment and procedures, such as gauging, venting and pumproom ventilation, reduce levels of exposure to vapors, thereby reducing long-term chronic effects from inhalation.

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The effect of chemical exposure on skin often is delayed while the substance is absorbed into the bloodstream. An LD_{50} ("lethal dose fifty") dermal is usually performed to test for chemical skin absorption. This is important whenever there is a possibility of liquid contact, such as in spill cleanups.

While tanker personnel do not ordinarily sample products on board, there is a danger of ingestion when chemical tanks are ruptured and leak into the water. If the discharge is near the intake of a municipal water system, the plant might have to shut down. An oral LD_{50} test is conducted to measure the degree of hazards under such conditions. Severely toxic products are kept away from the hull of a vessel where the tanks are the most vulnerable in a collision. Ships carrying these chemicals are also required to meet more stringent survivability standards.

There are some chemicals which can destroy skin and eye tissue, causing irreversible damage if not washed off immediately. Other products produce skin rashes and/or blistering. Protection should be available to crew members when handling such chemicals.

Finally, there are a small number of chemicals which can sensitize individuals exposed to them one or more times. An example of such a chemical is toluene diisocyanate, a respiratory sensitizer. Once an individual has become "sensitized," usually unwittingly, breathing even low concentrations will cause severe respiratory distress. To minimize this possibility, transport requirements prevent crew members from breathing vapors or only very low concentrations during normal operations.

Flammability

The IMO chemical codes do not protect individuals from products, such as gasoline, with "normal" flammability characteristics as their only significant hazard. However, this does not imply that these products are safe and do not require careful handling.

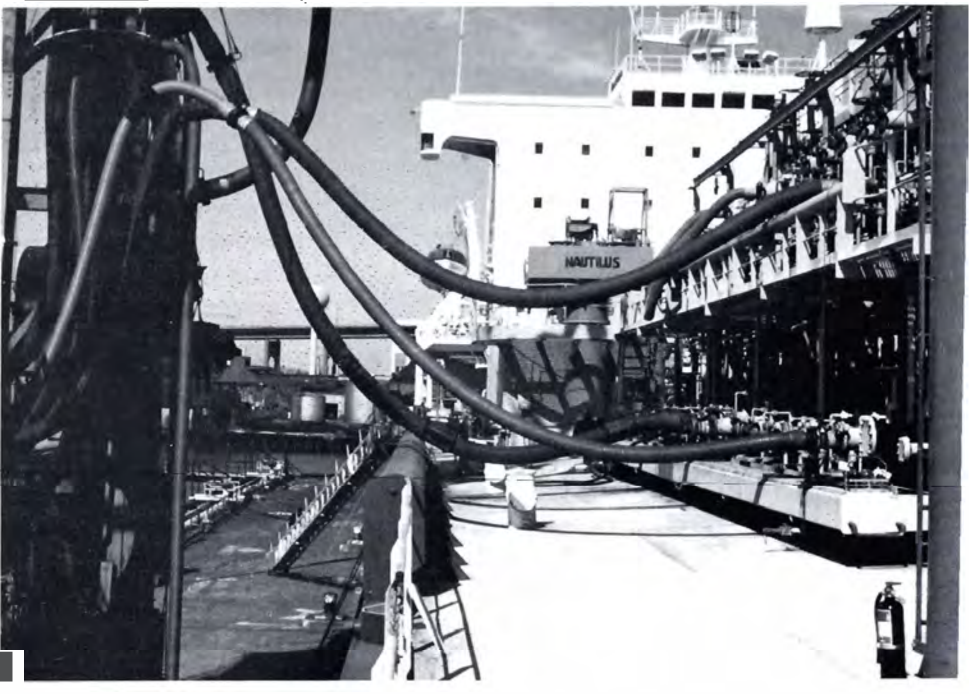
Certain chemicals have unusual flammability problems, placing them on a higher hazard level. Products with low autoignition temperatures or wide flammable limits are more dangerous because they are more likely to ignite.

Special precautions, such as inerting (keeping a non-flammable atmosphere in the cargo tank) and a more protective containment system to handle the hazards of these volatile cargoes is necessary for their safe carriage. IMO criteria addresses these problems.

Reactivity

Reactivity of certain chemicals with water, air, construction materials and with themselves are considered in the hazard evaluation system.

Some products in bulk react violently when mixed with water, which could result in an explosion. These chemicals are assigned to ship types 1 or 2; and are stowed away from the hull.



Solvents are loaded on a tankship.

Photo by Michael Morrissette.

Oxygen in the air can react with certain cargoes. During loading and as the tank breathes during transit, air will normally be in empty spaces. Many ethers react with oxygen to form peroxides. If the peroxides become concentrated, they can explode, particularly when small amounts of material remain in a tank or line after unloading, then evaporate, leaving less volatile peroxides behind. To prevent peroxide buildup, nitrogen gas should be introduced.

The tendency of some chemicals to self-react can also be dangerous by accelerating heat and sometimes gas. As a liquid heats, pressure is generated that can violently rupture a tank. Adding inhibitors to these chemicals helps prevent this reaction from taking place. Such chemicals should be separated from heated cargoes.

Chemical corrosion is another type of reactivity. Products that can seriously corrode common construction materials, such as steel, should not be loaded in cargo tanks made of this metal, unless they are suitably lined. Also chemicals which release hydrogen during corrosion will create flammable vapors in the tank or surrounding spaces, such as double bottoms or voids. These vapors could easily ignite.

Minimum hazard criteria

To determine whether a bulk chemical possesses properties dangerous enough to warrant special precautions during handling and transport, criteria establishing minimum hazards are necessary. New chemicals falling under the criteria are considered hazardous.

Following are criteria which identify chemicals requiring precautions. They are not to be followed as absolute, however. The suggested numerical values for a number of products need adjusting to account for such properties as vapor pressure, solubility and density.

Chemicals falling under one of these categories are considered hazardous and are assigned to the IMO Chemical Codes.

Examples

(a) Significantly toxic by inhalation -- LC_{50} (1 hour, rats) up to 2000 ppm, taking volatility into account.

(b) Significantly toxic by oral ingestion -- LD_{50} oral less than or equal to 1000 mg/kg. Factors, such as solubility and taste should be taken into account.

(c) Significantly toxic by skin absorption -- LD_{50} dermal less than or equal to 1200 mg/kg. Products with a somewhat higher LD_{50} dermal, but which are absorbed with very little or no irritation should be included.

(d) Inhalation of vapors is known to cause allergic sensitization, leading to serious or long-term effects.

(e) Intermittent exposure to vapors over an extended period of time is known to cause moderate to severe injury.

(f) Autoignition temperature below 200°C (392°F).

Products meeting one or more of these criteria are to be further evaluated to determine containment standards. When a substance is brought within the scope of the code by satisfying one of these minimum requirements, it is then appropriate to apply the following criteria.

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Crew member prepares to enter cargo tank.

Photo by Michael Morrissette.

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Ship types

Type 1

(a) Substances with particularly severe toxicity risks. (Substances determined to be too toxic for type 1 ships would be prohibited in bulk shipment.)

(b) Extremely reactive with water, producing large quantities of toxic or corrosive gas or aerosols (i.e., chlorosulphonic acid).

(c) Very severe flammability characteristics, i.e.:

(1) autoignition temperature below 65°C (149°F); and
(2) difference between the limits of flammability (expressed percent by volume in air) exceeds 50 percent.

Type 2

(a) Moderately to highly toxic products (meets one or more of the following):

(1) LD_{50} oral less than or equal to 300 mg/kg;
(2) LD_{50} dermal less than or equal to 600 mg/kg; and
(3) LC_{50} (1 hour, rats) less than or equal to 1000 ppm taking volatility into account.

(b) Highly reactive with water, producing toxic or corrosive gas or aerosols (i.e., oleum).

(c) Severe flammability characteristics, i.e.:

(1) autoignition temperature below 200°C (392°F); and
(2) difference between the limits of flammability exceeds 40 percent.

Type 3

All other bulk liquids meeting the minimum hazard criteria.

Other criteria

Criteria have also been developed to specify the following requirements:

Tank type
Venting device
Gauging device
Tank environmental control
Toxic vapor detection equipment
Cargo tank overfill protection
Pumproom
Respiratory and eye protection

Using the system

Evaluation system guidelines are quite complex and subjective, and are to be used only by those individuals familiar with chemical properties and evaluation procedures. The system was developed by an IMO working group for use in evaluating new products and assigning them to appropriate chemical codes.

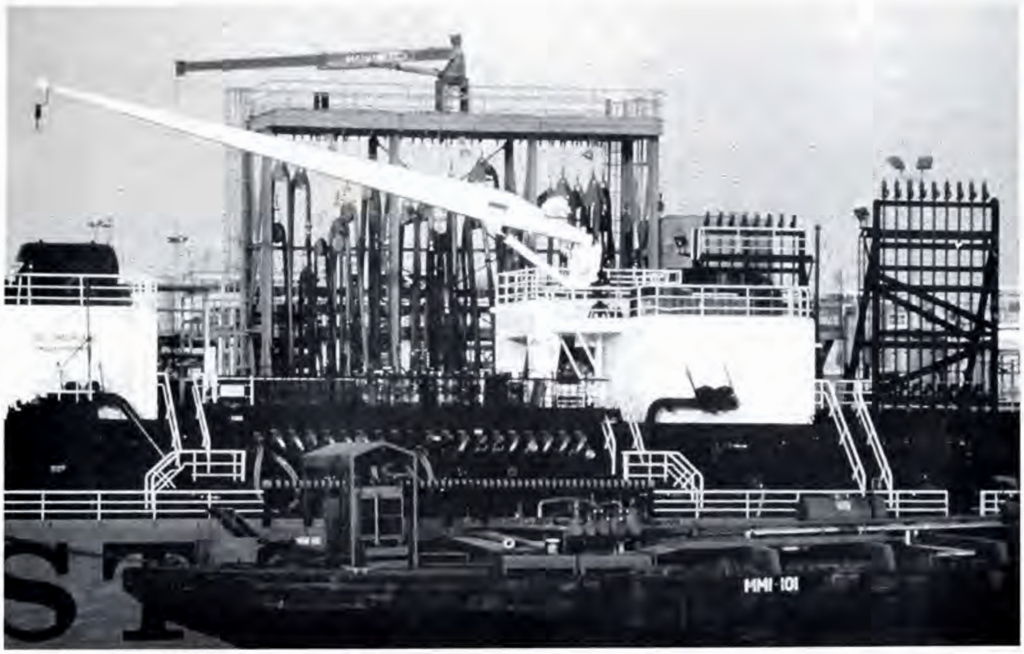
Many products can be processed through the evaluation system in a fairly objective and consistent manner. However, chemicals with unusual properties must be evaluated individually, because of extensive special requirements needed for safe transport.

The system has been in use about 15 years by IMO and various national administrations including the Coast Guard. Several hundred evaluations of new chemicals have been successfully performed, resulting in international transportation requirements that protect against the many hazards these chemicals possess.

New developments

On April 6, 1987, Annex II of the *1978 Protocol to the International convention for the Prevention of Pollution from Ships*, (MARPOL 73/78) came into force. This convention controls operational discharges from chemical tankers and provides additional protection from accidental spills Carriage requirements for chemical cargoes are now determined by evaluation of both their safety and pollution characteristics.

Mr. Michael Morrissette is chief of the Hazard Evaluation Section of the Hazardous Materials Branch.
Telephone: (202) 267-1577.



Multiple transfer operations take place on tankship.

Photo courtesy of Stolt-Nielsen.

Want speedy approvals for new bulk chemical shipments?

By Dr. Alan Schneider and Mr. Michael Morrissette

Before loading a bulk liquid on a tank vessel, you have to know the Coast Guard regulations for that particular cargo. However, what do you do if your cargo is not included on existing lists or tables?

First, you contact the Hazardous Materials Branch, Marine Technical and Hazardous Materials Division, Office of Marine Safety, Security and Environmental Protection at (202) 267-1217.

If your cargo is to be shipped abroad, the Coast Guard must follow international rules and regulations, which means working through the International Maritime Organization (IMO). This may be complicated, but it is simpler than the alternative. Without IMO, you would have to get the agreement of the country to which you intend to ship new cargo.

Fortunately, many chemicals are classified and their shipping requirements established. They are listed by name with their shipping requirements in the IMO Bulk Chemical Codes, which are available from IMO in London, England, or from United States maritime suppliers. The codes are valid in all countries which have signed Annex II of the MARPOL 73/78 Convention.

Tripartite process

Because of the long process of amending international treaties and conventions, it takes years to add new chemicals to IMO codes. Consequently, IMO developed a "tripartite process" to establish provisional requirements until new chemicals can be added to the codes.

If the only hazard from a chemical mixture is pollution - not corrosiveness or explosibility - there is a short cut, especially if the mix-,ture consists of classified substances. In the latter case, the manufacturers can calculate shipping requirements themselves.

For new chemicals, the manufacturer provides data to the exporting country's administration, and asks for provisional or temporary classification. The administration reviews the data and develops a set of shipping requirements.

Following international rules, the administration of the exporting country asks the importing country and the ship's flag state administrations to agree with the proposal. This is why it is called "tripartite," even though there is often more than one importing country and/or flag state involved.

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The administration of any of the countries involved can accept, reject, propose alternatives or ask for a delay within 14 calendar days. If an administration does not respond, one can conclude it is in agreement. If one or more disagree, the most stringent requirements proposed are accepted.

Approval is not sought from countries which have not signed Annex II. Manufacturers should contact these nations directly to discuss requirements.

Once a tripartite agreement has been established, the cargo may be shipped between the countries on vessels of those administrations for three years after the provisional classification is published by IMO in a circular. If the manufacturer subsequently wants to add more importing countries and/or ship flag states, the exporting administration must prepare additional tripartite agreements.

Simple agreements can be completed within a month or two. Up to six months should be allotted for complex evaluations.

IMO code submission

Before the three-year life of provisional classification expires, all the necessary data on a new chemical must be submitted and tests performed to add it to IMO's Bulk Chemical Codes. This is an involved process.

First, an IMO form, "*Characteristics of Liquid Chemicals Proposed for Marine Transport in Bulk*" (BCH/Circ.26), must be completed. (Blank forms may be obtained from the Hazardous Materials Branch.) It is quite extensive and testing of the chemical may be required to develop some of the data.

Depending on the chemical involved, this may include aquatic toxicity data on marine fish and crustaceans (how fatal the chemical is to marine life), mammalian toxicity (inhalation, dermal and ingestion), and marine environment bioaccumulation data (whether the chemical accumulates in marine animals). Often a manufacturer will have to determine whether the material irritates the skin, removes oxygen from the water, taints seafood and/or fouls up beaches.

The Coast Guard then submits the completed form to an international committee called the Group of Experts on the Scientific Aspects of Marine Pollution, which analyzes the data and prepares a hazard profile on the product's marine pollution characteristics. This profile and the original data is then submitted to IMO's Bulk Chemicals Subcommittee for consideration. The subcommittee also considers safety hazards of the chemical, i.e., the chance of it burning or exploding. The IMO group then develops the shipping requirements for the chemical.

The IMO subcommittee classification is incorporated into the next set of amendments to the chemical codes. Once this is done, tripartite agreements are no longer needed. All member countries follow the same set of requirements. The IMO classification is permanent, unless modified by the subcommittee on the basis of new scientific data.

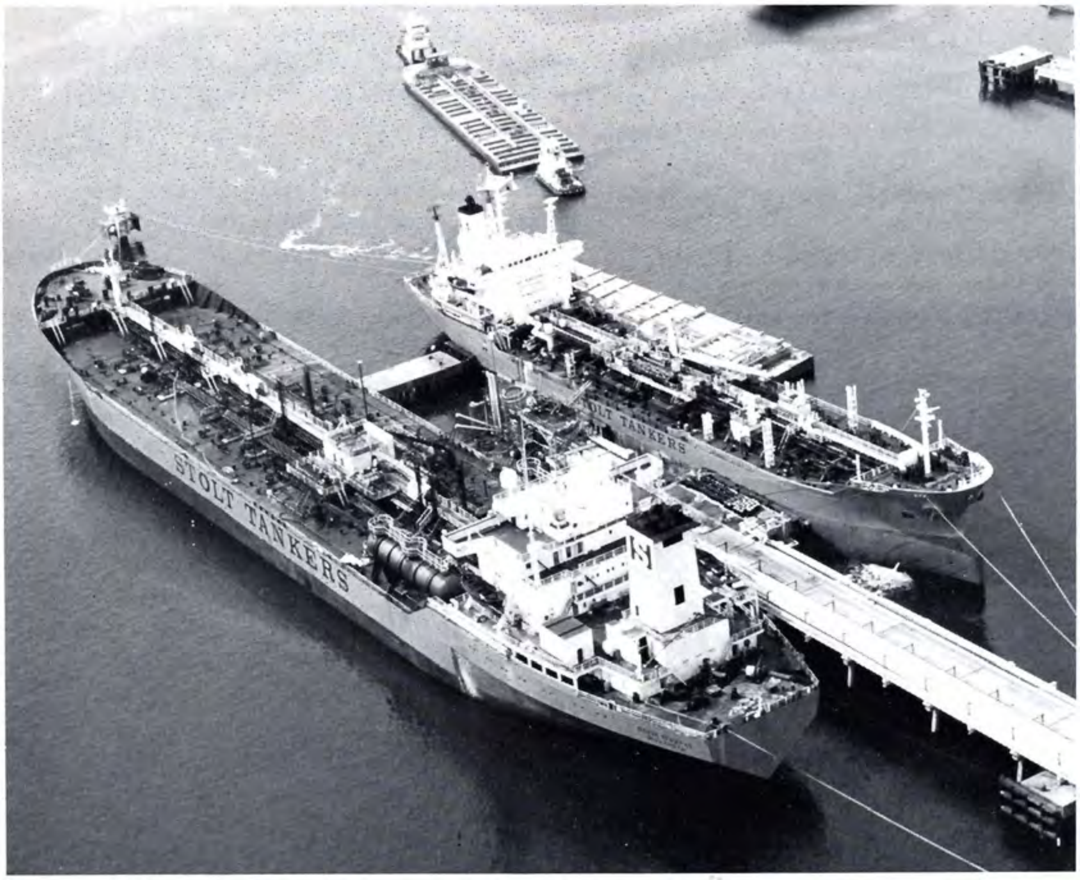
Mr. Michael Morrissette is chief of the Hazard Evaluation Section of the Hazardous Materials Branch and Dr. Alan Schneider is a chemical engineer with the same branch.

Telephone: (202) 267-1577.

The Exxon Charleston transports petroleum by-product to refinery in Bayway, New Jersey.

Photo by LT Tom Butler, USCGR.

How chemical tanker design standards evolved



Large parcel tanker transfers cargo to a smaller ship that can enter shallow water ports.

Photo courtesy of Stolt-Nielsen.

By LCDR Greg Buie

October 12, 1971 -- The InterGovernmental Maritime Consultative Organization (now the International Maritime Organization - IMO) adopted the "Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk" (BCH Code). Its successor, the "International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk" (IBC Code, for ships built after July 1, 1986), was adopted on June 17, 1983. These design and equipment standards for chemical tankers were developed in an arena of international cooperation to ensure the safe shipment of large quantities of hazardous chemicals by sea.

Background

During the early 1960s, the worldwide demand for chemicals grew dramatically, and marine chemical shipments surged. The Coast Guard initiated a program of plan review and inspection in 1965 for all foreign-flag vessels carrying hazardous cargoes in United States waters. However, because of the tremendous influx of tankships, some carrying up to 40 different chemicals, the task proved overwhelming for Coast Guard resources.

In 1967, the Coast Guard approached IMO requesting action. In response, the Maritime Safety Committee established the Subcommittee on Ship Design and Equipment to:

". . . consider the construction and equipment of ships carrying bulk cargoes of dangerous chemical substances other than petroleum and similar inflammable products normally carried in tankers, and to recommend suitable design criteria, construction standards and other safety measures to minimize the risk involved in loading, carrying and discharging such cargoes.

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In carrying out this task, the Subcommittee will consider:

(i) the hazards of each product with respect to the ship itself and its crew, as well as the hazards to the neighborhood;

(ii) special hazards affecting the design or adaptation of the ship, such as specific gravity, and the pressure and temperature at which the cargo is carried; and

(iii) the influence of these hazards on the design, construction or adaptation of the ships carrying the goods in question. . ."

Work began

In January 1968, the subcommittee conducted its first session on a code for chemical tankers. Representatives of France, the United States, Italy and Japan submitted papers stating that this code should address the integrity and reliability of the cargo containment system. A failure of this system could lead to extensive pollution of the sea and air, fatalities and injuries to crew members and innocent people, and the destruction of property.

The subcommittee than set up an ad hoc working group to work out the complex details of the chemical tanker standards. This group was made up of representatives of Norway, the United Kingdom and the United States, with observers from the International Chamber of Shipping. Subsequently, representatives from the Netherlands joined the group, and assistance was provided by representatives of the Federal Republic of Germany, Italy and the Union of Soviet Socialist Republics.

The ad hoc working group met ten times during three years, producing two codes. The first was a set of interim recommendations for existing ships, and the second was the comprehensive BCH Code.

Completed at the sixth subcommittee session, the BCH Code relates the cargo containment features of ship design, construction and operation to the hazards of the chemicals it regulates. The IBC Code is similar.

BCH Code

The BCH Code regulates very specific cargoes as follows:

a) chemicals with fire hazards in excess of petroleum and similar flammable products;

b) chemicals having significant hazards in addition to or other than flammability; and

c) chemicals which may be hazardous to the environment if accidentally released.

A complex process known as hazard evaluation determines if a cargo falls within the scope of the codes. If so, minimum requirements are developed for the cargo and it is added to the codes. The codes also list products that fall outside their scope.

Ship design standards

Some of the most important requirements in the codes are ship design standards, which are intended to prevent accidental release of hazardous cargoes. It was well recognized that ship damage from collision or grounding could lead to the uncontrolled release of cargo.

Three ship types with different degrees of protection were developed. The extent to which a ship should be capable of remaining afloat after damage, along with the location of cargo in the ship's side or bottom is specified. The nature and severity of a product's hazard is considered in the matching of ship type to cargo.

Type 1 ship

A type 1 ship affords the highest standard of protection. It is required for substances considered to have the greatest environmental and safety hazards. Release of these products would have far-reaching effects beyond the immediate area of the ship.

Type 1 cargoes must be placed in tanks well inside of the sides and bottom of the ship. In addition, the ship must be able to survive a high level of prescribed damages.

Elemental phosphorous is an example of a type 1 cargo.

Type 2 ship

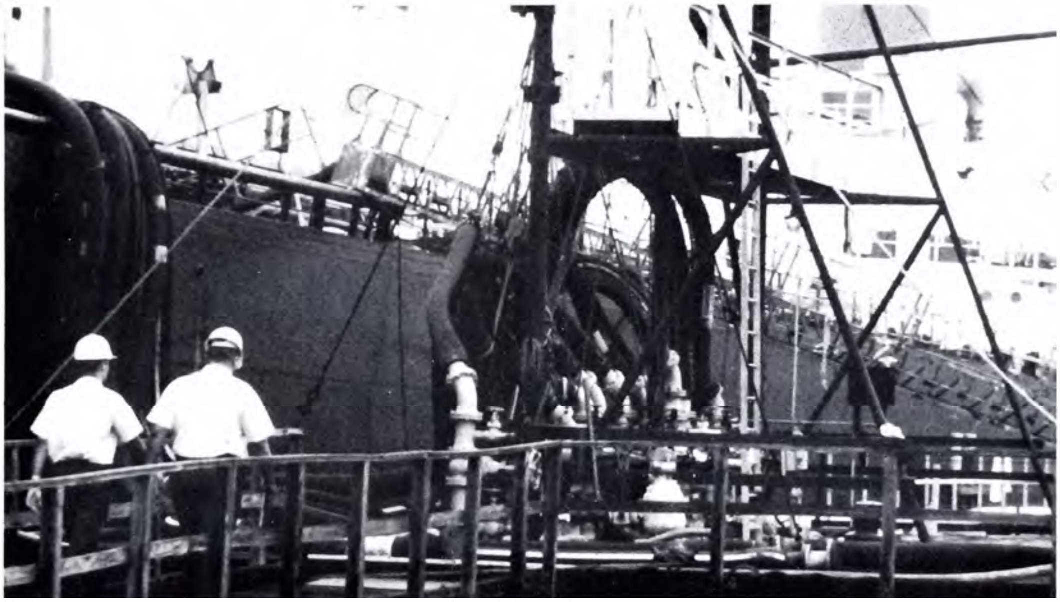
A type 2 ship affords a mid-level standard of protection. It is required for cargoes with significant hazards, but whose release does not have far reaching effects. This standard protects the cargo against low energy collisions and groundings associated with vessels in port.

Type 2 cargoes must be located prescribed distances away from the sides and bottom of the ship, which must be able to survive a prescribed level of damage that is less than that required of type 1 ships.

Carbon disulfide is an example of a type 2 cargo.

There are also numerous special requirements which recognize particular hazards or problems associated with bulk handling of specific cargoes. For example, phosphorous has 12 special requirements under the IBC Code because of its self-igniting properties.

The codes also include design and equipment requirements implementing the convention which controls pollution of the oceans from many code cargoes. This is Annex II of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL 73/78).



Coast Guard port safety personnel monitor cargo transfer operations from a tankship.

Type 3 ship

The lowest level of protection is afforded by the type 3 ship, which is designed to carry products of sufficient hazard to require a moderate degree of containment to ensure survival in a damaged condition. The prescribed level of damage is less than that for ship types 1 and 2.

Type 3 cargoes can be located at the sides and bottom of the ship.

Sulfuric acid is an example of type 3 cargo.

Other standards

The codes also include standards for cargo transfer, construction materials, cargo temperature control, tank vent systems, environmental control, electrical installations, fire protection and extinction equipment, cargo area ventilation, instrumentation and personnel protection.

With the inclusion of Annex II, the codes have become a comprehensive set of standards.

Summary

Two decades of safe bulk chemical shipments have demonstrated the effectiveness of the BCH Code and the IBC Code in addressing chemical tanker hazards. The codes are constantly evolving. The IMO provides a strong, effective international forum for continual chemical tanker safety improvement.

LCDR Greg Buie is the chief of the Naval Architecture Branch of the Cargo Division of the Marine Safety Center, 400 7th Street, S.W., Washington, D.C. 20590-0001.

Telephone: (202) 366-6441.

Ironing out problems with cargo-authority processes

By LT Hung M. Nguyen

Cargoes with improper names, changes in bulk chemical carriage requirements, misunderstandings about deck foam and vapor control system regulations -- the cargo-authority process has frustrating imperfections that need attention. Cooperative efforts between Coast Guard and the marine industry should clear up much of the confusion and resolve some problems.

Problems

Improper names

Some cargo requests are labeled with trade names instead of generic cargo names. For example, how is a reviewer to identify cargo that is called, "ABCD 1234," or "Perfection?" Cargo products cannot be reviewed for carriage unless they can be identified by names from 46 CFR tables. If not, the requester must submit a CG-4355, "*Characteristics of Liquid Chemicals Proposed for Bulk Water Movement*" form to the Hazardous Materials Branch of the Marine Technical and Hazardous Materials Division (G-MTH-1). This form may be obtained from any local MSO or G-MTH-1. Call (202) 267-1217 for further information.

Requirement changes

Some changes are made to carriage requirements under 46 CFR every year. For example, in 1992, there were requirement alterations for 122 chemicals. Even though a chemical is currently listed on a tank barge's Certificate of Inspection or a tankship's List of Authorized cargoes, the vessel may no longer meet the carriage requirements. Such problems generally surface when the Coast Guard checks vessel credentials or when vessel operators request the authority to carry additional cargoes.

Operators may have their vessels reviewed for carriage of eligible products by providing the Marine Safety Center with information on their cargo systems on the "*Tank Group Characteristics Loading Form*" for barges or ships, which may be obtained from the center. Copies of applicable 46 CFRs may be purchased from a Government Printing Office outlet.

Deck foam

Some cargoes may not be carried because the vessel's fire-fighting systems do not fully meet regulations. For example, oceangoing tankships carrying polar solvents regulated under 46 CFR part 153 must have a deck polar foam fire-fighting system.

It is a misunderstanding that all deck polar foam fire-fighting systems are effective against all fires involving polar solvent cargoes. This is not true. Navigation and Vessel Inspection Circular No. 11-82 provides guidance on deck foam fire-fighting systems for tankships carry-ing polar solvent cargoes.

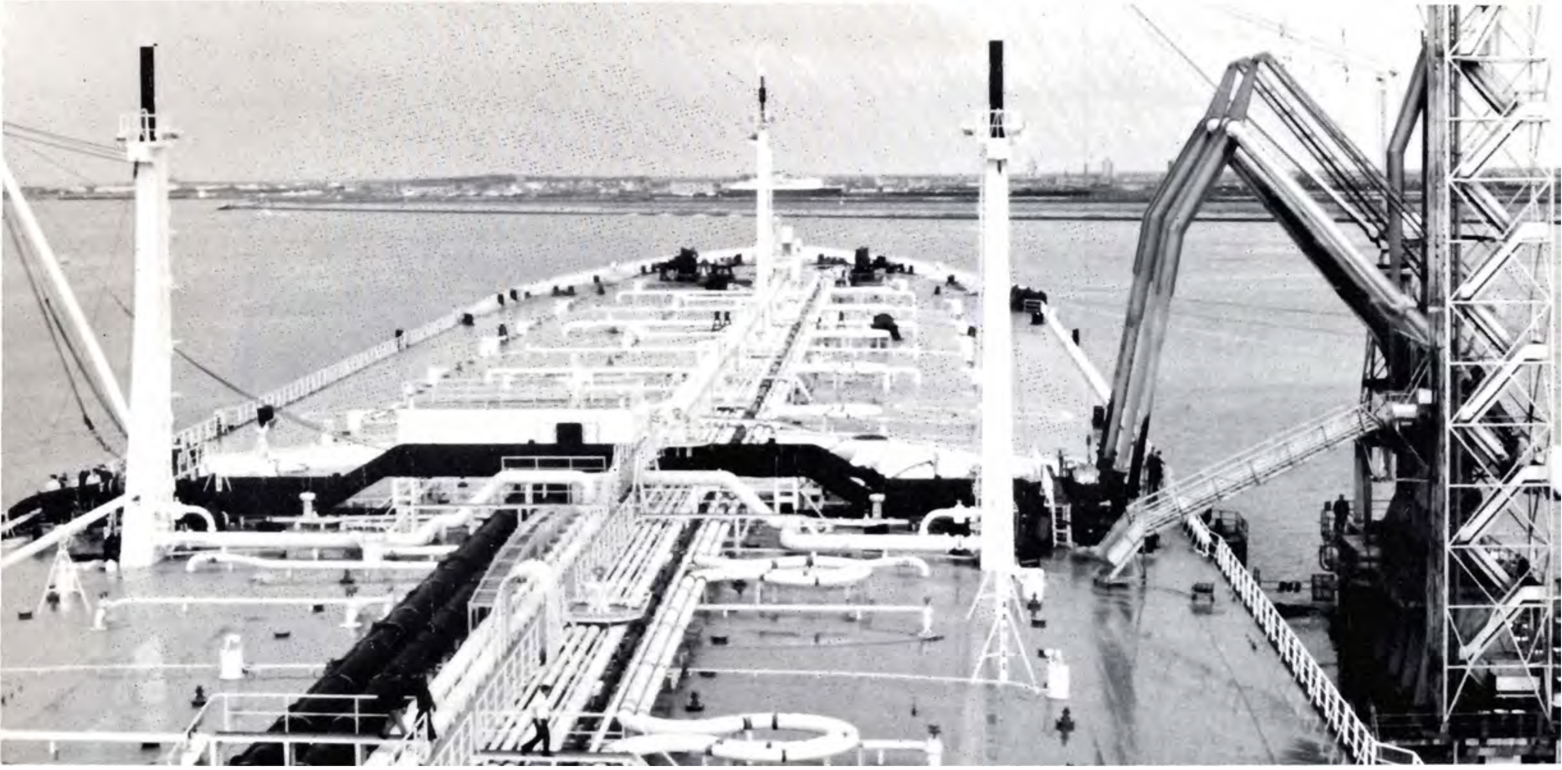
Call the Survival Systems Branch of the Merchant Vessel Inspection and Documentation Division at (202) 267-1444 for further information.

Vapor control systems

The regulations for vessel vapor control systems went into effect on July 23, 1990. Plans, calculations and specifications for vessels with new vapor collection systems must be submitted to the Marine Safety Center for approval before installation. For existing systems, the deadline was July 23, 1992 for benzene, gasoline and crude oil cargoes, and is July 23, 1993 for other flammable or combustible cargoes.

System plans and calculations are reviewed by the Marine Safety Center, while construction and testing must be approved by the local Officer in Charge, Marine Inspection (OCMI). Vapor control systems are approved for specific cargoes at certain maximum vapor-air mixture densities and liquid transfer rates. Tank vessel owners and/or operators must request OCMIs to endorse their Certificates of Inspection to indicate the vapors which may be used in their systems.

G-MTH-1 assigns cargoes to one of eight categories shown in the accompanying table, based upon molecular characteristics, toxicity and vapor pressure. To date, 162 of 796 bulk liquid products now listed in 46 CFR have been assigned to categories one, two, three or four.



Chemical cargo is transfered to a large tankship.

An example

An example is a recent request to add the polar solvent ethyl tert-butyl ether (ETBE) to a tanker's list of authorized cargo. A flammable/ combustible gasoline additive, ETBE is a popular alternative to methyl tert-butyl ether (MTBE) because of its lower vapor pressure. (See page 25 for article on both chemicals.)

Classified as a subchapter D commodity on February 4, 1993, ETBE was assigned to vapor control system category one, which has the same requirements as those for gasoline, benzene and crude oil.

ETBE is a newly regulated commodity and has not been evaluated for a polar foam fire-fighting system. Therefore, it cannot be authorized for oceangoing tankships. Before the product can be approved for a fire-fighting system, the manufacturer has to submit test data on the effectiveness of a system against ETBE fires.

Review improvements

Although it is the responsibility of the submitter to research applicable regulations and provide supporting data, the Coast Guard can and is making the process less confusing and costly by providing additional guidance.

For example, the Marine Safety Center and G-MVI-3 have amended foam system manuals to include cargoes in 46 CFR that do not require deck polar foam systems. In some cases, polar solvent cargoes are added to a foam system manual if they have similar characteristics to those already approved for that system.

To standardize vapor control system calculations, the Marine Safety Center is working with G-MTH-1 on a standard method for calculating vapor-air mixture densities and vapor growth rates for flammable or combustible cargoes other than benzene, gasoline and crude oil.

With the assistance of the Chemical Manufacturers Association, the center is getting data on all cargoes listed in category five through eight. Draft procedures have been sent to four major classification societies, and a number of domestic naval architecture firms and maritime shipping companies for comment.

If the standard procedures are found acceptable, designers will have an easy, reasonable way to do vapor control system calculations. The Marine Safety Center will be able to supply comprehensive lists of vapor control system cargoes for tank vessels and review submissions faster.

The Coast Guard is seeking ways to provide the marine industry with a list of cargoes evaluated for vapor control system requirements and those with approved deck foam fire-fighting systems. The feasibility of an electronic bulletin board is being investigated.

Industry assistance

The Marine Safety Center will be able to respond faster on cargo authority requests if the

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Vapor control system requirements

CATEGORIES	REQUIREMENTS
1	Same requirements as for benzene, gasolines and crude oil.
2 polymerizes	In addition to Category 1, the vapor control and venting system must be designed to accommodate internal visual examinations.
3 highly toxic	In addition to Category 1, a spill valve or rupture disk arrangement cannot be used as the primary overfill protection device.
4 toxic and polymerizes	Must comply with requirements of categories 1, 2, and 3.
5 high vapor growth rate	Actual vapor growth rates for cargoes with a vapor pressure greater than 190 mm Hg must be reported to G-MTH-1.
6 high vapor growth and highly toxic	Must comply with requirements of categories 1, 3, and 5.
7 high vapor growth and polymerizes	Must comply with requirements of categories 1, 2, and 5.
8 unknown or not enough data	Form CG-4355, *"Characteristics of Liquid Chemicals Proposed for Bulk Water Movement,"* must be submitted to G-MTH-1.

Continued from page 23

marine industry can reduce the number of those which are returned for lack of information. The cargo authority review process can also be improved by feedback from the marine industry.

Comments from industry on the standard procedures recommended for vapor control system calculations would be extremely helpful. Since the Coast Guard approach is based on theory, the industry can help validate its accuracy with actual measured vapor-air mixture densities and vapor growth rates. With this data, the procedures may be extended to cargoes in categories five, six and seven.

Recommendations from the marine industry to the Marine Safety Center on better ways of doing things are welcome. For example, industry suggestions on computer programs will help the center to improve its technical abilities, thus serving the public better.

LT Hung M. Nguyen is a chemical engineer in the Cargo Division of the Marine Safety Center, 400 7th Street, S.W., Washington, D.C. 20590-0001. Telephone: (202) 366-6441.

Working together--

the Coast Guard and marine industries can make cargo authority processes as smooth as silk.

MTBE or ETBE?

How to carry these additives - that is the question

By Mr. Robert Query and CDR Lutz Buesing

In many areas of the United States this past winter, gasolines contained new additive compounds to reduce automotive pollution. Most frequently, the compound was methyl tert-butyl ether (MTBE) or a related compound, ethyl tert-butyl ether (ETBE).

MTBE is made from methane, the principle component of natural gas. Although there are some arguments concerning the ability of MTBE to reduce pollution, many regions have required that it be added to winter gasoline to achieve higher air quality. The resulting demand for the compound has led tank vessel operators to seek authorization to carry it.

MTBE

An organic liquid of relatively low toxicity, MTBE is flammable and poses a modest hazard to the environment if spilled. Fires of MTBE are difficult to control compared to substances such as gasoline. It is a good solvent and tends to attack rubber and other elastic components of cargo containment systems.

Gasolines containing this additive are termed oxygenated, because MTBE contains an atom of oxygen. Gasoline's other constituents are almost entirely hydrocarbons.

MTBE is a polar grade C flammable liquid and category D noxious liquid substance under Annex II of the *Convention for Prevention of Pollution from Ships*, MARPOL 73/78. It is not an oil or oil-like cargo and cannot be carried on vessels approved only for Annex I.

MTBE is regulated under 46 CFR parts 30 through 35, and 33 CFR part 151. It has the Coast Guard CHRIS Code MBE. (ETBE has CHRIS Code ETB.)

Obtaining Approval

To carry MTBE, an owner or operator initially requests the Marine Safety Center in Washington, D.C. to add it to the vessel's cargo entitlement.

To be eligible to carry MTBE, a vessel must have the following:

1) **Certificate of Inspection (COI) issued under 46 CFR parts 30-35 authorizing grade C flammable liquids;**

2) **endorsements on the COI of oceangoing vessels showing that MTBE is carried under the requirements in 33 CFR part 151 pertaining to category D noxious liquid substances, and showing that an MTBE-approved vapor control system, if required, will be used when transferring the additive;**

3) **Procedures and Arrangements (P & A) Manual for category D noxious liquid substances for oceangoing vessels;**

4) **Cargo Record Book described in 46 CFR 153.490 and available from local MSOs for oceangoing vessels;**

5) **deck foam systems covering the MTBE cargo tanks when required by 46 CFR part 34; and**

6) **Noxious Liquid Substance Certificate issued under Annex II of MARPOL and endorsed to carry MTBE for vessels operating in waters of countries that signed the MARPOL convention, including the Panama Canal.**

After a vessel has been evaluated to carry MTBE by the Marine Safety Center, the local Coast Guard Officer in Charge, Marine Inspection (OCMI) will issue these certificates and endorsements authorizing its carriage.

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P & A Manual

The P & A Manual required by Annex II of MARPOL is a set of operating instructions for a specific vessel, which is used by the crew to limit ocean pollution from tank cleaning.

A manual covering only category D noxious liquid substances can be simpler to use than one covering all categories, because its content can be specified by the Hazardous Materials Branch of the Marine Technical and Hazardous Materials Division (G-MTH-1). For example, if an unmanned barge trades only between United States ports and discharges tank washings only to approved reception facilities, G-MTH-1 will usually allow an endorsement on the COI to serve as the P & A Manual.

Otherwise, the Marine Safety Center evaluates a P & A Manual under the requirements of 46 CFR 153.490 and appendix D of the *Standards for Procedures and Arrangements*. The latter document is published by IMO under its *Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk* (Annex II of MARPOL).

The first two chapters of the P & A Manual for vessels carrying only category D noxious liquid substances should follow standard language cited in appendix D.

Cargo residue dilution

Annex II minimizes the effects of category D residues by dilution before they are discharged into the sea. This may be achieved either by mixing cargo residues with water before discharge or by discharging the residues through an underwater outlet approved under Annex II. Most non-chemical tankers do not have such outlets, so dilution before discharge is common.

Annex II requires diluting cargo residues with water until the concentration of the chemical is no greater than one part in ten. To be precise, this ratio should be based on weight, but most manuals actually prescribe a one in ten dilution based on volume. Since the density of most category D noxious liquid substances is not much different than that of water, a dilution based on volume is reasonably accurate, easy to carry out and acceptable to the Coast Guard.

For dilution before discharge to be effective, the amount of cargo residue to be diluted must be known. Thus, the manual should have detailed instructions on estimating the amount of cargo remaining in a tank after discharge, including that which clings to the tank when it is a significant part of the total residue, as is sometimes the case with internally framed tanks. If the manual does not specify procedures to ensure

The parcel tanker, MT Stolt Emerald, could carry MTBE. *Photo courtesy of Stolt-Nielsen, Inc.*

that cargo piping drained cleanly back to shore or into the tank, a method for estimating cargo remaining in the piping should be included. If such methods are too clumsy to be practical, conservatively high volumes may be specified in the manual. In any event, the contents of the tank should always be measured in some way because they can vary from one cargo load to the next.

Directions for measuring and mixing the water to achieve a one in ten dilution should be clearly laid out in the manual. If water is added through a washing machine, as is often the case, calculating the amount of time needed to run the machine at different water pressures should be explained. Or a method should be detailed in the manual explaining how to estimate the amount of water added directly to a tank. Also a procedure for back flushing deck lines or circulating wash water through them should be included in case the deck lines do not drain cleanly.

Annex II requires that discharges of category D residue take place at least 12 miles from land and underway en route (not steaming in circles) at a speed of at least seven knots (four for barges in the United States). This ensures that the discharge is distributed over a large volume of sea water so that it is quickly diluted to very low concentrations.

Foam

Newer tank vessels carrying flammable or combustible cargoes are required by 46 CFR part 34 to have fire-fighting systems capable of supplying foam to deck areas over cargo tanks and adjacent spaces. Many tanker systems use foam designed for "non-polar" cargoes like gasoline, crude oil or diesel fuel. MTBE is a polar cargo.

Polar cargoes tend to cause certain foams to break down when applied. This makes the foam lose effectiveness in suppressing fires. A foam to be used with a polar cargo must be tested under 46 CFR part 34 to learn whether or under what conditions it is effective with that cargo.

Such tests must also determine the rate of application of a foam needed with a polar cargo. Test results are reviewed by the Survival Systems Branch of the Merchant Vessel Inspection and Documentation Division (G-MVI-3). If the results are acceptable, they are compiled in a manual by the foam manufacturer.

Before the Marine Safety Center can add MTBE to an authorized cargo list, the manual for the foam system must specify an application rate for the chemical within its capability and must be approved by G-MVI-3. Note that polar foams are assumed to be as effective as non-polar foams when applied to non-polar cargoes, so they can be used with a wider range of cargoes.

Vapor control

Some American states and terminals require that vapor control systems be used to recover and process cargo vapors displaced during loading. These systems must be approved under 46 CFR part 39 for the specific cargo vapors they will handle. The systems are usually approved for at least one of three base cargoes: gasoline, benzene and crude oil.

In most cases, MTBE can be handled in vapor control systems approved for the base cargoes at the same transfer rate, although the vessel's COI must be endorsed specifically to allow use of vapor control with the additive. Requests to add MTBE to the list of cargoes for vapor control should be sent to the Marine Safety Center, which ensures that the approved transfer rates and other parameters are appropriate.

ETBE

Closely related to MTBE, the additive ETBE has a lower vapor pressure and is made from ethanol. Authorization to carry ETBE has been requested often by tanker operators in recent months. A vessel authorized to carry MTBE could carry ETBE if the following were accomplished:

- the foam system was approved for ETBE at an appropriate rate of application;
- the P & A Manual was modified to address the handling of ETBE residues; and
- the vapor control system was approved for ETBE.

The procedures for obtaining approval are the same as for MTBE. A transition to ETBE would be easier if the vessel's P & A Manual covered all category D noxious liquid substances, with specific cargoes listed in a cargo table.

Mr. Robert Query and CDR Lutz Buesing are chemical engineers with the Marine Safety Center, 400 7th Street, S.W., Washington D.C. 20590-0001.

Telephone: (202) 366-6441.

Handle anhydrous ammonia *with care*

By LTJG Randy W. Tucker and LTJG Chris T. Moore

Before World War I, two German chemists synthesized ammonia from elemental hydrogen and nitrogen. This discovery turned out to be an enormous agricultural benefit due to its value as a major fertilizer component. It also led the way for the production of ammonia derivatives including nitric acid, ammonium nitrate and urea.

Until World War II, solid fuels, such as coal, coke and lignite, were used predominantly in the manufacture of ammonia. However, some methane, derived from coke-oven gas, was used in producing hydrogen. A process, based on the reaction between methane and steam, was used.

The synthetic ammonia industry grew rapidly after World War II because of the increased demand for fertilizers, synthetic fibers and plastics, all of which use large volumes of ammonia as a raw material.

Coast Guard boarding officers test warning alarm and light for proper operation aboard anhydrous ammonia tankship.

Hazards

A liquefied compressed gas, anhydrous ammonia (NH_3) is toxic and corrosive. The colorless gas has a powerful odor and is poisonous if inhaled. The liquid causes burns or frostbite when in contact with skin.

Anyone exposed to anhydrous ammonia vapors should be removed to fresh air immediately. If a victim is not breathing, cardiopulmonary resuscitation should be administered and affected clothing removed.

Exposure to 700 ppm (parts per million) of the chemical causes eye irritation; 5000 ppm can cause inflammation, edema of the larynx and immediate death from spasm. The short-term inhalation limit is 50 ppm for five minutes.

Anhydrous ammonia poses a significant fire hazard. It can also form an explosive compound when combined with mercury.

Precautions

Operating requirements specify that whenever anhydrous ammonia is in the tanks, the vessel shall be under constant surveillance.

Hose stations shall provide an adequate water supply to remove vapors. However, water is not recommended on liquid ammonia.

At least two units of self-contained breathing apparatus (SBA) must be on board -- one unit forward of the cargo tanks and one aft. Persons involved in filling and discharge operations must be properly trained in SBA use.

On self-propelled cargo vessels, every person shall carry or have close by a canister mask approved for ammonia, or carry respiratory protection for emergency escape from vapors.

During the transfer of bulk cargo, the vessel, while fast to a dock, shall display a red flag by day and a red light at night.

Anhydrous ammonia barge awaits loading at facility on McKellar Lake in Memphis, Tennessee.

The barge should be checked for leaks and an escape route should be planned before boarding. Also, personnel must be familiar with safe work practices on ammonia barges and wear the proper safety equipment.

Carriage of anhydrous ammonia is regulated by 46 CFR part 151.50.32 and subpart 98.25. The latter regulations list specifics of carriage and tank design.

Barges and tanks

Most anhydrous ammonia barges in use today are from 25 to 30 years old, and range from 2100 to 2500 gross tons. They require type II hulls, which are intended for cargoes requiring stringent control. Some have double bottoms, while others have single bottoms.

The liquefied gas barge generally has three compartments in the bow and two in the stern for extra stability. The standard hopper barge usually only has one bow and one stern compartment.

The typical design calls for two cylindrical cargo tanks lying lengthwise within the bay of a liquefied gas barge. The barge may be open or have sheet metal covers to keep tree limbs and other debris out.

The cargo tanks are mounted in saddles and held in place with chains. In theory, if the barge sank, the cargo connections could be blanked off and unfettered. Since the product is lighter than water, the tanks would float to the surface to be salvaged.

The tanks have from one to four six-inch relief valves, depending on the initial design requirements. Pressure-vacuum valves are required on low-temperature systems, while safety relief valves must be installed on tanks when cargo is carried at pressures over 10 pounds per square inch (psi).

All tanks are insulated to help keep the anhydrous ammonia in its liquid state. The insulation thickness depends on its quality.

Copper, copper alloys and copper-bearing alloys are not to be used in the construction of tanks, pipelines, valves, fittings and other equipment that may come in contact with either liquid or vapor anhydrous ammonia.

Suitable cargo hoses may be made of seamless steel pipe, wire-braided armored rubber or other flexible metallic structure not subject to deterioration by the chemical.

Refrigeration

Carrying anhydrous ammonia in its gaseous state would be highly inefficient, because very little would fit in a tank capable of being carried on a barge. By carrying it as a liquid, up to 40 times the amount of product can be carried.

There are two ways in which a gas can be transformed into its liquid state. One is by compressing it and holding it under pressure. The other is by cooling it. Most of the anhydrous ammonia barges on the Mississippi River use the cooling method.

Anhydrous ammonia is carried at a gauge pressure of 0 kilograms per square centimeter (0 psi) which relates to approximately 2.2°C (28°F).

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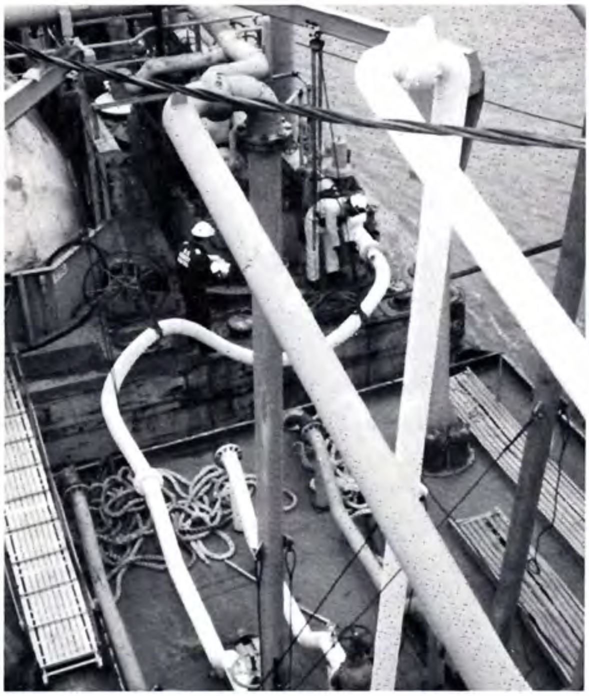
Low concentrations of anhydrous ammonia can harm aquatic life and endanger water intakes.



Tankerman hooks up lines to transfer anhydrous ammonia.

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The cargo cooling system maintains temperature in a manner similar to a home refrigerator. The hot vapors are drawn out of the tanks and compressed. Next, they pass through a condenser which cools them into liquid with river water. The water is either pumped up and over the condenser or a skin cooler is used. The cooled anhydrous ammonia then goes to a receiver that maintains the liquid level in the tank.

Each tank has its own cargo refrigeration and transfer system, which can be cross connected to each other. The tanks also have independent cargo-control and alarm systems. The alarms are connected to temperature sensors throughout the refrigeration system and can detect any failures and shut the system down. Usually three to five emergency shut-down switches are located around the barge. Tanker operators can immediately stop all cargo functions from any location.

The barges must be equipped with at least one standby refrigeration unit in addition to those needed to maintain the cargo vapor pressure below the tank maximum allowable relief valve setting. The standby unit must be as large as the largest required single unit.

Before loading, tanker operators should make sure that the product is handled within the temperature limits for which the tanks and system were constructed.

Inspections

As regulated in 46 CFR part 153, pressurized cargo barges have much the same inspection requirements as other vessels, plus those items unique to the carriage of the product. Besides hull design and tank structure, the important check points of the anhydrous ammonia barges are hull integrity, void spaces, cargo piping and transfer equipment, as well as proper functioning gauging systems, acceptable relief valve settings for the specified refrigerated cargoes, and high-level alarms.

Cargo pressure and temperature alarms on refrigerated tanks must be inspected to ensure all audible and visual signals, and emergency shutdowns work. The automatic shutdown and alarms for the different parts of the refrigeration system should be capable of manual activation to ensure proper operation. The number of temperature sensors must be checked.

It is recommended that pressure-vacuum valves be removed and bench tested every four years. Some valves have fittings that allow air hoses to be attached so that the valves can be tested in place.

In the past, internal cargo tank inspection was required. Since the anhydrous ammonia is carried under a vacuum, it was determined that there was no oxygen present, and, therefore, no corrosion. At the present time, non-destructive testing is considered sufficient. The tanks are required to be tested every ten years after a barge is 30 years old.

Conclusion

Because of its value in fertilizer and other important products, anhydrous ammonia ranks among the top petrochemicals in the world. Because of its extreme toxicity, it must be treated with great caution. Inspectors, tanker operators and other boarding personnel must be always mindful of its stringent carriage regulations and the need for handling anhydrous ammonia with great care.

Photos by BMC Rick Martin and BM3 Keith Hobbs of MSO Memphis.

LTJG Randy W. Tucker is assistant chief of Port Operations and LTJG Chris T. Moore is with the Regional Examination Center at MSO Memphis, 200 Jefferson Avenue, Suite 1301, Memphis, Tennessee 38103-2300.

Telephone: (901) 544-3941.

Monitor spreads foam on tanker deck fire.

New data on chemical hazards is now available to the public

By Dr. Alan L. Schneider

Determining the vapor pressure of aviation gasoline is hard enough. However, finding data on less common chemicals, such as the boiling point of 4-nitroaniline, would be next to impossible . . . if it weren't for "CHRIS."

One of the best sources of physical, chemical and toxicological properties of chemical substances is the Chemical Hazards Response Information System (CHRIS), published by the Coast Guard. A new CHRIS edition with updated information and data on more than 200 additional chemicals is now available from the Government Printing Office.

Background

In the late 1960s, an increasing number of chemicals were shipped by water in large quantities. The hazards of volatile chemicals spilling, burning or forming toxic clouds were far more serious than those of crude oil and gasoline, cargoes with which the Coast Guard was familiar.

Charged with the responsibility to respond to spills of all descriptions to protect life, property and the environment, the Coast Guard had to learn about these new chemical shipments very rapidly. Therefore in the early 1970s, CHRIS was developed to help Coast Guard personnel estimate effects of spills, including vapor cloud travel distances, safe fire-fighting distances and spill travel on water. There have been several editions since.

CHRIS manuals

There are two manuals of CHRIS currently being distributed. Manual 1 is a condensed version of Manual 2, which contains comprehensive descriptions of more than 1,200 chemicals. A summery of vital data, 12 categories and eight tables of physical properties over a range of temperatures, is prepared for each chemical.

Manual 1

Forward

- **Who to notify in event of spill**
- **Index of codes**
- **Manual instructions**
- **Emergency information**
- **Additional information sources**
- **Data sheet explanations**
- **Cargo compatibility guide**
- **Synonym index**
- **CHRIS code index**

Summary

- **Common synonyms**
- **Color**
- **Odor**
- **Spill reactions**
- **Spill precautions**
- **Fire precautions**
- **Exposure precautions**
- **Pollution potential**

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Manual 2

Forward

- CHRIS components
- Explanation of terms
- Additional information systems
  - * Chemical Transportation Emergency Center
  - * National Fire Protection Assn.
  - * International Maritime Organization
  - * Department of Transportation
  - * National Academy of Sciences
  - * Environmental Protection Agency Oil & Hazardous Materials Technical Assistance Data System
  - * Local poison control centers
- Conversion factors
- Water, ice and air properties
- Index of synonyms
- Index of CHRIS codes
- Data sources

Summary

- Common synonyms
- Color
- Odor
- Spill reactions
- Spill precautions
- Fire precautions
- Exposure precautions
- Pollution potential

12 Categories

1) Discharge responses
2) Shipping label
3) Chemical designations
4) Observable characteristics
5) Health hazards
6) Fire hazards
7) Chemical reactivity
8) Water pollution
9) Shipping data
10) Hazard assessment code
11) Hazard classifications
12) Physical & chemical properties

8 Tables

1 - Saturated liquid density
2 - Liquid heat capacity
3 - Liquid thermal conductivity
4 - Liquid viscosity
5 - Solubility in water
6 - Saturated vapor pressure
7 - Saturated vapor density
8 - Ideal gas heat capacity

Other CHRIS components

Also part of CHRIS is the Hazard Assessment Computer System, which contains the programs necessary to calculate spill effects. These programs are only available on a VAX computer.

Manual 3, containing a noncomputerized version of the Hazard Assessment Computer System, is out of print.

Manual 4 is a compilation of spill response resources which is out of date, and out of print.

Obtaining CHRIS

Copies of CHRIS may be ordered from:
Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402
Telephone: (202) 783-3238

As of yet, there are no prices or numbers assigned. Manual 2 is available on magnetic tape and floppy disk.

For additional information and corrections, contact:

Commandant (G-MTH-1)
Coast Guard Headquarters
2100 Second St., S.W.
Washington, D.C. 20593-0001
Fax: (202) 267-4816

Dr. Alan L. Schneider is a chemical engineer with the Hazard Evaluation Section of the Hazardous Materials Branch.
Telephone: (202) 267-1577.

Help us make the rules

By Mr. Emmanuel P. Pfersich

You can get involved in formulating regulations and international standards. Interested members of the public, as well as of the transportation industry are welcome to help develop regulations and standards for transporting and handling hazardous materials both domestically and internationally. In fact, your participation is encouraged to ensure that the issues are fully explored from the perspectives of all interested parties, thus arriving at the best solutions.

Regulations

Two administrations in the Department of Transportation share the responsibility for the safe transportation of hazardous materials by water: the Coast Guard, and the Research and Special Programs Administration (RSPA), in particular, the Office of the Associate Administrator for Hazardous Materials Safety.

The Coast Guard is responsible for regulations governing bulk transportation of hazardous liquids, liquefied gases and solids by tankships, tank barges and bulk carriers. These regulations are found in 46 CFR subchapters N and O.

RSPA develops the regulations covering packaged hazardous materials, which are found in 49 CFR subchapter C. "Packages" include bags, boxes, drums, portable tanks, rail cars and highway vehicles, to name a few.

The Coast Guard works closely with RSPA in developing the special regulations for water transport of packaged hazardous materials, and has primary enforcement responsibility.

Domestic involvement

Typically, the publication of a notice of proposed rulemaking and, in some cases, an advance notice of proposed rulemaking in the *Federal Register* notifies all interested parties and gives them the chance to submit comments. In some cases, the Coast Guard conducts public forums on issues. Advance notice of such meetings is given in the *Federal Register*.

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A tug, pleasure craft and the parcel tanker Lisa D are normal New York Harbor traffic. *Photo by LT Tom Butler, USCGR.*

You are encouraged to get involved in this rulemaking process.

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Any member of the public may petition or make recommendations to the Coast Guard or RSPA with regard to issuing new regulations, or amending or repealing existing ones. However, it is preferable to be involved up front when you can be heard before a regulation is issued.

International standards

Internationally, there are four primary bodies involved in regulations for the transport of packaged and bulk hazardous materials by water. They are IMO's subcommittees on bulk chemicals, on the carriage of dangerous goods, and on containers and cargoes, plus the United Nations (UN) Committee of Experts on the Transport of Dangerous Goods.

The Subcommittee on Bulk Chemicals is responsible for codes covering the transport of bulk chemicals and liquefied gases. These include the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, and the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.

The Subcommittee on the Carriage of Dangerous Goods is in charge of rules governing the maritime transport of packaged hazardous materials, and develops the International Maritime Dangerous Goods (IMDG) Code.

The Subcommittee on Containers and Cargoes develops the IMO Code of Safe Practice for Solid Bulk Cargoes.

The committee of experts develops the UN Recommendations on the Transport of Dangerous Goods, known as the orange book. This standard forms the basis for the various specific requirements, such as the IMDG Code.

International involvement

The Coast Guard heads United States delegations to the three IMO subcommittees, while RSPA's Office of the Associate Administrator for Hazardous Materials Safety heads United States delegations to the UN committee, upon which there is a Coast Guard advisor.

With some variation, the IMO subcommittees meet once a year, while the UN committee and/or its subcommittee meets twice a year.

Knowledge about the work of these committees and involvement in the formation of United States positions are extremely important. More and more international standards are precursors of domestic regulations.

The principal avenues for public involvement in the preparation of United States positions on the IMO subcommittees are Safety Of Life At Sea (SOLAS) working groups. They operate under the Department of State's Shipping Coordinating Committee. There is a working group supporting the work of the United States in preparation for meetings of each subcommittee. Issues before the respective subcommittees are discussed and proposed United States positions are presented for comment at working group meetings.

Meetings of these groups are announced in the *Federal Register* at least 30 days in advance. They are all open to the public and welcome attendance. In addition, SOLAS working group chairpersons at Coast Guard headquarters maintain mailing lists of members of each group and notify them of meetings.

Similarly, RSPA's Office of the Associate Administrator for Hazardous Materials Safety announces public forums preparing for meetings of the UN Committee of Experts on the Transport of Dangerous Goods in the *Federal Register*. These forums are also posted on the Hazardous Materials Information Exchange, a computerized bulletin board managed by RSPA and the Federal Emergency Management Agency.

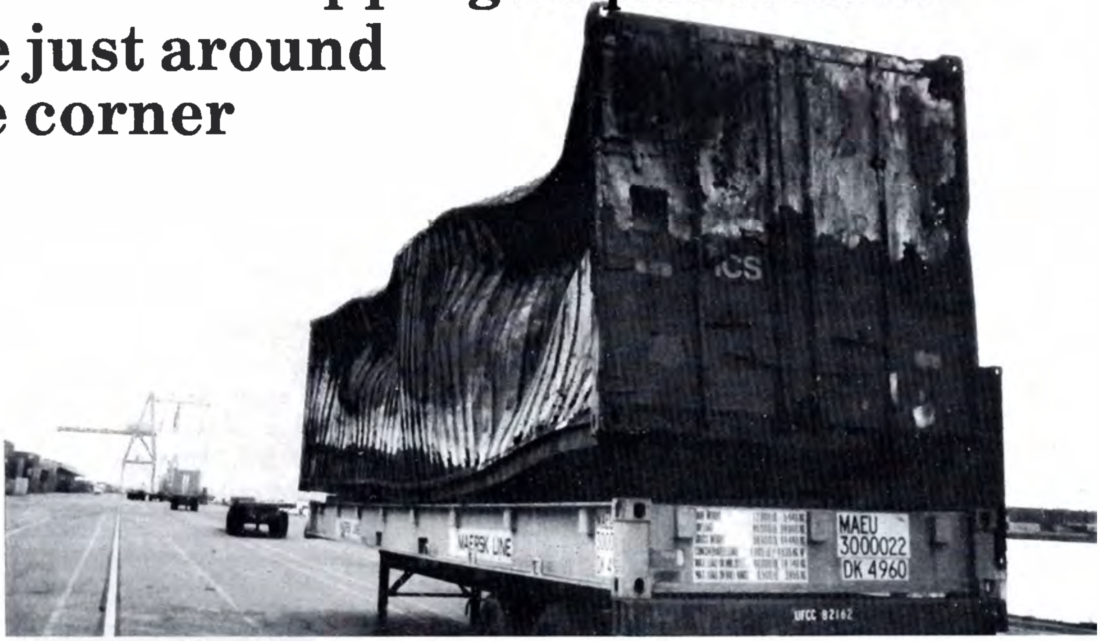
Get involved

Anyone interested in helping to formulate United States regulations and international standards is encouraged to take advantage of these opportunities and get involved. Contact the Hazardous Materials Branch at (202) 267-1577 for further information.

Mr. Emmanuel P. Pfersich is chief of the Packaged Cargo Section of the Hazardous Materials Branch.

Telephone: (202) 267-1577.

Universal shipping requirements are just around the corner



By LCDR Phillip C. Olenik

It may seem like an eternity away, but 1995 is really right around the corner. This is when all modes of transportation are adopting a uniform system for carrying dangerous goods. Specialized requirements will be kept to a minimum.

This universal system should result in facilitated trade, increased regulatory compliance, and a safer transportation and storage environment throughout the world.

IMDG Code

The most familiar publication for water transportation is the *International Maritime Dangerous Goods (IMDG) Code*. The *United Nations Recommendations on the Transport of Dangerous Goods*, developed by the United Nations Committee of Experts on the Transport of Dangerous Goods form the basis for the *IMDG Code*. These recommendations also influence the United States domestic hazardous materials regulations (49 CFR parts 170-180).

Amendment 27, the next scheduled amendment to the *IMDG Code*, will be consistent with provisions of the *United Nations Recommendations on the Transport of Dangerous Goods*. Amendment 27 is on the way, moving full speed, and should be at the dock, effective January 1, 1995.

Following are a few highlights.

Motor vehicles

Included are vehicles (or other mechanical equipment such as automobiles, motorcycles, trucks, tractors, towmotors, aircraft, helicopters, boats and generators) powered by internal combustion engines when carried as cargo, if the engine or fuel tank contains class 3 flammable liquid fuel or if either battery cable is connected.

Elementary rules for such transport have been on the books in the United States for years. An extensive accident record helped generate effort to bring similar controls to the *IMDG Code*. After years of deliberations, there will be a new *IMDG Code* schedule outlining the conditions of cargo transport. Such equipment will be shipped as **ENGINES, INTERNAL COMBUSTION, UN 3166, Class 9**.

Fumigated freight containers

A new Class 9 entry will address closed transport units loaded with cargoes under fumigation. The principal hazard is either poisonous or asphyxiant gases inside the units. These gases evolve from solid or liquid preparations distributed within the closed cargo transport unit. It can be dangerous for unsuspecting personnel who enter a unit before the gases have dissipated.

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The new schedule will rely primarily on the IMO-ILO *Guidelines for Packing Cargo in Freight Containers or Vehicles*, as well as the *Recommendations on the Safe Use of Pesticides in Ships*. Both of these guidelines are found in the *IMDG Code Supplement*.

The ship's master will be informed of the nature of the cargo before loading. Also, a warning sign displaying the name of the fumigant, and the date and time of fumigation will be posted on the doors. The proper shipping name is **CARGO TRANSPORT UNIT UNDER FUMIGATION**.

Elevated temperature liquids/solids

Three new schedules have been produced to accommodate hazards associated with:

> **Elevated temperature liquid, flammable**, N.O.S., with flashpoint above 61°C, at or above its flashpoint, UN 3256, Class 3.3.
>
> **Elevated temperature liquid**, N.O.S. at or above 100°C and below its flashpoint, UN 3257, Class 9.
>
> **Elevated temperature solid**, N.O.S. at or above 240°C and below its flashpoint, UN 3258, Class 9.

The first entry is based on the fact that any liquid transported at or above its flashpoint performs as a flammable liquid when in contact with an ignition source. While the upper limit of 61°C for flammable liquids addresses most scenarios, some liquids with higher flashpoints are heated and are above their flashpoints.

The other entries pick up the hazards caused by high heat. A new red mark has been created to accentuate the danger associated with high temperature materials. This red mark will consist of a partially filled thermometer inside a triangular border.

Marine pollutants

Marine pollutants are determined by hazard profiles assigned by the Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP). To accommodate new or changed hazard profiles, and give industry and governments maximum flexibility, new language is introduced into section 23 of the general introduction as follows:

> 23.1.1 When a substance, material or article is suspected to possess properties that may meet the definition of a marine pollutant or severe marine pollutant, but is not identified in this code, such substance, material or article may be transported as a marine pollutant or severe marine pollutant in accordance with this section. All relevant data should be submitted to GESAMP as appropriate.
>
> 23.1.3 With the approval of the competent authority, substances, materials or articles that are identified as marine pollutants in this code, but which, on the basis of a revised GESAMP hazard profile no longer meet the criteria for designation as a marine pollutant or severe marine pollutant, need not be transported in accordance with the provisions of this code applicable to marine pollutants.

This new language will offer some administrative relief during the period between when GESAMP hazard profiles are revised and when changes are made to the *IMDG Code*.

Limited quantities

Section 18 of the general introduction to the *IMDG Code* deals with limited quantities. These provisions are among the most widely used, since most dangerous goods that are packaged and distributed for purposes of personal care or for household use fall into this category, such as paint, nail polish remover and cleaning products.

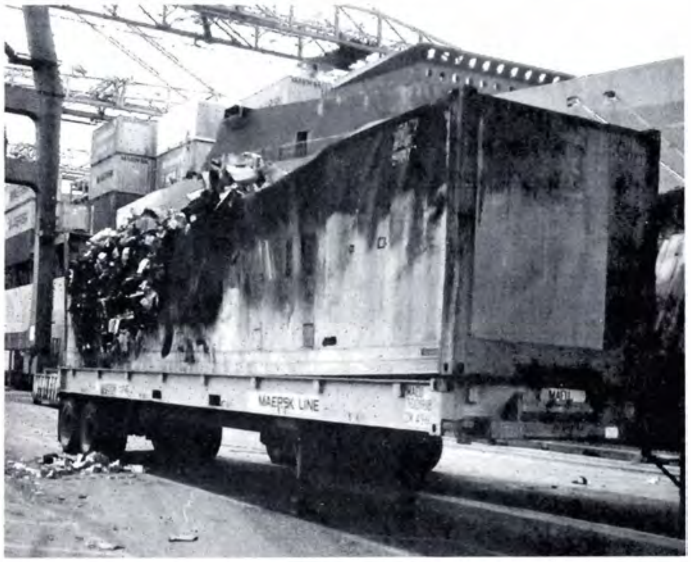
The limited quantity requirements have been rewritten to further clarify the existing language. Also, provision has been made for limited quantities in Class 9, including marine pollutants.

Portable tanks

Amendments to section 13 of the general introduction to the *IMDG Code* have been adopted. These amendments cover the transport of solid dangerous substances in tanks. These include molten substances in solidified form and the transport of dangerous substances under heated conditions.

Also, there are many new entries on the list of substances suitable for carriage in portable tanks and road tank vehicles.

Universal regulations should help to prevent cargo disasters like these from occurring.



Entry into enclosed spaces

A new section 28 to the general introduction has been incorporated. This section will advise users of the *IMDG Code* about personnel hazards on board vessels in enclosed spaces. Oxygen depleted atmospheres and the presence of poisonous gases and vapors are work hazards of which all aboard should be acutely aware.

Summary

These are only a few highlights of the broad spectrum of things to come for vessel transport. Since our domestic rules have been recently changed to allow transportation under the *IMDG Code* in most cases, the significance of the provisions of Amendment 27 is greater than ever before.

Work at IMO continues on such issues as ship's stores of a hazardous nature; the revision of the *Recommendations on the Safe Transport, Handling and Storage of Dangerous Substances in Port Areas*; Regulations II-2/53 and 54 of the International Convention for the Safety of Life at Sea (SOLAS); the role of the human element in maritime casualties; the use of radio beacons on containers and packages; stowage and segregation in open-top (hatchless) container ships; requirements for the safe carriage of irradiated nuclear fuel and many others.

These issues should be settled by 1997 - which, after all, is not far around the corner.

LCDR Phillip C. Olenik is a chemical engineer with the Packaged Cargo Section of the Hazardous Materials Branch.

Telephone: (202) 267-1577.

Explosives' regulations change

By LT Steven C. Hunt

On December 21, 1990, the Department of Transportation's (DOT's) Research and Special Programs Administration issued a final rule signaling a comprehensive change to the regulations for transporting all classes of packaged hazardous materials, especially concerning classification, communication, packaging and handling.

Known as "docket HM-181," this rule was developed partly to streamline the intermodal transportation of hazardous materials' process, domestically and internationally. The rule was based primarily on the United Nations' recommendations for the transport of dangerous goods.

Explosives (class 1 materials) were directly affected by the changes. Also, the distinction between the transport on water of military and commercial explosives was eliminated. Now one set of regulations governs both.

Commercial vs military

For nearly 20 years, the regulations for transporting military explosives by vessel were in 46 CFR part 146, while those for shipping commercial explosives were in 49 CFR part 176 (DOT's Hazardous Materials Regulations).

The preamble to a notice of proposed rulemaking under docket HM-204A issued in 1990 contained these observations: *"The existence of two essentially overlapping sets of regulations is of historical, rather than technical or legal origin . . . The regulations governing military explosives which remain in 46 CFR overlap and, in some areas, conflict with the explosives' regulations in the Hazardous Materials Regulations. . ."* and *"The existence of two sets of regulations, either of which could apply to the shipment of military explosives, cause shippers to be confused about which rules they must follow."*

On January 29, 1991, HM-204A was published as a final rule, revoking the regulations contained in 46 CFR part 146 on transporting military explosives by vessel, effective October 1, 1991. However, provisions of 49 CFR part 176 allowed a two-year transition period, during which time either the old or new regulations could be used.

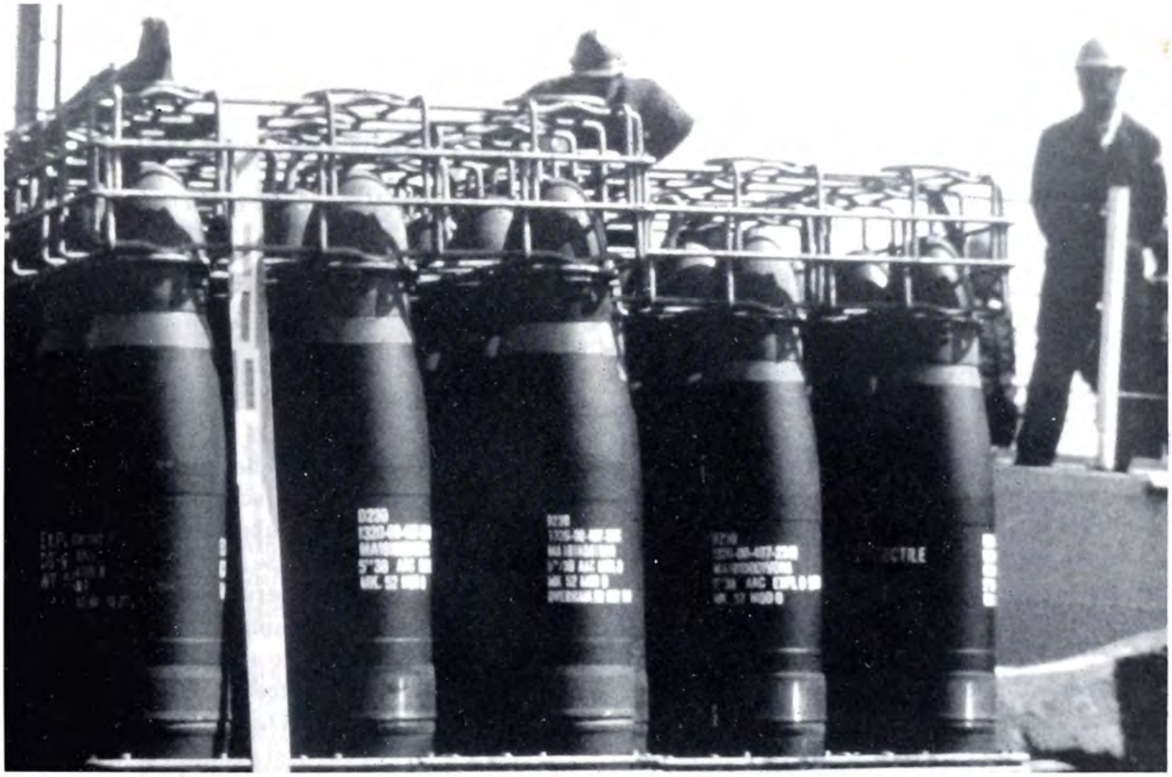
Certain requirements over classification of new explosive materials and other items were to take effect before the October 1, 1993 deadline.

Approvals

The need for special approval by the Coast Guard's Marine Technical and Hazardous Materials Division (G-MTH) for the transportation of explosives in freight containers, highway and railroad vehicles was also eliminated. Written permission from G-MTH is no longer needed as long as the containers comply with provisions in 49 CFR part 176 pertaining to their structural integrity. Certain other restrictions on handling and stowage also apply.

Container defects

A structurally serviceable container is one which has a current approval plate under the International Convention for Safe Containers. The container must not have any major defect in structural components, including top and bottom side and end rails, corner posts and fittings, door sill and header, and floor cross members.



Major freight container defects include:

- dents or bends in structural members greater than 19 mm (0.75-inch) in depth, regardless of length;
- cracks or breaks in structural members;
- more than one splice (repair of structural member replacing material, but not the entire member) or an improper splice (such as lapped material) in top or bottom end rails or door headers;
- more than two splices in any one top or bottom side rail;
- any splice in door sill or corner post;
- door hinges and hardware that are twisted, broken, missing or otherwise inoperative;
- gaskets or seals that do not seal; or
- any distortion of the overall configuration great enough to prevent proper alignment of handling equipment, mounting and securing chassis or vehicle, or insertion into ship's cells.

Any deterioration, such as rusted metal in sidewalls or disintegrated fiberglass is prohibited. However, normal wear, including small dents, scratches and surface rust, is acceptable.

In addition to standard documentation for the shipment of dangerous goods, the transport of class 1 materials (except those in division 1.4 or old class C) must have a statement certifying that the freight container is structurally serviceable.

Conclusion

On October 1, 1993, the transition period for optional use of the old regulations for explosives' transport expires, and the new rules apply Shipment of explosives in freight containers complying with the provisions in 49 CFR can continue without any special approval.

These changes should facilitate the safe transport of class 1 materials by eliminating duplicate requirements and special approvals.

LT Steven C. Hunt is a chemical engineer in the Packaged Cargo Section of the Hazardous Materials Branch.

Telephone: (202) 267-1577.

Two ways to test for benzene

By LCDR John C. Edgar

During benzene operations on vessels inspected by the Coast Guard, initial and periodic evaluation of the potential exposure to the chemical is required by 46 CFR 197. There are two basic methods used by industrial hygienists to measure benzene concentrations in the air.

The most common method is active sampling by a pump pulling a sample of air through a tube filled with activated charcoal. The charcoal is then sent to an analytical laboratory where the amount of benzene is measured and compared to the amount of air which moved through the tube. This will give the amount of benzene per volume of air.

The second method is passive sampling using a wafer impregnated with activated charcoal. The wafer is worn by a worker or placed in a location for a specified time, and then sent to a laboratory where the amount of benzene is measured and related to the time period of exposure to the environment. The volume of air that would have been diffused to the wafer is calculated through the exposure time. It is then possible to determine the amount of benzene per volume of air.

Both methods are usually reported in parts per million, and correspond to the benzene regulations.

Passive versus active

There have been several claims that passive sampling is not appropriate for high humidity environments or for short periods of time. In response to these claims, in 1989, the Coast Guard conducted a study comparing the two methods in a marine environment.

The results of the Coast Guard study demonstrated that each sampling method gives accurate evaluations of benzene exposures experienced by personnel in a marine environment. The passive method is much easier to use.

Other studies conducted in the 1980s by private industrial hygienists generally corroborate the findings of the Coast Guard analysis. Comparative studies between passive sampling for organic vapors and the traditional active method using charcoal tubes have generally given good results.

The wafers or badges used in passive sampling for solvent exposure have several advantages. Compared with personal sampling pumps with activated charcoal tubes, the passive devices are cheap, easy to use and maintenance-free. Coast Guard field personnel favor the devices over the active paraphernalia because of their light weight and the absence of encumbering tubes. Also, the reduced expense of eliminating personal pumps and technicians at the unit level allows for additional samples to be taken, increasing the statistical strength of the studies.

Double strategy

Conducting benzene tests in the marine environment may be best served by using a double sampling strategy with local personnel taking passive tests and the professional industrial hygienist using active methodology.

Although the passive method has not been found in error, it is not presently the accepted industrial standard. It is only acceptable if accompanied by corroborating results of the active method.

Therefore, using both active and passive methods will dispel any questions concerning the adequacy of the latter. However, either method fully complies with the benzene evaluation regulations.

"Conducting benzene tests . . .may be best served by using a double sampling strategy . . ."

LCDR John C. Edgar is a certified industrial hygienist with the Hazard Evaluation Section of the Hazardous Materials Branch. Telephone: (202) 267-1577.

Chemical of the month terminology

Replacing the usual chemical of the month are definitions of terms used to describe substances.

Acute -- Health effects which show up a short length of time after exposure.

Autoignition temperature -- The minimum temperature required to ignite gas or vapor without a spark or flame being present.

Boiling point -- The temperature at which a liquid or solid becomes a vapor.

CAS number -- The American Chemical Society's *"Chemical Abstracts Service Registry Number"* is unique to each chemical.

CHRIS Code -- The three-letter designation assigned to each entry in the Chemical Hazard Response Information System.

Chronic -- Health effects which show up a long time after exposure or after a long exposure.

Fire point -- The lowest temperature at which a liquid or solid produces sufficient vapor to flash near its surface and continue to burn.

Flammable limits (upper & lower) -- Ignition can occur between the minimum and maximum concentrations of a flammable gas or vapor. Concentrations below the lower flammable limit are too lean to burn, while concentrations above the upper flammable limit are too rich to burn. When a material is between its upper and lower limits, it can easily explode.

Flash point -- The lowest temperature at which a flammable or combustible liquid or solid gives off sufficient vapor to form an ignitable mixture with air near its surface. The material will flash at this point, but not continue to burn.

IMDG Code -- International Maritime Dangerous Goods Code published by the International Maritime Organization (IMO).

Melting point -- The temperature above which a solid becomes a liquid.

NFPA -- National Fire Protection Association.

Oxidizer -- A compound that releases oxygen during a chemical reaction or fire. The oxygen feeds the fire.

Permissible exposure limit (PEL) -- or the **threshold limit value (TLV)** refers to an airborne concentration of a product expressed in parts per million by volume in air. These are the **time-weighted average** concentrations believed to be safe for a normal person for prolonged periods.

pH -- The p (power of) H (hydrogen) is a measure of the degree of acidity or alkalinity. The pH scale ranges from 0 to 14. The lower the number, the stronger the acid, the higher the number, the more caustic the material.

Polymerization -- A chemical reaction in which heat is generated when two materials combine to form a third.

Solubility -- The percentage of a material by weight that will dissolve in water at room temperature.

Specific gravity -- The ratio of the weight of a substance to that of an equal volume of water, or the density of a substance compared to the density of water. The specific gravity of water is one. Materials with a specific gravity of less than one are lighter than water and will float. Those with over one are heavier than water and will sink.

Vapor density -- The weight of a vapor or gas compared to that of an equal volume of air. Air has a vapor density of one. Materials with a vapor density less than one are lighter than air, and materials with a density greater than one are heavier than air. Density affects whether a vapor will seek low areas or rise.

Vapor pressure -- The pressure a saturated vapor exerts above its own liquid. The lower a material's boiling point, the higher its vapor pressure, and the higher the vapor pressure, the greater the material's tendency to evaporate into the atmosphere.

The following items are examples of questions included in the third assistant engineer through chief engineer examinations and the third mate through master examinations.

ENGINEER

1. While operating a two-stage flash evaporator in sea water of 50°F and a salt water feed temperature of 170°F, the three-way solenoid valve trips, dumping the distillate pump discharge to the bilge. Which of the following is the probable cause for this?

A. Excessive and violent flashing in each stage.
B. Insufficient vacuum being developed as a result of the sea temperature.
C. Excessive amount of feedwater being supplied to the first stage.
D. Insufficient brine density being maintained in the second stage.

2. Coast Guard requires the temporary emergency electrical power source on a tank vessel of over 1600 GTs on a coastwise voyage to be able to supply power to each_____.

A. electrically controlled or powered ship's whistle
B. emergency loudspeaker system
C. smoke detector system
D. all of the above

3. Air leaks through the inner or outer casings of a boiler will_______________

A. improve fuel combustion
B. decrease stack temperatures
C. cause boiler panting
D. reduce boiler efficiency

4. Assigned emergency stations are found__.

A. on the ship's clearance papers
B. on the ship's permit to proceed
C. on the ship's certificate of inspection
D. on the ship's station bill

5. An explosion or flareback could occur in a boiler if _______________

A. too much excess air were supplied for combustion
B. the boiler firing rate exceeded the end point of circulation
C. the fuel being burned had been heated to the flash point
D. a firebox is not purged before attempting to light a fire

6. A cargo hold has a relative humidity of 80% and a dry bulb temperature of 85°F. When the hold is sealed and the dry bulb temperature decreases, the relative humidity in the space will _______________

A. decrease
B. increase
C. decrease to zero
D. remain unchanged

7. You should avoid excessive water flow in any heat exchanger to prevent__________.

A. erosive tube failure
B. waterside deposit buildup
C. tube sheet bowing
D. water hammer damage

8. The relief valve on the discharge side of the fuel oil service pump may discharge to the suction side of the pump or to the _____

A. fuel oil heater inlet
B. oil header return tank
C. double bottom fuel tank
D. fuel oil settling tank

9. If the steam pressure to the first effect of a distilling plant fluctuates, the distiller _____

A. capacity will also fluctuate
B. air ejector will operate erratically
C. water levels will automatically lower
D. brine density will increase

DECK

1. The reaction of a gyrocompass to an applied force is known as?

A. Precession.
B. Earth rate.
C. Gyroscopic inertia.
D. Gravity effect.

2. What is the spoken emergency signal for a "man overboard" on the VHF radio?

A. Man overboard.
B. Security.
C. Mayday.
D. Pan-pan.

3. A flag hoist 62.2 would be sent as pennant 6, pennant 2, ______________.

A. answering pennant, first substitute
B. answering pennant, second substitute
C. space, second substitute
D. answering pennant, third substitute

4. A vessel's light draft displacement is 7400 tons. The center of gravity at this draft is 21.5 ft. above the keel. These weights are loaded: Wt. #1-450 tons, VCG #1-17.4 ft.; Wt. #2-220 tons, VCG #2-11.6 ft.; Wt. #3-65 tons, VCG #3-7.0 ft. The CG above the keel is?

A. 14.7 feet.
B. 17.8 feet.
C. 18.7 feet.
D. 20.9 feet.

5. What is the geographic range of Mount Desert Light, Maine, if your height of eye is 24 feet?

A. 8.7 miles.
B. 9.9 miles.
C. 14.4 miles.
D. 15.5 miles.

6. The proximity of pack ice may be indicated by ______________.

A. changes in seawater salinity
B. glare on clouds on the horizon
C. changes in air temperature
D. icebergs

7. On vessels equipped with electric power-operated lifeboat winches, the master must see that such winches and associated equipment are examined at least once in each period of ______________.

A. two months
B. three months
C. four months
D. five months

8. The dividing meridian between zone descriptions +7 and +8 is ______________

A. 105° W
B. 112°30' W
C. 117° W
D. 120°30' W

9. Which of the following statements describes the primary process by which fires are extinguished by dry chemical?

A. The stream of dry chemical powder cools the fire.
B. The dry chemical powder attacks the fuel and oxygen chain reaction.
C. The powder forms a solid coating over the surface.
D. The dry chemical smothers the fire.

10. BOTH INTERNATIONAL AND INLAND: A vessel which is towing and showing three forward white masthead lights in a vertical line is indicating that the length of the ______.

A. towing vessel is less than 50 meters
B. towing vessel is greater than 50 meters
C. tow is less than 200 meters
D. tow is greater than 200 meters

ANSWERS

Engineer

1-A, 2-D, 3-D, 4-D, 5-D, 6-B, 7-A, 8-D, 9-A.

Deck

1-A, 2-D, 3-B, 4-D, 5-D, 6-B, 7-B, 8-B, 9-B, 10-D.

If you have any questions concerning "Nautical Queries," please contact U.S. Coast Guard (G-MVP-5), 2100 Second St., S.W., Washington, D.C. 20593-0001. Telephone: (202) 267-2705.

Final rule

CGD 87-094, Subdivision and damage stability of dry cargo vessels (46 CFR part 174) RIN 2115-AC87 (April 1).

These regulations require new dry cargo ships of 500 gross tons or more, calculated in accordance with the International Convention on Tonnage Measurement of Ships, 1969, to meet a minimum standard of subdivision and damage stability. These regulations implement an international standard developed to ensure that a ship can sustain limited damage without loss.

Effective date: May 3, 1993.

Addresses: Unless otherwise indicated, documents referenced in this preamble are available for inspection/copying at the office of executive secretary, Marine Safety Council (G-LRA/3406), Coast Guard headquarters, 2100 Second Street, S.W., room 3406, Washington, D.C. 20593-0001, between 8 a.m. and 3 p.m. Monday through Friday, except federal holidays. The telephone number is (202) 267-1477.

For further information, contact: LT Robert Holzman, Office of Marine Safety, Security and Environmental Protection at (202) 267-2988.

Interim final rule

CGD 91-228, Class II civil penalties under the Federal Water Pollution Control Act and Comprehensive Environmental Responses, Compensation and Liability Act (33 CFR part 20) RIN 2115-AE39 (April 6).

The Coast Guard is issuing an interim final rule addressing practice and procedure for cases assessing class II civil penalties under section 311(b) of the Federal Water Pollution Control Act (FWPCA), as amended by the Oil Pollution act of 1990 (OPA 90), and section 109 of the Comprehensive Environmental Response, Compensation and Liability Act. The Coast Guard is issuing the regulations to make available the enhanced enforcement capabilities provided by the OPA 90 amendments to FWPCA. All class II penalties will be assessed following notice and opportunity to be heard in proceedings that meet the requirements of the Administrative Procedures Act. In addition, with regard to FWPCA, this rule provides for public notice of a class II civil penalty action and an opportunity for interested persons to comment on the proposed civil penalty, to present evidence at a hearing and to seek a hearing if none is scheduled. To the extent discussed in the preamble, these rules will apply to the assessment of class II penalties during the public comment period.

Dates: The interim final rule was effective on April 6, 1993. Comments must have been received by June 7, 1993.

The executive secretary maintains the public docket for this rulemaking. Comments are part of this docket and are available for inspection or copying at room 3406, Coast Guard headquarters.

For further information, contact: Ms. Pamela M. Pelcovits, OPA 90 staff at (202) 267-6823.

Addresses: Unless otherwise indicated, documents referenced in this preamble are available for inspection/copying at the office of executive secretary, Marine Safety Council (G-LRA/3406), Coast Guard headquarters, 8 a.m. to 3 p.m. Monday through Friday, except federal holidays. The telephone number is (202) 267-1477.

For further information, contact: LT Jonathon C. Burton, project manager, Marine Environmental Protection Division (G-MEP-1), The telephone number is (202) 267-6714.

Advanced notice of proposed rulemaking

CGD 91-202a, Escort requirements for vessels in the navigable waters of the United States (33 CFR part 168) RIN 2115-AE10 (April 27).

The Coast Guard seeks comment on where an escort should be required for vessels navigating in the waters of the United States, and which vessels should be required to comply with an escort rule. Recommendations are also sought on what the escort vessel should be expected to do.

Date: Comments must have been received by June 28, 1993.

The executive secretary maintains the public docket for this rulemaking. Comments are part of this docket and are available for inspection or copying at room 3406, Coast Guard headquarters.

For further information, contact: CAPT Gerald T. Willis, project manager, Oil Pollution Act (OPA 90) staff. Telephone: (202) 267-6732.

Notice of proposed rulemaking

CGD 92-71, Recordkeeping of refuse discharges from ships (33 CFR part 151) RIN 2115-AE17 (May 20).

The Coast Guard proposes to require that all manned, oceangoing United States vessels 40 feet or more in length engaged in commerce and all manned fixed or floating platforms keep records of garbage discharges and disposals. Regulations specifying the vessels and platforms required to maintain these records are mandated by statute. The use of shipboard garbage discharge and disposal records would promote compliance, facilitate enforcement, and reduce the amount of plastics discharged into the marine environment.

Date: Comments must be received by July 6.

Addresses: Comments may be mailed to the executive secretary, Marine Safety Council (G-LRA/3406), Coast Guard headquarters, or may be delivered to room 3406 between 8 a.m. and 3 p.m., Monday through Friday, except federal holidays, (202) 267-1477. Comments on collection of information must be mailed also to the Office of Management and Budget, 725 17th St., N.W., Washington, D.C. 20503. ATTN: Coast Guard desk officer.

For further information, contact: LTJG Claudia Gelzer, G-MEP, (202) 267-6714.

Final rule

CGD 84-068, Personal flotation device components (46 CFR parts 159, 160 and 164) RIN 2115-AB70 (May 20).

This final rule establishes procedures for obtaining Coast Guard acceptance of non-standard components, requirements for oversight of non-standard components, self-certification requirements for standard components and production quality control requirements for all components used in the manufacture of Coast Guard-approved personal flotation devices (PFDs). This rule also prohibits the use of cotton thread as a PFD component, designates specific nylon and polyester threads as standard components, and adds new performance requirements for non-standard thread.

Effective date: November 16, 1993.

For further information, contact: ENS Jerry Johnson, G-MVI-3, (202) 267-1444.

Notice of proposed rulemaking

CGD 88-079c, Immersion suits for documented and undocumented commercial fishing industry vessels operating on coastal waters that are only seasonally cold (46 CFR part 28) RIN 2115-AD12 (May 20).

The Coast Guard is proposing a regulation to require the carriage of immersion suits for each individual on board undocumented commercial fishing industry vessels operating on coastal waters which are only seasonally cold; and documented commercial fishing industry vessels operating inside the boundary line on coastal waters which are only seasonally cold. This regulation aims to improve the overall safety of commercial fishing industry vessels.

Date: Comments must be received by Aug. 18.

Addresses: Comments may be mailed to the executive secretary, Marine Safety Council (G-LRA/3406), Coast Guard headquarters.

For further information, contact: LCDR Tim Skuby, G-MVI-4, room 1405, Coast Guard headquarters, (202) 267-2307.

Introducing...
The Chemical Transportation Advisory Committee

By CDR Kevin J. Eldridge

The Chemical Transportation Advisory Committee (CTAC) was chartered to provide advice and consultation to the Coast Guard's Office of Marine Safety, Security and Environmental Protection on issues concerning the water transportation of hazardous materials in bulk.

Formerly known as the Chemical Transportation Industry Advisory Committee, CTAC has been in existence since 1972, except for a brief hiatus in the early 1980s, when many advisory committees were discontinued by executive order. Reestablished in 1986, the committee is a key partner in the Coast Guard's efforts to ensure safe transportation of bulk hazardous materials by water, as well as maintain open communication with the chemical transportation industry.

Membership

There are 25 regular members of CTAC appointed by the commandant of the Coast Guard, subject to the approval of the secretary of the Department of Transportation. The members have been drawn from the broad population -- maritime transportation industry (chemical shippers, carrier owners/operators, producers and health professionals), academia, government agencies and the general public.

A committee member serves for a three-year term or until a replacement is appointed. Membership terms are staggered with approximately one-third expiring each year. The current CTAC committee consists of members representing the following:

- **seven** from the chemical barge industry;
- **three** from the chemical tankship industry;
- **four** from chemical shipping and production industries;
- **three** from industrial hygiene, occupational safety and health fields;
- **five** from maritime transportation fields;
- **one** from port authorities, and
- **one** from academia.

The selection of members is influenced by projects on the agenda and planned for the future. To provide for a healthy turnover without disrupting continuity, not more than half the members with expiring terms may be reappointed. CTAC members serve without compensation (no travel nor per diem).

Meetings

Committee meetings are held at least once a year. Recently, however, CTAC has been meeting twice a year, in August and in February. Much work is delegated to subcommittees formed to address specific issues. They meet as often as necessary.

All committee and subcommittee meetings are open to the public and are announced in the *Federal Register*. They are held at Coast Guard headquarters in Washington, D.C. However, regional issues have dictated that some subcommittee meetings be held outside of Washington. Minutes are mailed to all members and meeting attendees.

Issues and assignments

Over the years, CTAC has provided invaluable advice to the Coast Guard on many hazardous materials' transportation issues. The committee has also played a key role in developing transportation safety regulations, as well as in forming United States positions taken at meetings of IMO's Subcommittee on Bulk Chemicals.

The work to be undertaken by the committee is determined through a formal assignment process. Issues that need attention are often identified by the Coast Guard or by members during CTAC meetings. Subsequently, a formal statement of the work that needs to be done is drafted by the Coast Guard and submitted to the committee for acceptance or rejection. Once accepted, subcommittees are formed and completion deadlines established.

CTAC has tackled some major assignments over the years, providing the Coast Guard with outstanding results that have facilitated the regulatory process.

Recent significant accomplishments include:

- Assistance in the development of the Coast Guard's vapor control system regulations published in 1990. An ambitious deadline to have the regulations out in time to coincide with the Clean Air Act Amendments of 1990 was met because of hundreds of work hours put in by the CTAC Vapor Control Subcommittee. This work was also used by the Coast Guard to successfully negotiate international standards for vapor control systems at IMO that parallel United States regulations.

- A report completed by CTAC's Subcommittee on Coal Transport was used as the basis for a paper submitted to IMO which was used to amend its Code of Safe Practice for Solid Bulk Cargoes. The subcommittee's report is also being used to revise United States regulations for the carriage of coal.

- Recommendations of the Subcommittee on Marine Occupational Safety and Health were used by the Coast Guard to develop a comprehensive Navigation and Vessel Inspection Circular on industrial hygiene program guidelines for marine personnel.

- A report by the Subcommittee on Tank Filling Limits formed the basis for the United States position at IMO. The subcommittee's invaluable technical expertise allowed the Coast Guard to successfully derail a move to relax the limits beyond what had been considered safe.

Present and future CTAC projects include:

- A complete review and update of 46 CFR part 151, chemical tank barge regulations is scheduled for completion this fall.

- A review of the Chemical Compatibility Chart (46 CFR part 150), considering new data. The potential for a formal CTAC statement will be discussed at the 1993 fall meeting.

- Reconvening of the Marine Occupational Safety and Health Subcommittee to evaluate the need to lower the benzene volumetric concentration level to meet provisions of the benzene marine occupational safety and health standard in 46 CFR part 197. The subcommittee will also consider establishing similar standards for other hazardous chemicals carried in bulk. The potential for a formal statement will be discussed at the fall meeting.

- A review of the impact of the Oil Pollution act of 1990, in particular, the requirement for vessel response plans for chemical carriers. This will be discussed at the 1993 fall meeting.

Conclusion

The Coast Guard is a major international and domestic player in ensuring the safe transportation of hazardous materials by water. All its standards and regulations are developed in close partnership with the industry and the general public.

CTAC provides a vital forum for the discussion of many initiatives that affect the maritime industry and overall public safety. Over the years, the committee has not only provided expert advice, but has also completed much of the developmental work itself. This has been crucial in assisting the Coast Guard to meet many marine safety goals.

CDR Kevin J. Eldridge is the executive director of CTAC and the chief of the Hazardous Materials Branch.

Telephone: (202) 267-1217.

Getting the bugs out . . .
interim fumigation regulations

By Mr. Frank K. Thompson

In 1974, the Coast Guard published interim regulations for shipboard fumigation (46 CFR part 147A). The intention was to issue regulations in a final form after sufficient experience with the interim requirements. After nearly 18 years, the regulations are still "interim."

Background

In 1973, in New Orleans, two individuals were killed and six others injured by residual fumigant gases in a grain hold. This and other serious incidents emphasized the need for stiffer regulations concerning the carriage of grain under fumigation. At the time, the only rules governing fumigants on shipboard were the ships stores regulations (46 CFR part 147), which merely required Coast Guard certification of the fumigant product.

Fumigants

Vessel cargo holds and other storage areas for grains and similar vegetable products must be treated with toxic materials (fumigants) to kill any insects. Fumigants are applied as liquids or solids, which release toxic gases when in contact with the atmosphere.

Probably the most common fumigant now in use is aluminum phosphide, a solid which releases phosphine gas (hydrogen phosphide). It is a very effective insecticide, but extremely poisonous to humans and flammable at certain concentrations.

Phosphine is a colorless gas with a "fishy" or "garlic" odor. Its permissible exposure limit is 0.3 ppm. Marketed under such trade names as Phostoxin, and Fumitoxin, aluminum phosphide is safe and effective when used with caution according to the manufacturer's instructions.

Other regulations

Other federal agencies that regulate fumigation include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA) of the Department of Labor, the Research and Special Programs Administration of the Department of Transportation and the Federal Grain Inspection Service of the Department of Agriculture.

EPA regulations and classification of pesticides, certification of commercial pesticide applicators, packaging and labeling, and the safe disposal of residues are contained in 40 CFR chapter 1, subchapter E.

OSHA regulations (29 CFR part 1917.25) are intended to protect those persons who are engaged in long-shoring and related operations in and around marine terminals from exposure to toxic fumigants.

The Research and Special Programs Administration requires freight containers containing fumigated cargo to be placarded with warning signs under 49 CFR part 173.9(b).

Federal Grain Inspection Service regulations refer to fumigation of pest-infested grain, but have no safety requirements. The agency has issued a handbook providing grain inspectors with policy and procedures for vessel fumigation while in transit.

However, none of these agencies address fumigation procedures on vessels or the protection of shipboard personnel from exposure to toxic fumigants.

Coast Guard requirements

The interim regulations require that both the fumigator and the vessel operator each designate a "person in charge" for each fumigation operation. These two individuals have specific duties and must keep fumigators and vessel personnel informed of all their activities.

The regulations also refer to a "qualified person," with experience in or knowledge of a particular fumigant, detection equipment and shipboard procedures; or an EPA-certified applicator.

It is implied that the person in charge of fumigation is a supervisor and the qualified person, an employee of the insecticide company. The person in charge of the vessel may be the master or other person designed by the operator.

Before fumigation, a marine chemist or other qualified person must evaluate the vessel's

"If any danger is determined to exist, all measures necessary to protect those on board must be taken."

construction to determine safe spaces for human occupancy during the operations and how often such spaces are to be inspected by the person in charge of fumigation. The marine chemist should be certified by the National Fire Protection Association [46 CFR part 91.50-1(c)].

Procedures

Before applying the chemicals, the vessel operator must notify the Captain of the Port when and where this will take place. The person in charge of fumigation must inform the person in charge of the vessel of the spaces to be sprayed, the characteristics of the chemicals and the vessel spaces which are safe for occupancy during the operation.

The fumigator must be sure that all spaces to be sprayed are properly sealed to prevent leakage and that warning signs and observers are posted at the entrances to these spaces. Warning signs must comply with instructions in 49 CFR part 173.9(c), instead of National Fire Protection Association standards.

In port

A qualified person must monitor the vessel while fumigated in port to ensure that operations are confined to designated spaces. If any leakage is detected, the person in charge of fumigation must inform the individual in charge of the vessel, and ensure the necessary precautions are taken to protect the health and safety of all.

When the operations are completed, fumigated spaces must be properly ventilated and vessel personnel notified that these spaces are safe to enter. If any leakage is detected, the vessel may not leave port until there is no danger.

In transit

If fumigation is conducted on a vessel underway, a qualified person must monitor the entire operation. When over, the spaces must be properly ventilated and tested to determine that there is no danger to health or safety. All personnel involved in the operation must be issued appropriate protective clothing and equipment, along with fumigation detection devices. If any danger is determined to exist, all measures necessary to protect those on board must be taken.

Applicability

The interim regulations apply to all vessels covered by hazardous materials requirements of the Research and Special Programs Administration (49 CFR part 176.5). This includes all domestic and foreign vessels in navigable United States waters, including barges. Exempted are vessels operated by the United States government and foreign vessels crossing our territorial waters without entering United States ports.

Special permits

Since the interim regulations do not contain waivers or exemption provisions, the Coast Guard issues special permits (No. 2-75) relieving operators of unmanned barges of many of the requirements. Currently, 22 companies have these special permits, which may be granted to fumigators, vessel operators or shippers. Requests for these permits may be addressed to the Hazardous Materials Branch, Marine Technical and Hazardous Materials Division (G-MTH-1).

Freight containers

The Coast Guard issues another special permit (No. 52-75) for shipboard fumigation of freight containers, which is also not addressed in the interim regulations. Persons planning to ship freight containers with fumigated cargo should contact G-MTH-1 for the requirements.

Conclusion

The Coast Guard is planning to go ahead and develop regulations on shipboard fumigation. Anyone interested in submitting observations, recommendations or other comments on the subject should contact G-MTH-1.

Mr. Frank K. Thompson is a chemical engineer with the Hazard Evaluation Section of the Hazardous Materials Branch.
Telephone: (202) 267-1577.

Safety center salvage team gathers momentum

By LCDRs William Diehl and Frank Paskewich

Background

In recent years, the Marine Safety Center has played a vital role in salvage operations following marine casualties. Safety center engineers were on hand advising salvage workers after the *Exxon Valdez* oil spill in Prince William Sound, Alaska, in March 1989; the *Mega Borg* explosion in the Gulf of Mexico in June 1990; and the burning and sinking of the *Jupiter* on Michigan's Saginaw River in September 1990. The engineers provided the Captains of the Port (COTPs) with technical advice on various salvage proposals by evaluating important stability and structural issues.

It became evident from these incidents that there was a definite need in the field for quick access to critical technical information after a casualty. Thus, the Marine Safety Center Salvage Team was established in 1990 as a source of technical advice on vessel mishaps.

With the center's vast experience in vessel stability and structures as a resource, team members could provide sound advice on such typical questions as:

- How hard aground is the stranded vessel?
- Will the vessel be stable after salvage?
- What is the best way to unload the vessel without incurring further structural damage?
- How much oil has spilled?

Salvage team

Six to eight staff engineers from the Hull and Cargo Divisions of the safety center comprise the salvage team. Presently, there are six naval architects and a chemical engineer, all of whom have masters degrees and are proficient with computers. Most are licensed professional engineers with extensive shipboard and/or marine inspection expertise.

Once the team is activated, one member assumes the role of lead technical advisor and either goes on scene at the request of the COTP or becomes the point of contact within the Marine Safety Center.

The supporting team members track down vessel plans, contact owners and classification societies for information, enter hull forms and structural data into the computer, and load the unit's laptop with pertinent information for the team leader to take on scene.

With such assistance, the lead advisor is able to focus on the particulars of the casualty, provide immediate support to the COTP and minimize analytical response time.

Computer capabilities

To accurately assess the effects of flooding, stranding or structural damage, the salvage team uses a computer program that can rapidly run preliminary conditions based on dimensions of similar vessels, in the event data on the vessel involved is not available.

The team has access to a database of some 4000 vessel hull forms from which to choose. Thus, in the event of a casualty, there is an excellent chance that an exact hull model is available. If not, it is easy to obtain a close match. This flexibility comes in handy when dealing with foreign-flag vessels, which are often difficult to track down. Once the detailed model is entered, the program can provide very accurate assessments of the vessel's condition, including:

- ground reaction and its effects on stability and hull strength;
- longitudinal strength degradation based on the extent of hull damage;
- evaluation of weight changes and tidal effects aboard the vessel;
- oil outflow calculations; and

Stability was a problem while fighting the fire on the tankship Mega Borg.

Structural failure became a concern when refloating the Jupiter.

- comparisons of a damaged ship's stability characteristics to United States and international standards.

This computer program allows the team to quickly evaluate ramifications of a salvage operation prior to carrying it out.

Another great asset of the program is its ability to translate difficult naval architecture concepts into understandable graphics. This makes weighing various salvage proposals and making rapid informed decisions much easier.

Team experience

In addition to assisting salvage efforts of the three major casualties mentioned earlier, the team helped the Marine Safety Office Providence salvage the grounded container ship *MSC Chiara* off Buzzards Bay in February 1993. During the next month, the team assisted COTP Long Island with the tankship *Anthony J* which had grounded off Long Island Sound.

The salvage team has also participated in numerous drills, including the United States-Mexico Joint Response Team Pollution Simulation Drill held in San Diego in December 1992. The salvage capabilities were demonstrated effectively and were well received by industry and government agencies involved.

Conclusion

The Coast Guard is continually upgrading its response efforts during and after pollution incidents or vessel casualties. The salvage team is a major step in this process - a valuable tool for the COTP when evaluating salvage techniques to stranded vessels or other marine mishaps.

To contact the salvage team, call the Marine Safety Center during work hours at (202) 366-6480, or off hours at (202) 267-2100.

LCDR William Diehl and LCDR Frank Paskewich are naval architects and marine engineers in the Machinery and Cargo Divisions of the Marine Safety Center, 400 7th Street, S.W., Washington, D.C. 20590-0001.

Telephone: (202) 366-6441.

HAZSTRIKE '93 - success through teamwork

By LTJG Stephen Schroeder

Coast Guard inspector verifies placement of flammables against vessel stowage plan.

It is estimated that nearly 75,000 freight containers of hazardous materials are moved through West Coast ports to and from Asia every year. That is roughly equivalent to 100 fully loaded modern container ships.

HAZSTRIKE '93 was a three-day, multi-agency task force conducted in early March 1993 in the San Francisco Bay area of California. It involved 75 individuals representing all the agencies that regulate hazardous materials' shipping in the state.

The agencies included the Bureau of Alcohol, Tobacco and Firearms of the Department of Treasury; the Federal Highway Administration, the Federal Railroad Administration, the Federal Aviation Administration and the Coast Guard of the Department of Transportation; the California Highway Patrol, the Railroad Safety Branch of the California Public Utilities Commission and the California State Fire Marshal.

The Coast Guard was selected as the lead agency in the effort, primarily due to its familiarity with the port facilities and broad jurisdiction over hazardous materials transported by vessel.

The goal of HAZSTRIKE '93 was to determine the type and amount of hazardous materials moved through the Port of Oakland, along with the level of compliance with applicable federal and state regulations. The operation also focused on illegal shipments of explosives, especially fireworks.

Eleven intermodal container facilities, six freight consolidators, two vessels and three local rail yards were inspected to ensure compliance with regulations under 49 CFR parts 171-177. All hazardous material shipping was targeted to be inspected for the required placarding, packaging, marking, labeling and documentation.

In conjunction, the Federal Highway Administration and the California Highway Patrol set up inspection stations for shipments moving in and out of the port by vehicle. Inspectors verified the qualifications of the drivers and the material condition of their vehicles and trailers.

Another inspector checks motor vehicle container warnings.

Coast Guard team member inspects load of corrosives.

Results

The first day, March 2, ended without any major incidents. Once the road inspection sites were established, the amount of vehicle traffic diminished.

The second day had similar results. Most of the violations were minor, however, a total of five hazardous material shipments were delayed, having had more serious violations. A container leaking terpene hydrocarbons (a flammable liquid) was found at a railroad terminal.

Federal Railroad Administration personnel learned that, to avoid inspection, hazardous materials' rail shipments were held at Rocky Mountain and midwest locations until the end of the operation, while others were held at various California locations until after inspections were concluded for the day. Consequently, one team began their working hours at 4 p.m. to catch shipments arriving at night. Personnel later learned that shipments were moved after the day's inspections were finished.

The last day of HAZSTRIKE '93 saw teams at marine terminals inspecting two vessels and visiting six freight consolidators. Several containers held for blocking and bracing problems were released when reinspected.

Over the three days, the Coast Guard found 105 hazardous materials' violations after inspecting 110 containers. The Federal Railroad Administration found 30 such violations after 43 inspections. And the Federal Highway Administration found 16 violations and 249 safety violations after inspecting 203 trucks.

Conclusions

Most violations found by the Coast Guard and the Federal Railroad Administration were minor, ranging from improper or missing placarding and labeling to mistakes or omissions on shipping papers. Several empty containers were still placarded as containing hazardous materials and a few containers had inadequate blocking and bracing of hazardous cargoes. Some hazardous materials were accidentally unmanifested.

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There was no blocking or bracing in a truck containing class 1.4 explosives.

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More serious violations included several leaking drums and flammable gas in cylinders that did not meet Department of Transportation requirements.

Overall, it was difficult to approximate the amount of hazardous materials moving through the port due to the numerous shipments held back, especially on the railroads.

Recommendations

A much larger scale operation is needed, including simultaneous inspections at all major port and railway centers in conjunction with inspections in and around these locations. This would reveal a more accurate count of hazardous materials actually being shipped, and defeat the tactic of holding back shipments to avoid inspection and possible violations.

Improved training of industrial personnel is needed. Shipping paper violations should not be occurring as frequently. Hopefully, when the new training requirements in 49 CFR parts 171-177, *"Training for Safe Transportation of Hazardous Materials,"* is carried out, this problem will be alleviated.

HAZSTRIKE will be an annual event for MSO San Francisco Bay. Such teamwork allows each agency to see how the others work, improves communications and is excellent training for all involved. The real success of the operation, however, comes from the hard work of the men and women from all the different organizations pulling together as a team.

LTJG Stephen Schroeder is with the Planning Department of MSO San Francisco Bay, Building 14, Coast Guard Island, Alameda, California 94501-5100.

Telephone: (510) 437-3138.

The drum on the dolly was discovered leaking terpene hydrocarbons (orange oil).

Coast Guard inspectors examine hazardous material containers at the Port of Long Beach, California.

Photo by ENS Sherri Brown.

Intermodal coordination fosters safe hazardous materials transport

By LT Steve Hanewich

Introduction

Approximately four billion tons of regulated hazardous materials are transported each year, with about 500,000 shipments each day, according to the Department of Transportation (DOT).

Hazardous materials are defined by DOT as substances or materials capable of posing an unreasonable risk to health, safety and property when transported in commerce. The federal Hazardous Materials Transportation Act (49 U.S.C. 1801 et seq., as amended) gives the secretary of DOT the regulatory authority to protect the public against this risk.

The enforcement authority for the Hazardous Materials Transportation Act has been delegated to five administrations within DOT: the Federal Aviation Administration, Federal Highway Administration, Federal Railroad Administration, Coast Guard, and Research and Special Programs Administration. Each administration provides oversight for the transportation of hazardous materials in its respective mode. The Coast Guard is responsible for the safe shipment of hazardous materials by water.

Port activities

In the past few decades, the rapid growth of containerization has led to considerable expansion of activities at port areas where cargo shifts from one transportation mode to another. The intermodal marine container transportation chain is complex with numerous links: shippers and consignees, intermediaries, highway and rail carriers, ocean carriers, and marine terminals and ports.

Consequently, the Coast Guard has increased its levels of coordination with other agencies on regulatory compliance and enforcement of hazardous materials regulations.

Joint inspections

The small size of the Coast Guard's hazardous materials enforcement staff compared with the size of the regulated industry requires maximum leverage of resources. Joint inspections with other federal, state and local agencies are an effective way to make the most of available resources.

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Interagency team inspects freight container at Long Beach.

Photo by ENS Sherri Brown.

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For example, for many years, the Coast Guard has enjoyed a close working relationship with the Office of Hazardous Materials Enforcement of the Research and Special Programs Administration in conducting joint inspections of shippers in and around major ports.

The Coast Guard has recently become very active in multi-agency hazardous materials task force operations. This entails working with other federal, state and local enforcement authorities in conducting unannounced inspections of hazardous materials shippers and carriers in and around United States ports.

These task force operations frequently target containerized and packaged hazardous materials to inspect for compliance with domestic regulations contained in 49 CFR parts 171-180, as well as the International Maritime Dangerous Goods Code, where applicable.

Specifically, inspectors from the task force examine hazardous materials, to ensure that they are properly documented, packaged, marked, labeled, stowed, secured, segregated from incompatible materials and otherwise in conformance with applicable regulations. In addition, vehicles, freight containers, railroad tank cars and portable tanks are examined to ensure they are in compliance and are structurally sound.

During the past year, multi-agency task force operations were successfully conducted at numerous ports around the country. Several involved more than 50 participants.

The specific objectives of these operations vary depending on the priorities and perceived needs of the agencies involved. While most task force activities focus on hazardous materials in general, there are some dedicated "sting" operations aimed at shippers with poor compliance histories or specific commodities, such as fireworks and similar explosives. Joint sting operations with other federal agencies including the United States Customs Service have been quite successful.

Cooperative enforcement

To coordinate federal and state government efforts, and encourage uniform regulatory enforcement of hazardous material regulations for all modes of transportation, the Research and Special Programs Administration established the Cooperative Hazardous Materials Enforcement Development program in 1986. This program promotes information exchange among state and federal agencies responsible for all aspects of hazardous materials transportation. Semi-annual regional meetings of state and federal program members focus on current and future regulatory enforcement activities, and are forums for discussing problems and needs.

Some marine safety units have also established intermodal work groups to regularly address issues concerning hazardous materials enforcement, prevention and response.

Conclusion

There is tremendous potential benefit to be gained from increased coordination among all federal, state and local enforcement agencies. While various agencies have different jurisdictions of enforcement, their programs are often complementary.

When carefully planned and carried out, multi-agency operations can provide excellent training and promote widespread compliance with applicable laws and regulations, thus contributing to the safest possible port environment.

LT Steve Hanewich is a project officer in the Port Operations Branch of the Port Safety and Security Division.

Telephone: (202) 267-6700.

Improperly stowed drums of hazardous materials

Cover Photos

Front: Cargo transfer from tankship using single transfer arm.

Rear: View over a deck of a parcel tanker.
Photo courtesy of Stolt-Nielsen, Inc.

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