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Special issue on the hazardous cargo of the *Santa Clara I*

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January-February, 1993 *Vol. 50, No 1*

Special issue on the hazardous cargo of the Santa Clara I

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Crane on barge lifts responder clad in maximum protective gear on Santa Clara I to "rake" spilled magnesium phosphide from the cargo hold.

Photo by PA3 Simone Adair

After the casualty, Santa Clara I lies at anchor in Charleston Harbor.

The fateful voyage of

Santa Clara I

The *Santa Clara I*, a 479-foot container ship, began on December 2, 1991, what was to have been a routine run from Valparaiso, Chile, with calls in Chile, Peru, Ecuador and the United States ports of Philadelphia, Pennsylvania; New Haven, Connecticut; Port Elizabeth, New Jersey; Baltimore, Maryland; Charleston, South Carolina and Miami, Florida. A month later, the 17-year-old, 9593-gross-ton vessel left Port Elizabeth under a weather forecast with severe storm warnings.

As the *Santa Clara I* headed south off the New Jersey coastline, the weather deteriorated throughout the night with winds gusting to over 50 knots and seas up to 28 feet. By midnight, the seas were extremely rough and the ship rolled heavily, pounding, surfing and taking water on deck. The severest ship motions were noted between 1:30 and 2:30 a.m., January 4, when the *Santa Clara I* rolled up to 35°.

During the worst turbulence, the ship lost 21 containers up to 40 feet long and one piece of machinery overboard from stowage on the #2 hatch. Four of the lost containers were loaded with arsenic trioxide. Ten palletized drums of magnesium phosphide in the #1 upper tween deck broke loose and were breached.

The *Santa Clara I* made its initial port call at Baltimore, where the severity of the hazardous conditions was masked. It was not until its next port of call, Charleston, where the risks were fully identified and positive measures initiated to mitigate the situation.

Santa Clara I -- Why the incident is so unique

By CAPT Jack McGowan

A container ship, the *Santa Clara I*, lost some containers over the side early in the morning of January 4. This was not an unusual occurrence for container ships passing through severe storms. In fact, two other ships and a barge reported losing containers in the same storm.

What was so special about the *Santa Clara I* that it remained at the center of its own storm for the next two months, caught up in a rush of media, congressional and legal controversy?

For those assigned by the commandant of the Coast Guard to conduct a special board of inquiry into the cargo loss, three aspects of the incident were particularly striking.

Number one

The first concerned the extremely hazardous nature of the cargo carried on board the *Santa Clara I*. A single dose of arsenic trioxide no larger than the size of an aspirin tablet is lethal to humans. The main deck and several cargo hatches of the vessel were literally awash with the substance when it arrived at the pier in Balti-more that same day.

Below deck in the #1 cargo hold, magnesium phosphide had spilled. The deadly powder was piled several inches deep in some areas. Magnesium phosphide, when exposed to air or combined with water vapor, produces phosphine gas -- an extremely efficient fumigant, but only a few "whiffs" is threatening to humans. Compounding this hazard is the tendency of magnesium phosphide to spontaneously ignite with explosive force when combined with water.

Such hazardous cargoes are commonly manufactured overseas and transported in and out of United States ports. These cargoes are often stored with general cargo such as lumber or household goods, as on the *Santa Clara I*.

Number two

A second concern was the casual manner in which these hazardous cargoes were treated. The board encountered repeated examples of ignorance associated with the handling of *Santa Clara I*'s cargo and in the response to its loss.

The vessel's owner and crew failed to record the drums of magnesium phosphide on the cargo manifest. A crewman scooped up some of the spilled powder in his hands, smelled it, and , though he felt sick, never reported it to the ship's medical officer.

Longshoremen also failed to recognize the hazard and offloaded the magnesium phosphide drums in Baltimore, even though they were clearly labeled as "poison." The crew freely wandered about the deck contaminated with arsenic trioxide, despite the fact that they were warned of the danger.

Number three

The final and, perhaps the most serious aspect of the *Santa Clara I* incident, was an unwillingness by the owner of the vessel to step forward and call attention to the gravity of the problem.

The Santa Clara I arrives in the port of Baltimore with a 40-foot container dangling off the side.

Elaborate decontamination measures included wearing protective clothing and discarding all items exposed to the hazardous chemicals.

For the two days that the vessel remained at the pier in Baltimore, a cargo surveyor hired by the ship's owner examined the condition of the cargo. He witnessed extensive cargo damage and spillage below decks, and produced a volume of photographs.

Photos taken before the #1 hatch was unloaded clearly showed the spillage of magnesium phosphide and the poison label on the damaged drums. Additional photos taken by the surveyor showed spillage of hazardous materials in other cargo holds.

Crew members, when interviewed, denied knowledge of any spilled hazardous material, other than the on-deck arsenic trioxide. Even a month after the incident, attorneys for the ship's owner were unwilling to allow the board to interview the surveyor.

Since no report was filed of any additional spillage with the Coast Guard or other authority, the vessel left the port of Baltimore in an extremely hazardous condition, placed its crew back in harm's way and ultimately put the port of Charleston and its citizens at great risk.

Conclusion

It is not often that the Coast Guard recommends criminal action against a party it regulates. The board of inquiry made such a recommendation against the *Santa Clara I*'s owner.

The Department of Justice has declined criminal prosecution of the crew. They were granted immunity to compel them to testify in an on-going civil action against the owner to recover the costs of the incident.

The board of inquiry made several recommendations to prevent cargo losses of this nature in the future. It is hoped that the board's report will sharpen the focus that all parties responding to a hazardous materials incident must share.

Everyone must place liability concerns in proper perspective and be immediately forthcoming with information when ships' crews, hazardous response personnel, and the people and property of port areas are placed at risk.

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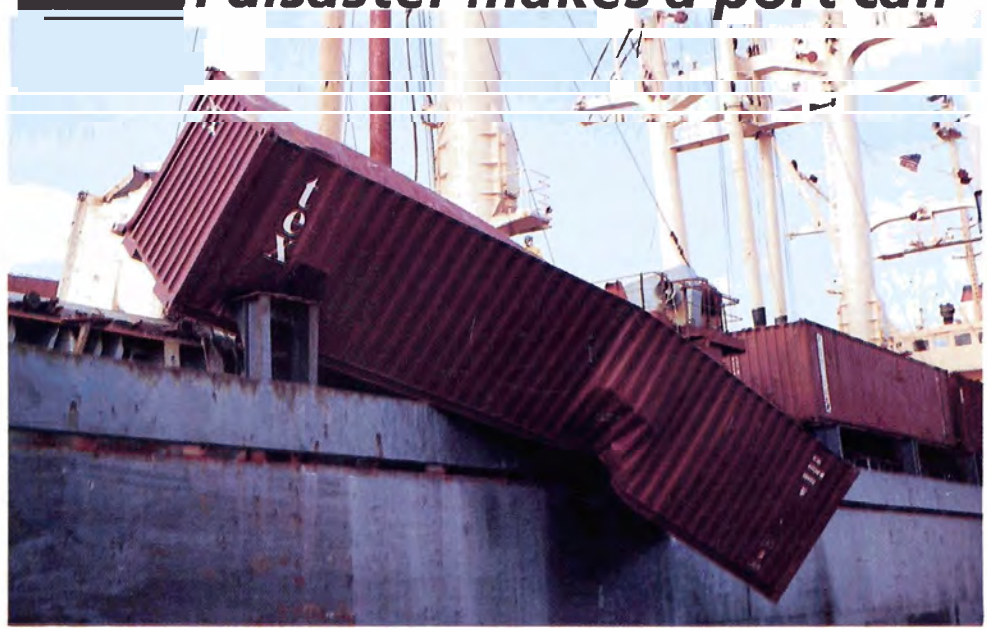
When disaster makes a port call



By LT Gary Merrick

Even a casual observer would have noticed that there was something wrong with the *Santa Clara I* as it arrived in the port of Baltimore. It is safe to say, however, that no one standing on the dock watching the wounded cargo vessel tie up on January 4 could have predicted the potential for disaster the *Santa Clara I* brought along.

Hazards

The most obvious problem was the 40-foot container dangling precariously off the port side of the vessel. A closer look would have revealed a large number of blue 55-gallon drums strewn about the deck.

As often is the case, the most obvious problem was not the most serious. The large container was manifested to contain cotton products and was later removed to gain access to deck areas during cleanup operations.

The blue drums did pose a serious problem. Each contained about 375 pounds of arsenic trioxide, a highly poisonous metal oxide used as an insecticide, herbicide and wood preservative. *(See page 27 for a complete profile.)* There were ap-proximately 13 damaged drums that had spilled their contents of an estimated two tons of loose arsenic trioxide onto the deck.

The initial response and entry onto the vessel were conducted by members of the Maryland Department of the Environment's emergency response team assisted by local hazardous material teams. After it was determined that there was no immediate danger and the situation had progressed into the post-emergency phase, a local contractor was hired to clean up the arsenic trioxide from the deck, which took a little more than one day. The vessel departed Baltimore for Charleston, on January 6.

Information provided by the *Santa Clara I* dangerous cargo manifest indicated that the arsenic trioxide was the only hazardous cargo on board. This was believed to be the case until several days later, when approximately 830 pounds of loose magnesium phosphide was discovered in the hold of the vessel in the port of Charleston.

This discovery sent shockwaves back up the coast to Baltimore, where the local cleanup contractor was directed by *Santa Clara I* insurers to overpack four damaged drums that had been off-loaded and were sitting at the terminal. This was done without notifying the Coast Guard.

A review of stevedoring records indicated that it was sometime between 9 and 10:30 a.m. on January 5 that cargo described as "three skids of steel drums and four loose damaged drums," was removed from the #1 hold of the *Santa Clara I* and placed on the apron outside of a stevedore shed. That cargo turned out to be magnesium phosphide, a grayish granular material used as an active ingredient in commercial fumigants. The chemical reacts violently with water, pro-

ducing poisonous, flammable phosphine gas. (*See page 27 for a complete profile.)*

Cleanup

On January 11, the long process of magnesium phosphide cleanup began in Baltimore. All ten drums of the chemical were moved from near the stevedore shed to Area 98, a more remote location on the Dundalk Marine Terminal.

Six undamaged drums were inspected by the consignee, accepted and subsequently shipped to their intended destination. The four damaged drums remained in Area 98, while their disposal plans were reviewed by authorities.

The contractor hired by the *Santa Clara I* insurers to remove the damaged drums submitted an initial plan, involving the deactivation of the magnesium phosphide by exposing it to ambient air and allowing it to react with the moisture. When this deactivation was completed, then the chemical would have been immersed in water to react any residuals. After review by the federal on-scene coordinator and other authorities, this plan was determined unacceptable because of the risks involved in the on-site treatment in the densely populated terminal. The contractor was directed to submit another plan.

An amended plan submitted by the contractor also called for the deactivation of a limited quantity of the magnesium phosphide on site. This plan would have required two Maryland permits, covering the treatment of the chemical itself and any phosphine emissions generated during this treatment. The state was reluctant to issue these permits unless there were no other options available.

Additional disposal firms were invited to bid on the drum removal by submitting plans

Damaged fiberglass container with arsenic trioxide drums.

calling for the repackaging and off-site transportation of the magnesium phosphide, rather than on-site treatment. A new contractor was selected based on a draft plan calling for repackaging of the chemical in a nitrogen-inerted atmosphere.

When the draft protocol was approved, the contractor was asked to submit a remedial action plan, and a site-specific health and safety plan, both of which were to detail the conduct of on-site operations. While these plans were reviewed, site preparations, including the construction of an inert enclosure were underway in Area 98.

Plan amendments were made based on Atlantic Strike Team and the Maryland Department of the Environment recommendations. On June 26, the on-scene coordinator determined that all the plans were satisfactory, and the contractor could proceed, weather permitting.

The first three drums were repackaged without incident. However, while a remote puncturing device was used on the fourth and final drum, the phosphine gas inside exploded, propelling the drum into the overhead of the in-

Continued on page 6

View of container, debris and drums on deck looking forward.

Continued from page 5

ert enclosure. The drum landed in the original overpack after releasing about 10 gallons of magnesium phosphide into the inert enclosure.

After the atmosphere in the inert enclosure stabilized, decontamination was conducted and the loose magnesium phosphide was repackaged. By 8 a.m. on June 30, all of the chemical and associated wastes were packaged and loaded onto a transport vehicle bound for the final disposal site in Arkansas.

Another area was the interaction between the agencies involved in the *Santa Clara I* incident. While there was excellent cooperation between these agencies, their individual concerns should be prioritized before any future incidents of this nature take place.

New center

An existing link between the port of Baltimore and the educational community has provided a good outlet for discussing agency relations within the port. Dundalk Community College, the Maryland Port Administration, the Carriers Container Council, the International Longshoreman's Association, the Private Sector Port Committee and the Steamship Trade Association are among the organizations involved in creating a center for port-related industries. The initial objective of this alliance was to develop a port-wide total quality management program.

This center has a high level of diverse participation, and offers a unique opportunity for the whole port community to focus on the needs of customers. In doing so, the various agencies already are gaining a better understanding of each other's role in making the port of Baltimore into a "total quality port."

Port side of the vessel after damaged general cargo container was removed. Arsenic trioxide drums and overpacks are in foreground.

Concerns addressed

The *Santa Clara I* incident generated areas of concern which were addressed by the Maryland Port Administration, the Steamship Trade Association and MSO Baltimore. Several areas were identified as priority needs.

The first area was that of hazardous materials awareness. The fact that damaged drums of hazardous material could be off-loaded, transported and stored without notifying any appropriate authority indicated a need for general awareness training among the longshoring and stevedoring industries within the port.

This concern was addressed by establishing a series of training sessions starting on April 30 at the Maritime Institute of Technology and Graduate Studies in Linthicum, Maryland, designed to focus hazardous materials awareness at the longshoring and stevedoring members of the port of Baltimore.

On September 30, a hazardous cargo workshop was sponsored by the Steamship Trade Association to extend that awareness training for other port customers.

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Operation arsenic trioxide response **unique and successful**

By CDR John C. Reed, LTJG John P. Flynn and LTJG Sean K. Moon

Overview

The first of its kind in the marine environment, this chemical response followed many classic development stages: incident notification, strategy development, approval by a higher advisory organization, initiation of response actions and final successful completion.

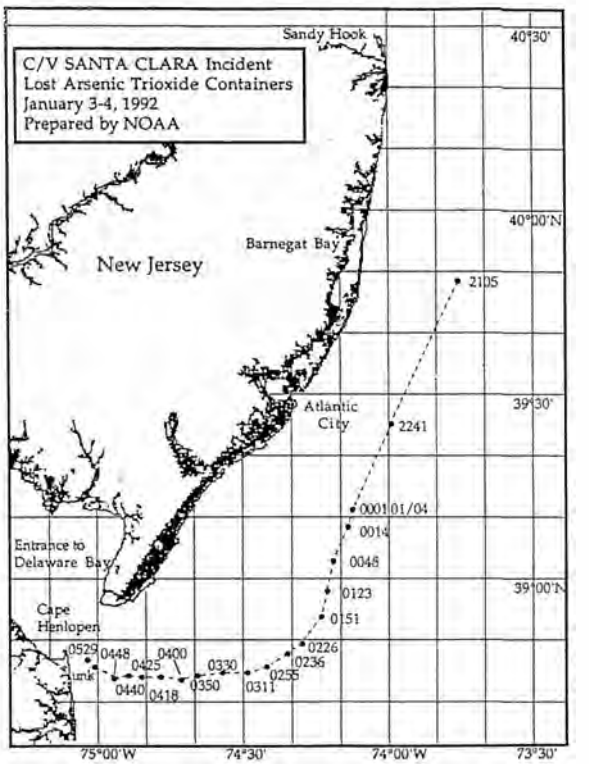
However, due to the sensitivity of the case and the fact that this was a premiere marine response under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of a highly toxic inorganic chemical (seven drops on the tongue of an average adult will cause death) in an economically important bivalve fishing zone, it drew high-level attention of congressional and federal agencies.

All of these factors make this CERCLA response to the *Santa Clara I* incident the *Exxon Valdez* of the Atlantic. The case plowed new response ground and set a high standard and precedent for all to follow.

Arsenic trioxide cargo

Sometime during the early morning hours of January 4, the *Santa Clara I* lost 21 intermodal containers overboard some 30 nautical miles off the coast of Cape May, New Jersey. They consisted of 17 general cargo shipments and four separate containers loaded with 25-gallon drums of arsenic trioxide. In addition, two damaged containers holding this highly toxic chemical remained on the vessel. Nine drums from these containers were lost over the side.

Santa Clara I



An analysis of the cargo manifest indicated 414 374-pound drums of highly toxic inorganic, industrial strength arsenic trioxide were lost overboard in 125 feet of water.

Since the vessel was shrouded in thick fog and heavy weather, no one on board realized that any deck cargo had been lost overboard. Upon arrival at the Delaware pilot pickup station, the boarding pilot reported to the ship's master that a container was hanging over the port side. The master expressed surprise, as he had not realized that there was a problem with the cargo.

Nevertheless, the *Santa Clara I* proceeded up the Delaware Bay to the Chesapeake and Delaware Canal, arriving in Baltimore late in the day.

The stage was set for the first of its kind marine CERCLA search, salvage and recovery operation in United States history.

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Initial operations

MSO/Group Philadelphia and the Fifth Coast Guard District Operations Center in Portsmouth, Virginia, were notified of the storm damage aboard the *Santa Clara I* by MSO Baltimore.

Along with an initial search for the lost containers, a letter of federal interest was issued on January 8 to assess the ship's owners' interest in recovering the lost arsenic trioxide drums from the sea floor along the New Jersey coast. Basically, the letter stated that "either the potential responsible party recovers the pollutant or the federal government would do so and bill the potential responsible party for triple the expenses and associated costs."

"...a massive air search was begun on the morning of January 5..."

Since it was not known at first if the containers sank immediately or floated for a short time, a massive air search was begun on the morning of January 5 along the New Jersey, Delaware, Maryland and Virginia coasts. Aircraft from Coast Guard air stations conducted a visual air search of over 20,000 square miles along the East Coast. A number of Coast Guard vessels also assisted in the search.

Initial search efforts found no sign of the missing containers or debris. On the third and final day of the flights, a 40-foot red container was sighted by a passing vessel 35 miles east of Chincoteague, Virginia.

Close examination of this container positively identified it as being from the *Santa Clara I*. The manifest listed its contents as wood and lumber, which is why it remained afloat. However, based on this find and a second interview with the *Santa Clara I* master, a more probable location of the general submerged debris field was calculated.

On January 7, the Coast Guard contacted the Environmental Protection Agency (EPA) to request funding from CERCLA for the response to the incident. EPA agreed and established a "superfund" account with an initial ceiling of $1 million. When the response operation concluded in October, the available funding had been increased to $4.4 million.

On January 8, a meeting of the Multi-Agency Local Response Team was called at MSO/Group Philadelphia for consultation on how best to proceed with response efforts. Atlantic Strike Team representatives were also at this meeting. Their expertise and support were essential in developing site safety plans; directing search and recovery, and Navy air operations; and overseeing National Marine Fisheries Service environmental sampling procedures.

Public information

Of major importance was the establishment of a joint public information center between MSO/Group Philadelphia and the Multi-Agency Local Response Team to address community concerns over the incident, to allay unnecessary fears and keep the public fully informed on search, salvage and recovery operations.

The Public Information Assist Team (PIAT) from the National Strike Force Coordination Center, Elizabeth City, and the Fifth Coast Guard District Public Affairs staff helped set up the center. When everything was in place, the MSO's public affairs officer and an assistant handled the day-to-day media activities, which included five press conferences and more than 1,500 press inquiries in a five-month period.

Three phase plan

A master plan of action involving three major phases was developed in skeleton form, to be fleshed out as additional information was obtained. Phase I was to be an initial sub-surface search to locate probable targets along the *Santa Clara I*'s trackline. Phase II would be the positive identification of those contacts by remotely-operated vehicles (ROVs) equipped with video cameras. Phase III would include the recovery/salvage of the containers or drums as well as packing and transporting the arsenic trioxide to a facility capable of appropriate disposal.

Experts in various disciplines were consulted. For example, on January 24, the need for short-term ocean environmental monitoring in the area of the debris site, and concerns about the methodology used to recover the damaged drums from the sea floor were addressed. Plans for obtaining water, sediment and bivalve tissue samples in the area were also developed.

The possible impact of arsenic trioxide on clamming beds as well as the potential for skin contact by local fishermen supported the closing

HM-14 Navy Sea Dragon helicopter searched for debris from Santa Clara I.

by the National Marine Fisheries Service of the debris area to fishing from February 6 through August 13, 1992.

Another major concern of the fisheries service was the potential impact of the chemical on endangered species, including right whales, humpback and fin whales, bottlenose dolphins, and loggerhead and ridley turtles. A group of scientists in the field were consulted. They and the National Marine Fisheries Service advised that contained recovery of the damaged arsenic trioxide drums would reduce the potential threat to these species.

Phase I

The first phase of the response involved the search for arsenic trioxide drums or debris from the *Santa Clara I*. Due to extremely short favorable weather windows at sea and the possible remote location of the debris field, assistance was requested of the Navy Helicopter Mine Countermeasures Squadron (HM-14) based in Norfolk, Virginia. These helicopters towed Westinghouse ACS-14 side-scanning sonar systems that could quickly "paint" a first cut approximation of debris locations that would be followed up by vessel-based systems.

Joint response cooperation grew when the Federal Aviation Administration (FAA) Technical Center in Pomona, New Jersey offered its facilities as a base of operations during the initial sonar search. Personnel from MSO/Group Philadelphia, HM-14, the Atlantic Strike Team and the National Oceanic and Atmospheric Administration (NOAA) used this center as a 24-hour forward command post from January 9 to 17, which greatly facilitated efforts to locate the missing containers.

On January 10, 92 individuals and three Navy MH-53E *Sea Dragon* helicopters were temporarily staged out of the FAA center. This air arm had successfully demonstrated its ability to locate similar sized objects in the Persian Gulf war, and was eager to prove its capabilities in the "peace arena."

The search began in an offshore area near the entrance to Delaware Bay, because the *Santa Clara I* master recalled experiencing the most difficulty handling the ship there. When an initial survey produced no results, the master reported that he also had steering problems in heavy rolling seas further north. A search of this area was fruitful.

On January 12, a large debris field was discovered by the HM-14 squadron. Contact was made with items identified in sonar lingo as "hard returns" on the ocean floor. They were rectangular and appeared to be the same size as the containers lost from the *Santa Clara I*.

The EPA offered its research vessel *Peter W. Anderson* equipped with a remotely-operated vehicle (ROV) and an underwater sonar probe device known as a "fish" to positively identify the targets found by the air search. To ensure operational safety in the survey area, a moving buffer zone was imposed around the helicopters and surface vessels. Also, work by ship-borne sonar and ROV was limited to night time operations.

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The "fish" underwater sonar probe.

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Atlantic Strike Team members were placed on the *Peter W. Anderson* to assist in the search efforts and to ensure that safe decontamination procedures were carried out on all equipment to prevent exposures to arsenic trioxide.

The *Peter W. Anderson* started with a drift-by search with an underwater camera. However, a deteriorating sea state and lack of ground tackle did not allow the deployment of the ROV, putting a stop to search operations for the day. Poor weather delayed the search effort until January 14.

In the meantime, the Navy helicopters defined the boundaries of the debris field and continued to pinpoint contact positions. On January 17, HM-14's mission was completed and the squadron returned to its home base. During five days of flight, HM-14 spent 39 hours searching and 42 hours in transit. The squadron covered a little more than 305 nautical miles of trackline, resulting in 98.53 square miles of ocean searched.

On the 14th, the *Peter W. Anderson* resurveyed the debris area with its "fish". Sonar contacts showed evidence that the hard returns had minimal corrosion and little organic growth, indicating that they were probably recently deposited on the bottom. In addition, some of the sonar contact returns had the characteristics of rectangular shipping containers.

Phase II

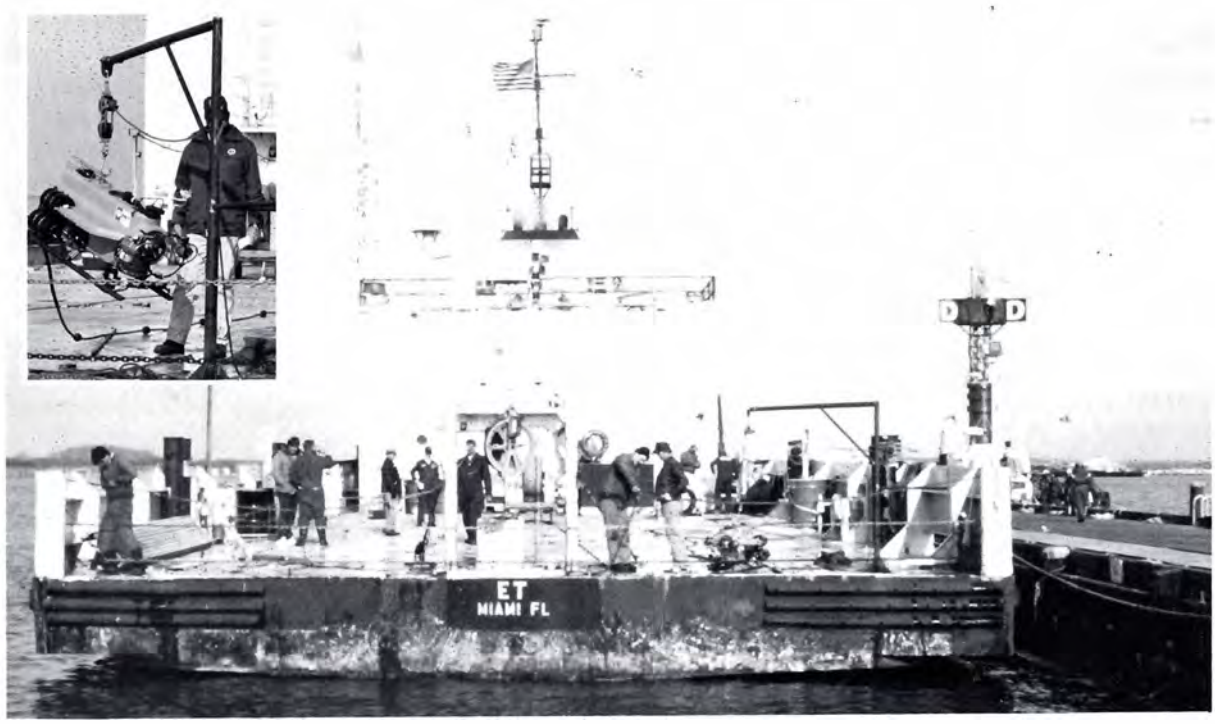
On January 19, after a series of weather-induced suspensions, the *Peter W. Anderson* got underway again. This time, its underwater TV cameras positively identified a steel shipping container. The cameras also captured a poison label and identification numbers matching those of one of the arsenic trioxide containers listed on shipping papers carried by the *Santa Clara I.*

Unfortunately, the container was badly damaged with its doors bashed in and the top torn open. It appeared to be empty and no drums were found at this time.

On January 19, due to other operational commitments, the *Peter W. Anderson* was relieved by the *M/V E.T.*, under contract to the Navy Supervisor of Salvage. Atlantic Strike Team members were placed on board the *E.T.* to ensure the safety of those on board and to provide liaison between search crews and the federal on-scene coordinator.

On January 22, the *E.T.* got underway from Cape May to align its navigation system with the data supplied by the HM-14 and the

The merchant vessel E.T. stood by to deploy an ROV (inset) to identify objects on the ocean floor.



The Sub Sea 278, a 290-foot salvage barge served as the platform for the recovery operation.

Peter W. Anderson. Heavy weather again forced suspension of operations the next evening, but not before a successful alignment.

In the meantime, a hydrostatic pressure test was conducted at the David Taylor Research Center in Annapolis, Maryland, on two drums from the *Santa Clara I*'s cargo. Both drums were filled with portland cement, simulating the arsenic trioxide as closely as possible. One drum was suspended vertically from the top of a tank and the other laid horizontally on the test bed. They were partially crushed at 120 feet, and the vertical drum was released to fall two feet onto a cushion, simulating an impact force.

After the tank had been under pressure for 30 minutes, the horizontal drum was raised vertically by a hydraulic system and slings to simulate recovery actions. Aside from minor crumpling, as the apparent air space was compressed, the drums maintained their integrity with only a slight leakage of water and no release of contents. While not conclusive, the tests indicated that the drums on the bottom would probably be relatively intact.

One concern that arose during the pressure testing was a back "gassing" of compressed air from the reduced air space of a crumpled drum. This escaping gas also carried small quantities of cement back into the water column. It was believed that unless the crumpled drums were placed in capsules prior to retrieval, they might spew arsenic trioxide back into the water column, thus endangering marine life.

Early on January 27, the *E.T.* left for the debris field, where it deployed an ROV. Shortly after noon, a second arsenic trioxide container was located and identified. It was badly mangled with an entire side missing. It contained two drums marked arsenic trioxide which were crushed, but did not appear breached, as had been predicted by the hydrostatic pressure test.

At 1:15 p.m., a large pile of drums was located near the second container. The missing side was spotted under the pile. The drums, which were identified as belonging to the *Santa Clara I*, appeared to be somewhat mangled, but did not seem breached.

About a half hour later, the *E.T.*'s ROV relocated the first arsenic trioxide container found. A close examination revealed that its drums were inside. It was hoped at that time that the search was over.

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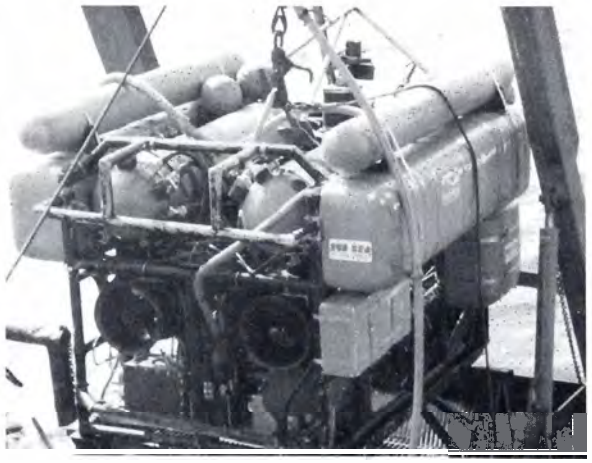


Scorpio (left) and Triton (above) picked up and retrieved drums.

Continued from page 11

Phase III

While the search was underway, MSO/Group Philadelphia and the Atlantic Strike Team were exploring ways to recover the drums. The possibilities were narrowed down to using hazardous material-trained divers, specially equipped ROVs or one-atmosphere hard shell diving suits. Technical feasibility, environmental and personnel safety as well as cost were all deciding factors.

Just as a contract was about to be awarded to a salvager, the owners of *Santa Clara I* took positive action and accepted the responsibility for recovery and salvage operations themselves. First, representatives of the owners met with the Coast Guard federal on-scene coordinator, Atlantic Strike Team members and other involved parties to discuss recovery and salvage plans.

The owners' representatives proposed to first completely resurvey the debris field to clearly verify the locations of the two arsenic trioxide containers, a pile of drums and other general cargo before any recovery attempts. They also hoped to locate a suspected fourth container and remaining missing drums.

The owners obtained the following equipment for the recovery operation:

- *M/V Seaboy Explorer* -- a survey vessel with side scan sonar and ROV,
- *Sub Sea 278* -- a 290-foot salvage barge with two large ROVs for drum pickup and retrieval,
- A 105-foot anchor-handling tug and
- a 110-foot support vessel.

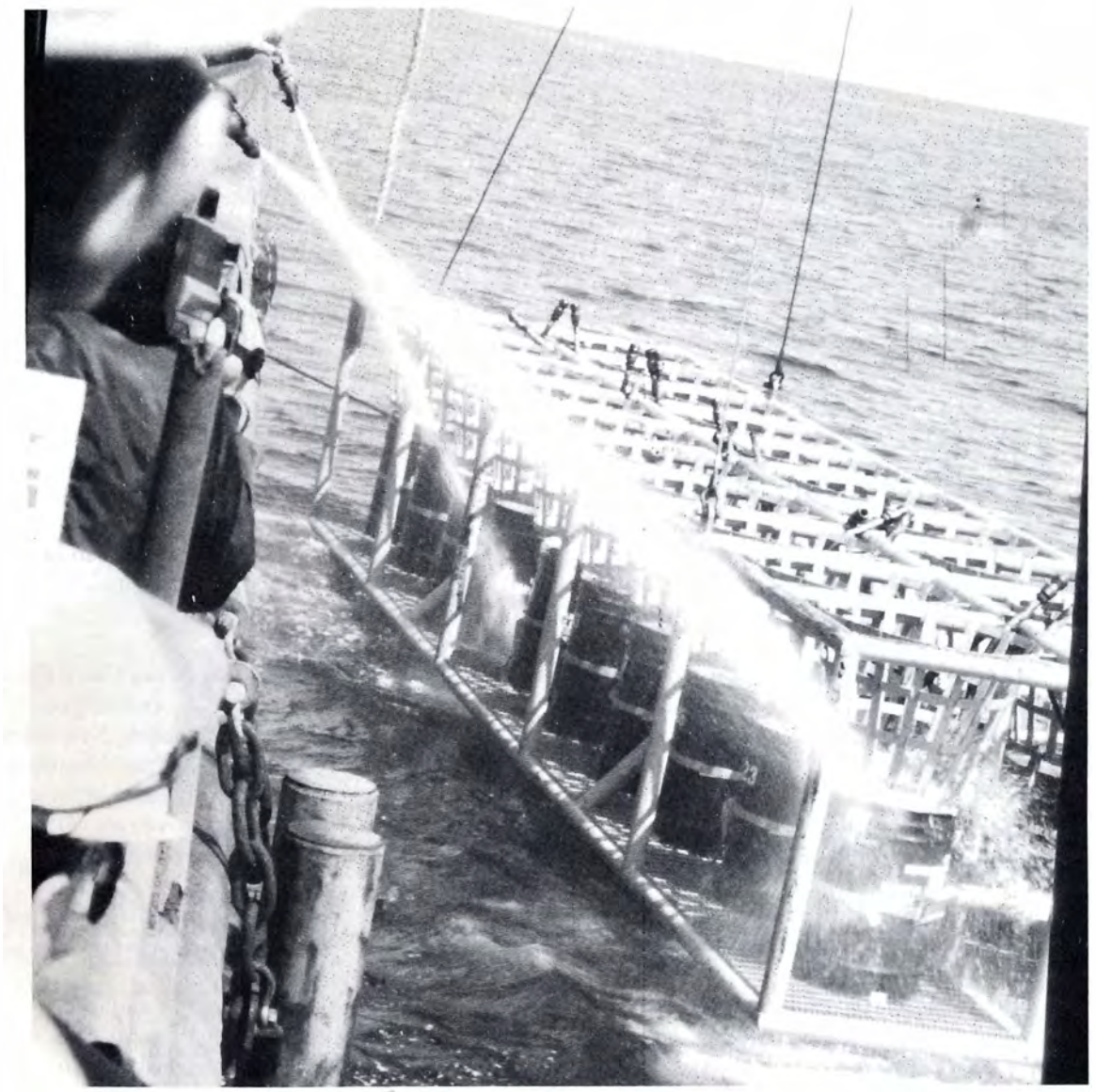
On April 6, salvage operations actually began. The *Sub Sea 278* was anchored over the debris to recover the arsenic trioxide drums using a unique method. First, a prefabricated rack or basket capable of holding twenty 55-gallon overpacked drums was lowered to the sea floor. It was filled with empty overpack drums.

The two large ROVs, *Triton* and *Scorpio*, were controlled from a station aboard the barge. The *Triton* had a seven-point mechanical arm that served as an underwater hand, controlling cement grout applications. The *Scorpio* picked up and maneuvered drums on the ocean floor.

The arsenic drums were loaded by *Scorpio* into the overpack drums on the rack. The void between the arsenic and the overpack drums was filled with marine cement or grout to eliminate the possibility of spillage of arsenic trioxide. The grout was mixed aboard the *Sub Sea 278* and pumped through a hose to overpacks holding arsenic drums. The process continued until all 20 overpack drums were filled. The rack was left on the ocean floor until the cement hardened, encapsulating the arsenic drums.

On April 14, the first rack of 20 filled overpack drums was raised to the surface by a barge crane and placed on deck. All racks were thoroughly decontaminated and tested to eliminate any possibility of exposure.

Throughout six weeks of salvage operations, personnel from MSO/Group Philadelphia and the Fifth Coast Guard District, and Atlantic Strike Team members directed all activities from the barge, ensuring that decontamination and site safety procedures were carried out.



Rack of arsenic trioxide drums in overpacks were washed thoroughly when brought to the surface.

Disposal

Once decontaminated, the overpack drums were placed in 20-foot shipping containers similar to those that originally held the arsenic drums. These containers were transported for temporary storage to a facility in Salem, New Jersey, authorized to handle hazardous materials. Disposal of the water-soaked chemical proved to be a complex process.

There were two disposal options: retrieval and reprocessing in Chile, or retrieval and proper landfilling in the United States. The manufacturer of the product did not want it sent to Chile for reprocessing, since this might damage its credibility in the world trade market.

On the other hand, there are no North American firms capable of processing 64 tons of tainted arsenic trioxide. Compounding these problems was an EPA land ban prohibiting future landfilling of arsenic trioxide which would be effective as of May 8, 1992. After that date, the chemical had to be vitrified (made into molten glass) before it was ruled "safe." This is an extremely expensive process.

Ultimately, the arsenic trioxide was landfilled in Pinewood, South Carolina. The shipment of the decontaminated chemical containers was in compliance with all appropriate federal, state and local requirements.

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Termination

On May 6, after recovering 320 of the estimated 414 drums of arsenic trioxide from the ocean floor, the owners of the *Santa Clara I* terminated their search and recovery operations. While the owners maintained that only three shipping containers holding arsenic trioxide were lost overboard, *Santa Clara I* shipping documents indicated that 94 drums remained unaccounted for.

In the interest of public safety, the Coast Guard continued its survey in two additional areas -- the general vicinity of the existing debris field and the area at the mouth of Delaware Bay. This federally-funded action was taken to ensure all coastal communities that the missing drums had not been lost in shallower reaches of the Bay's entrance. Two weeks later, when these surveys were completed in vain, the search for the still missing 94 drums was suspended pending further developments.

The federal on-scene coordinator asked a council of the scientific community where else a sonar survey should be conducted, and if there was a risk of arsenic trioxide contamination in the environment. It was noted that about 100 square-mile area had been searched, but that only a 0.2-square-mile area was found to contain the main debris field.

No scientific or environmental organization suggested any additional areas to survey. It was felt the sonar search was complete.

In addition, water and sediment contamination samples taken in and around the debris field only contained arsenic levels similar to natural levels found in the ocean. The Food and Drug Administration found shellfish tissue arsenic levels to be at natural background limits, and did not pose a concern.

On May 20, the federal on-scene coordinator temporarily suspended search and recovery operations. The area was reopened to commercial fishing on August 11.

However, to be prepared for any future drum or debris snagged by a commercial fisherman, the federal on-scene coordinator and the Atlantic Strike Team, working with the National Marine Fisheries Service, produced an educational flyer advising the maritime community of actions to take if a drum was located. This flyer described the shipping drums, the arsenic trioxide powder and related health hazards involved.

As an added measure, MSO/Group Philadelphia would continue to serve as the contact point for any reported drum encounter. If this should happen, an on-site assessment would be made and the MSO would arrange for the removal and final disposition of the drum or debris.

As of October 5, 1992, no additional arsenic trioxide drums had been reported, and the federal on-scene coordinator declared the case formally closed. However, should fishermen or recreational divers locate any debris or articles possibly associated with this incident, appropriate confirmation or recovery action will be initiated and the case will be reopened.

Conclusion

The response to the *M/V Santa Clara I*'s loss of arsenic trioxide "tried" the existing response experience of the Coast Guard. New innovative techniques and imaginative combinations of technology proved to be the ultimate answer to a difficult, dangerous and expensive recovery operation. By methodically and scientifically exceeding the "normal" boundaries associated with a CERCLA response activity, the combined federal, state and local resources prevented any possible environmental impact.

All agencies -- federal, state and local -- involved in this unique recovery operation are to be commended on their total support, which cut across agency boundaries and solidly unified the diverse group throughout the operation. It was through this combination of non-parochial actions that this successful response was possible.

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Charleston hazardous materials response
UNPRECEDENTED

The Santa Clara I at the Columbus Street Container Terminal.

By CDR Richard E. Bennis and CDR Jerzy J. Kichner

January 8

The *Santa Clara I* arrived at the Columbus Street Container Terminal in the Port of Charleston, South Carolina before daybreak. At first light, Coast Guard personnel from MSO Charleston boarded to gather information on the lost arsenic trioxide containers.

At 9:15 a.m., a stevedore working the vessel told the boarding officer that there was "a milky-gray powder covering the floor of the number one hold, and, by the way, none of us feel very well." Thirty-five stevedores who had difficulty breathing were taken to a local hospital, observed for respiratory irritation and released.

A longshoreman found a drum cover marked magnesium phosphide, a substance used to fumigate cargo holds and grain elevators. It is shipped as a gray, granular powder, which reacts violently with water, producing phosphine, a highly poisonous and flammable gas. *(See page 27 for a complete profile.)*

When the *Santa Clara I* was in Baltimore, longshoremen removed ten drums from the #1 hold, four of which were damaged. More than 850 pounds of spilled magnesium phosphide was left in the hold.

Representatives of magnesium phosphide manufacturers were summoned to address the hazards and to advise on recovery/deactivation techniques. During a test deactivation, a sample of less than three ounces of the spilled product was mixed with water, producing a large cloud of phosphine gas which self-ignited into an enormous fireball. The magnitude of the spill was larger than anything ever experienced by the manufacturers and recovery was determined to be too difficult to attempt.

As soon as this determination was made, the hold was closed and sealed to keep out any moisture. The ship was cordoned off, and teams from Charleston fire and police departments, as well as Air Force dry chemical trucks, police boats and a Navy tug with fire monitors stood by as precautions.

Attempts to remove 19 containers, each holding 108 drums of arsenic trioxide, were also unsuccessful because storm damage had jammed the hatch rollers. This could only be rectified by hot work, which was considered imprudent in view of the volatile cargo in the #1 hold nearby.

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(Right) Coast Guard and other responders place a barge along-side the ~~Santa Clara I~~ at an isolated anchorage.

(Below) Members of the various strike teams don protective clothing on the barge to board the Santa Clara I.

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January 9

The Gulf Strike Team, headquartered in Mobile, Alabama, was requested to provide technical assistance in hazardous material response. Five members were dispatched to Charleston immediately, arriving early that afternoon. After discussions with the federal on-scene coordinator, a visit to the vessel and an assessment of local response capabilities, the Gulf Strike Team representatives recommended a full scale chemical response.

The *Santa Clara I* was evacuated except for an emergency team of 10 crew members. Because of the danger the vessel presented to public safety, its proximity to the heavily populated downtown "historic" and business area, and the multitude of unknowns in its cargo makeup, the *Santa Clara I* was ordered to a more isolated anchorage northwest of Fort Sumter in Charleston harbor by the Captain of the Port. The anchorage area was designated a safety zone with Federal Aviation Administration-restricted air space.

The Gulf Strike Team responded with a large chemical trailer, a 32-foot munsen boat and eight additional personnel, including two members each from the Gulf Strike Team; the Atlantic Strike Team, headquartered in Fort Dix, New Jersey; the Pacific Strike Team, headquartered at Hamilton Air Force Base, California; and the

Public Information Assist Team (PIAT) from the National Strike Force Coordination Center in Elizabeth City, North Carolina.

The Medical University of South Carolina's marine biomedical facility at Fort Johnson on James Island became a command post and staging facility for cleanup efforts. Response equipment, communications and office trailers, along with phone lines, decontamination sites and the National Oceanic and Atmospheric Administration's (NOAA's) remote weather station were all set up in 24 hours at the site.

The remote weather station provided instant readouts on wind speed and direction, temperature, humidity and plume trajectory modeling for chemicals known to be on board the *Santa Clara I*. A NOAA scientific support coordinator obtained the necessary hazardous chemical expertise to determine the reactivity of the spilled chemicals with other cargoes on board. Computer modeling of the cargoes, stow plans and vessel design was contracted by NOAA.

Magnesium phosphide was the "known factor" and called for immediate action to safeguard the port. The amount of the chemical loose in the #1 hold was not immediately known. At first, it was thought that from 100 to 200 pounds was spilled from estimates of a cargo surveyor who checked the holds in Baltimore. An accurate assessment was not possible due to the general state of the hold as a result of severe cargo shifting in the storm the *Santa Clara I* encountered in its voyage from New York to Baltimore. (The amount was later found to be 866 pounds.)

The magnesium phosphide was not listed on the vessel's dangerous cargo manifest, nor was its presence reported to the local Captain of the Port. A question that arose immediately was that since the magnesium phosphide was not listed, what other hazardous cargoes were present and not manifested?

There were a large number of unknowns that needed to be answered. All the data that the federal on-scene coordinator had was that from the consignee's representatives, the report of the cargo surveyor and the explosive results of the wet deactivation on the pier.

Knowing the problems the *Santa Clara I* had on its voyage, what was the state of its other containers in the other holds and the cargoes within? In opening hold #4, the cargo shifted considerably. The 19 containers of arsenic trioxide in hold #2 were reported intact by the cargo surveyor, but the condition of their contents was not known. Was there any condition that would result in the contact of incompatible chemicals stowed in the other holds? A genuine concern was the possible formation of arsine gas by reaction of the arsenic trioxide with an acid.

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The tug Frances K. McAllister helped keep the Santa Clara I in place for testing, sampling and offloading work

Photo by PA3 Simone Adair.

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The federal on-scene coordinator requested the National Strike Force to provide the following:

- site assessment, including analysis of the actual conditions in the #1 upper tween hold and other holds below the affected one;
- assessment of conditions of hazardous cargo in the other cargo holds;
- determination of possible adverse reactions from the contents of breached containers mixing;
- verification of the dangerous cargo manifest and stowage plan;
- evaluation of responsible party/ contractor cleanup proposals;
- evaluation and enforcement of site safety for federal response and contractor plans, and overall hazardous area oversight;
- personnel and waterborne equipment to help enforce safety zone around the vessel;
- air monitoring oversight and general quality control;
- safety oversight of board of inquiry visit to the vessel;
- staffing at Fort Johnson command post;
- federal response expenditures; and
- public information assistance with local news media.

The actual entry required careful preplanning to ensure that all necessary precautions were taken to safeguard strike force personnel, the vessel and the port of Charleston. First of all, the logistics of undertaking a level A entry at that anchorage were considerable.

January 10

On Friday morning, January 10, the federal on-scene coordinator, the National Strike Force response officer and supervisor and the chief of the St John's Island hazardous material team boarded the *Santa Clara I* to evaluate the conditions for entry. Proceeding forward of cargo hold #3, they noted increasingly larger concentrations of caked white powder caught in the corners of the ship's cargo hatch stiffeners and container supports. Aware of the discovery of spilled arsenic trioxide on deck in Baltimore, the survey was terminated.

Originally it was planned to use the limited deck space forward of the superstructure or the #4 cargo hatch as the decontamination area. The exclusion area was to be forward up to #2 cargo hatch, and the hot zone starting at the ladder leading to the top of the forecastle and the entrance to the #1 hold.

There was little space on the vessel to set up a textbook hazardous material response with adequate separation of the different zones. Movement of personnel in bulky level A suits would be difficult.

The favorable weather window was forecast for Sunday, January 12.

A "level A" (the highest level of personal protection available for a person entering a hazardous environment) entry by strike force members was planned to provide vital information on cargo hold conditions, and to estimate the amount and condition of spilled magnesium phosphide. They were to conduct air monitoring to determine the activity of magnesium phosphide by the concentration of released phosphine gas, and ascertain any other factors that could hamper cleanup efforts.

Due to the water reactive nature of the chemical, a favorable weather window was necessary to open the cargo hatch and allow ventilation before the National Strike Force personnel could go in. That window was forecast for Sunday, January 12.

With the discovery of the white powder as far aft as the superstructure and the stern, it was prudent to treat it as an unknown hazardous material, suspected as arsenic trioxide.

The planned entry was further complicated by the fact that on January 10, personnel could not get close to the #1 hold to visually plan the entry approach and mechanics.

It was decided that a deck barge was needed as the base of entry operations and that a crane would be used to lift fully suited teams onto the vessel deck. It was also decided to stage a preliminary "level B" (the next highest level of protection) entry to survey the deck forward of cargo hatch #3, specifically the area around hatch #1. This team would also video tape the area and obtain samples of the white powder.

Gulf Strike Team member dresses out in level "B" protective gear for initial deck survey. Atlantic Strike Team member assists.

Photo by PA3 Simone Adair.

The original mission deadline was now severely taxed. It was now time critical to marshal necessary equipment, stage the barge alongside the *Santa Clara I* in an optimum position, and then make the required entries within a favorable weather window in day light.

Decontamination issues needed to be fully addressed and acted upon due to the volatile water reactivity of the magnesium phosphide. The decontamination procedure had to be dry.

Due to the probable arsenic trioxide contamination with its severe toxicity, a primary decontamination line was established on the vessel where outer garments were to be removed and a further "traditional" wet decontamination of inner garments was to take place on the barge.

Although not an inhalation hazard except in high winds, the presence of arsenic trioxide, along with the phosphine gas, required extremely strict procedures for personnel protection. Classified as a super toxin by the Environmental Protection Agency, the arsenic presented an acutely toxic hazard (with immediate effect), while the phosphine gas was highly unstable and could explode at any time.

January 12

On early Sunday morning, the winds were a lot higher than forecast -- about 15 to 20 knots from the northwest. This hampered the placing of the barge in an optimum position. It was predicted, however, that the winds would die down by mid-morning. In the light of a 72-hour forecast of rain and higher winds, it was decided to press on with the operation as planned.

The original timetable called for the barge to be secured on the port bow of the *Santa Clara I* by 8 a.m. It was in place by 11 a.m., and the first entry was made around noon on January 12 by members of the National Strike Force dressed in full protective clothing and positive pressure breathing apparatus. Members of the St. John's Island Hazmat team and the Charleston County Emergency Medical Service provided invaluable backup services.

A complete visual and video survey of the main deck near cargo hatch #1 and #2 were accomplished. The presence of white powder along the hatch top of #2 and the main deck on the port and starboard sides was much heavier

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than anticipated. Samples were obtained and sent off to a laboratory for analysis. Within 24 hours, it was determined that the powder was 68 percent pure arsenic trioxide, apparently residual from the containers lost overboard.

Air monitoring showed no concentrations of phosphine gas anywhere on the deck except in small amounts in the immediate vicinity of the #1 cargo hatch top. No other unanticipated personnel hazards were noted and a level A entry into the hold was a "go" for that afternoon.

recorded when the material was turned over. Ambient levels of phosphine in the hold were in the 40 to 50 ppm range.

The amount of chemical spilled on deck was greater than anticipated. It was estimated that the total amount of powder exceeded 500 pounds. A complete survey of the extent of spillage was not possible at this time due to the cargo strewn about the hold as a result of the storm encountered by the vessel off the New Jersey coast. A video of the conditions in the hold was taken for the federal on-scene coordinator.

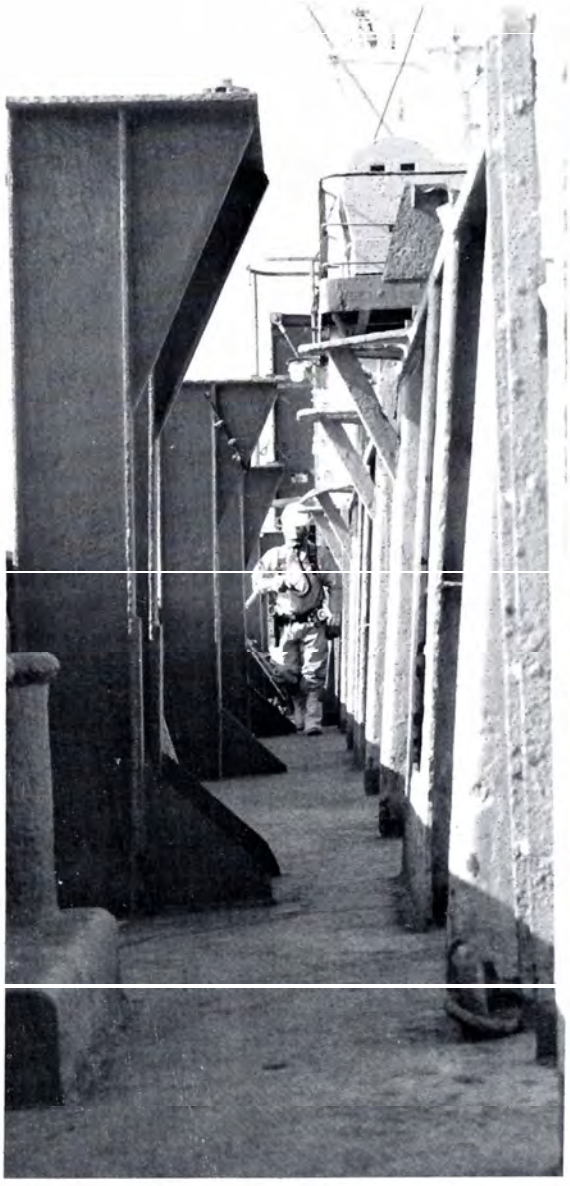
At about 3 p.m., two National Strike Force members dressed in teflon level A suits were lowered into the #1 upper tween cargo hold. This was the first level A entry ever undertaken by the Coast Guard National Strike Force on a vessel at anchorage. There was no textbook to rely on for procedures and precautions.

The team surveyed the hold, monitored the generation of phosphine gas, "raked" the spilled magnesium phosphide and left at about 4 p.m.

The raking was probably the most critical action in mitigating the entire situation. The bad weather forecast materialized and the hold was "buttoned up" for nearly five days. Raking exposed fresh material to moist air, greatly hastening the dry deactivation process.

The magnesium phosphide was "hotter" than anticipated with readings of phosphine gas in excess of 400 parts per million (ppm) [twice the immediate danger to life and health (IDLH) index] at the powder's surface, with much higher spikes

National Strike Force member in level B garb walks aft on the Santa Clara I. *Photo by PA3 Simone Adair.*



The next 30 days

Site safety and work plans had to be developed for the cleanup and recovery of the arsenic trioxide and for the deactivation of the magnesium phosphide. Access to the #1 hold could only be gained via the arsenic-contaminated decks.

A path was cleared of contamination along the port side of the deck to allow access to the hold, while plastic sheeting was placed over hatch covers and the starboard passageway. This permitted response personnel and cleanup workers to deal with the more volatile magnesium phosphide during clear weather, and concentrate on the residual arsenic trioxide when rain prevented work around the water-reactive chemical.

National Strike Force members were present during the month-long operation, bringing invaluable expertise and assistance. They made over a dozen level B entries onto the *Santa Clara I*, including into the #1 lower tween hold.

The process was time-consuming, but effective.

National Strike Force members in level A "NASA moon" suits prepare to deactivate magnesium phosphide. Photo by PAC Richard L. Woods.

The highly explosive nature of the magnesium phosphide coupled with the lack of industrial experience with a spill of this magnitude limited response options. Hazardous material experts on hand decided to "dry deactivate" the chemical inside the hold. This involved raking and leveling the spilled substance to encourage it to slowly react with naturally occurring moisture in the air, followed by the more rapid process of "wet deactivation," which involved the controlled introduction of magnesium phosphide into water, allowing the release of phosphide gas with controlled reactions. To facilitate this operation, the state of South Carolina issued a permit to release phosphine gas under specified controlled conditions.

A wet deactivation system was built and placed on the barge alongside the *Santa Clara I.* Designed to allow the chemical to react with water in a controlled environment, this system included an air-driven propeller to create a downward vortex, a nitrogen line and a fog nozzle.

Dry deactivated magnesium phosphide was lowered to the barge, placed in increments of less than one pound in cotton sacks. These were placed individually in metal cages mounted on poles. This allowed personnel in protective gear to introduce the chemical to the wet deactivation system from a safe distance. After the magnesium phosphide had spent itself, it was placed in a "cold barrel" for 24 hours to allow for any residual reactions to occur.

The system's vortex blower directed vapors away from response and cleanup workers. Two tugs with docking pilots remained at the stern of the *Santa Clara I* to keep the vessel steady and upwind of the operation. All workers were suited in appropriate levels of protective gear for their activities, and rescue and backup teams were always at hand.

The most significant difficulties encountered during the long operation were with the weather and the logistics involved in a water-

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Strike force members check the wet deactivator used to neutralize the magnesium phosphide.

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based response. Winds ranged from zero to 65 miles-per-hour with temperatures shifting as much as 35 degrees during a 24-hour period. This required rapid changes in response equipment and personnel support needs. Rain and fog terminated operations with the magnesium phosphide. No wind resulted in unacceptable concentrations of phosphine gas in the #1 hold and winds over 20 miles-per-hour caused the chemical to swirl. Frequent closure and moisture-proof sealing of the hatch cover occurred.

The effort required to maintain a response operation of the magnitude of the *Santa Clara I* was unprecedented in many ways. Supporting personnel and equipment on a vessel at anchor is far more involved than that of a land-based operation. For one thing, deck barges and the South Carolina Ports Authority Ro/Ro barge were critical for staging deactivation equipment, emergency backup teams, decontamination sites, press areas and around-the-clock on-scene operations.

February 10

After 32 days, the *Santa Clara I* was fully decontaminated of magnesium phosphide and only the arsenic trioxide in the seam of the jammed number two cargo hold remained. The vessel returned to the Columbus Street Terminal where workers repaired the hatch rollers. The remaining containers of arsenic trioxide were offloaded and taken to a controlled site where their contents could be examined for damage.

After wet deactivation of magnesium phosphide has taken place and the phosphine gas has dissipated, the residue is not a hazardous waste. Landfill disposal was authorized by the state. The arsenic trioxide residue was disposed of at an approved site.

On February 10 at 8:50 a.m., the *Santa Clara I* was certified clean and allowed to leave -- but not before proving how well all the diverse response and cleanup groups worked together.

Conclusion

The key to the success of this response is attributed to the close working relationship and communications established from the beginning between all involved parties. All Coast Guard units -- active, reserve and auxiliary -- worked as one with other federal, state and local agencies.

Twice daily briefings at the command post and frequent brainstorming among the various working groups kept problems and "surprises" at a minimum. There was a constant sharing of resources and expertise, which kept the whole operation up to speed and efficient. Indeed, it was an unprecedented experience with teamwork preventing what could have been a dreadful calamity with terrible consequences.

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Chemicals of the month

Arsenic trioxide

Arsenic trioxide (As_2O_3) is a white, odorless, tasteless powder, which is only slightly soluble in water. It reacts with acids, producing arsine, a colorless, highly poisonous gas.

Arsenic trioxide is used as a herbicide, insecticide and rodenticide; as a wood and hide preservative; and in pigments and enamels. It is the base for most other arsenic compounds. The earliest insecticides used against chewing insects were the arsenicals. However, due to the hazards posed to humans and animals, these materials have been replaced by other compounds.

Hazards

It is a known carcinogen, very poisonous by ingestion and dust inhalation, and possibly by skin absorption. It is corrosive to the eyes, skin and mucous membranes. It is harmful to aquatic life in very low concentrations.

Handling

Wear full protective clothing tied at the wrists and ankles, approved dust respirator, gloves and dust-tight goggles. Avoid breathing dust or mist. Promptly clean up any spills and shovel dry material into suitable containers. Wash hands thoroughly after handling, aerate contaminated clothing and gloves before laundering and reuse. Shower at the end of the day.

Fire

Wear special protective clothing and self-contained breathing apparatus. While arsenic trioxide itself is nonflammable, it may produce arsenic fumes when surrounded by fire. Prevent runoff into waterways. Notify local health and wildlife specialists, and water in-take operators.

Magnesium phosphide

Magnesium phosphide (Mg_3P_2) is a dark, charcoal gray nonflammable powder or granule. The commercial product is available as pellets, tablets or impregnated into plastic strips. It is used as a fumigant to control insects in stored grains, nuts, animal feed, tobacco and the like.

Hazards

Acutely toxic when ingested, magnesium phosphide is not absorbed into the skin in toxic amounts. It reacts with water or atmospheric moisture, producing hydrogen phosphide (phosphine), a highly poisonous, spontaneously combustible gas with a disagreeable garlic-like odor.

Handling

Wear gloves and protective clothing suitable for dusts and solids. Open containers only out-of-doors. Keep it away from moisture, open flames and heat. Wash hands thoroughly after handling, and aerate contaminated clothing and gloves before laundering and reuse.

In the event of a spill, have respiratory protection available. Promptly clean up. Material that has just been spilled and is uncontaminated can often be returned to its container. Contaminated soil, debris or water, should be scooped into small open buckets for disposal.

Fire

Wear gloves, protective clothing and self-contained breathing apparatus. Under fire conditions, magnesium phosphide may produce phosphoric acid. Suffocate flames with sand, carbon dioxide or dry chemical. DO NOT USE WATER. When in contact with moisture, magnesium phosphide produces phosphine gas.

Phosphine

Phosphine (PH_3) gas attacks the nervous and circulatory systems. Exposure to high concentrations results in tightness in the chest, dizziness, headaches, weak feeling, loss of appetite and increased thirst. At a concentration of 200 ppm, phosphine gas presents an immediate danger to life and health. Also, in an enclosed or confined space, its combustible nature may cause an explosion.

Remove exposed victims to fresh air immediately. Keep victim calm and warm. Call a physician right away. Delayed symptoms of severe poisoning may occur several days later.

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Arsenic trioxide

Formula: As_2O_3
Synonyms: Arsenic oxide, white arsenic
Physical description: White crystals or powder, odorless
Grade: Refined (99%), crude (95%)

Physical properties:
- Boiling point: 465°C (869°F)
- Melting point: 312°C (594°F)
- Sublimes: 193°C (379°F)

Permissible exposure limit:
- Time weighted average: 0.01 mg/m^3

Combustion properties: Nonflammable solid

Density: 3.74 @ 20°C (solid)

Identifiers:
- CHRIS code: ATO
- CAS registry number: 1327-53-3
- U.N. number: 1561
- U.N. class: 6.1, Poisons
- IMDG Code page no.: 6078
- Marine pollutant: P

NFPA:
- Health hazard: 2
- Flammability: 0
- Reactivity: 0

Magnesium phosphide

Chemical name: Magnesium phosphide
Formula: Mg_3P_2
Synonyms: None
Physical description: Dark charcoal gray powder or granules

Physical properties:
- Decomposition temperature: 1000°C

Combustion properties: Nonflammable solid

Specific gravity: 2.06

Continued next page

Magnesium phosphide continued

Identifiers:

CAS registry number:	12057-74-8
U.N. number:	2011
U.N. class:	4.3, Dangerous when wet
IMDG Code page no.:	4352

NOTE: Magneseum phosphide reacts with water or atmospheric moisture to produce hydrogen phosphide (phosphine), PH_3, a highly toxic, spontaneously combustible gas with a disagreeable garlic-like odor.

Phosphine

Chemical name:	Phosphine
Formula:	PH_3
Synonyms:	Hydrogen phosphide
Physical description:	Colorless gas with garlic-like odor
Physical properties:	
Boiling point:	-126°F (-88°C)
Freezing point:	-209°F (-134°C)
Vapor pressure:	593 psig @ 70°F
Threshold limit value:	
Time weighted average:	0.3 ppm
Short-term exposure limit:	1.0 ppm
Permissible exposure limit:	0.3 ppm
Combustion properties:	Spontaneously flammable
Autoignition temperature:	100°F (38°C)
Density:	1.53 g/l @ 0°C
Specific gravity:	1.15 @ 20°C
Identifiers:	
CAS registry number:	7803-51-2
U.N. number:	2199
U.N. class:	2.3, Poisonous gases
NFPA:	
Health hazard:	3
Flammability:	4
Reactivity:	2

This article was prepared by the Hazardous Materials Branch, Marine Technical and Hazardous Materials Division. Telephone: (202) 267-1577.

Nautical queries — *January-February, 1993*

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. Routine maintenance of boiler sliding feet should include _____.

A. painting the sliding surfaces to prevent corrosion
B. removing all grease from around bolts
C. torquing retaining bolts on the stationary base
D. wire brushing to remove scale, rust and dirt

2. With regard to pressure-closed hydraulic systems, where replenishing pumps are used, an additional function of these units may be to supply fluid flow to _____

A. the reservoir
B. a servo control circuit
C. manual control valves
D. the main system accumulators

3. With regard to pilot-controlled pneumatic regulating valves, the spring force on the valve unit should be adjusted to _____

A. maintain set point
B. maintain the valve of the manipulated variable
C. maintain the steam pressure of the system
D. the operating range of the pilot output loading pressure

4.How many volts are needed to provide a current of 10 amperes to a motor with a resistance of 11 ohms in the line?

A. 21 volts.
B. 110 volts.
C. 220 volts.
D. 240 volts.

5. While on watch in the engine room at sea with one generator on the line, the entire plant blacks out. What was the cause?

A. The micro switch at the throttle trip vibrated open, allowing the main breaker to open via the under voltage trip.
B. The main air compressor stopped.
C. The standby generator was motorized.
D. Someone pushed the trip button to the "Shore Power" breaker.

6. The amount of cylinder lubricating oil metered to each cylinder of a large low-speed diesel engine should be _____

A. the same, whether at sea or during maneuvering
B. corrected during each hour of operation while at constant RPM
C. higher at sea than while maneuvering
D. lower at sea than while maneuvering

7. Which device is often clutched to the flywheel of small and medium-size diesel engines to start them?

A. Magneto.
B. Electric generator.
C. Electronic SCR.
D. Air motor.

8. Fire protection for propulsion motors and generators of diesel electric drive vessels is usually a _____.

A. fixed foam extinguisher
B. fixed CO2 system
C. steam smothering system
D. carbon tetrachloride extinguisher

9. Flywheels reduce speed fluctuations by __.

A. maintaining a constant rack setting
B. storing kinetic energy
C. maintaining equal exhaust pressure
D. maintaining even camshaft speed

Deck

1. If the VCG of a ship rises 1.7 feet, the GZ for the various angles of inclination will ____.

A. decrease
B. increase
C. remain unchanged
D. be changed by the amount of GG' x cosine of the angle

2. When towing another vessel astern, the length of the towing line should be ____

A. as long as possible
B. such that one vessel will be on a crest while the other is in a trough
C. such that the vessels will be "in step"
D. not over two wave lengths in seas up to 10 feet

3. What is the effect of heated intake air on a diesel engine?

A. Increases efficiency.
B. Increases engine horsepower.
C. Increases engine life.
D. Reduces engine horsepower.

4. BOTH INTERNATIONAL AND INLAND
Which vessel is "underway" within the meaning of the rules?

A. A vessel at anchor with the engine turning.
B. A vessel tied to an offshore mooring buoy.
C. A vessel aground with the engine turning.
D. A vessel drifting with the engine turning.

5. Which statement concerning a 298-gross ton tug engaged in towing from Seattle, Washington, to Alaska is correct?

A. No able-bodied seamen are required.
B. Crew must be signed on before a shipping commissioner.
C. A licensed operator of uninspected towing vessels may serve as master.
D. Each crew member must be furnished with a record of sea service at the time of discharge.

6. BOTH INTERNATIONAL AND INLAND
You are aboard the give-way vessel in a crossing situation. Which of the following should you NOT do in obeying the rules?

A. Cross ahead of the stand-on vessel.
B. Make a large course change to starboard.
C. Slow your vessel.
D. Back your vessel.

7. While a vessel is in a foreign port without an American consul, a seaman becomes violent before sailing. The master should ____.

A. call local police, put the seaman in prison ashore and sail the vessel
B. pay off the seaman and arrange with the agent to return him to the original port of signing on in the United States
C. put the seaman in irons and sail to the next port with an American consul
D. send the seaman ashore and arrange with the agent to repatriate him by armed guard

8. The great circle on the celestial sphere that passes through the zenith and the north and south poles is the _____

A. hour circle
B. prime vertical
C. principal vertical
D. ecliptic

9. A sextant having an index error that is "off the arc" has a _____.

A. positive correction
B. dip error
C. negative correction
D. semidiameter error

Answers

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

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

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.

Notice of proposed rulemaking

CGD 90-068, Discharge removal equipment for vessels carrying oil (33 CFR part 155) RIN 2115-AD66 (September 29).

The Coast Guard proposes to establish regulations requiring vessels carrying oil in bulk as cargo to carry discharge removal equipment to contain and remove on-deck oil spills, install spill prevention coamings and install emergency towing arrangements. The proposed regulations would implement provisions of the Federal Water Pollution Control Act as amended by the Oil Pollution Act of 1990 (OPA-90). The purpose of these regulations is to reduce the risk of oil spills, improve vessel oil spill response capabilities and minimize the impact of oil spills on the environment. Proposed requirements for vessels to carry equipment for the removal of discharges of hazardous substances will be the subject of a separate rulemaking.

DATE: Comments must have been received on or before October 29, 1992, by the executive secretary, Marine Safety Council (G-LRA/3406), Coast Guard headquarters, 2100 Second Street, S.W., Washington, D.C. 20593-0001.

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. A copy of the material listed in "Incorporation by Reference" of this preamble may be inspected in room B-731.

For further information, contact: Mr. Frank Wood, project manager, OPA-90 staff. Telephone: (202) 267-6739. This telephone is equipped to record messages on a 24-hour basis.

Supplemental notice of proposed rulemaking

CGD 91-204, Use of automatic pilot: area restrictions and performance requirements (33 CFR part 164 and 46 CFR part 35) RIN 2115-AE00 (October 2).

On January 6, 1992, the Coast Guard published a notice of proposed rulemaking that would have allowed tank vessels to use automatic pilots in certain areas within the navigable waters of the United States, provided that the automatic pilot met certain standards and that a qualified helmsman was present. This supplemental notice revises the January 6 proposal by changing the applicability provisions, allowing highly sophisticated systems to be used in some areas, and deleting Regulated Navigation Areas from the list of areas where automatic pilots must not be used. This proposed rule should promote the safe operation of tankers and integrated tug/barge combinations in United States waters.

DATE: Comments must have been received on or before December 1, 1992, by the executive secretary, Marine Safety Council (G-LRA/3406), Coast Guard headquarters.

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. A copy of the material listed in "Incorporation by Reference" of this preamble may be inspected in room B-731.

For further information, contact: LCDR Paul Jewell, project manager, OPA-90 staff, between 7 a.m. and 3:30 p.m., Monday through Friday, except holidays. Telephone: (202) 267-6746.

Supplemental notice of proposed rulemaking

CGD 91-203, Unattended machinery spaces; operating requirements (33 CFR part 164) RIN 2115-AE12 (October 2).

On April 9, 1992, the Coast Guard published a notice of proposed rulemaking that would have allowed highly automated tank vessels to navigate with unattended machinery spaces in the navigable waters of the United States. This supplemental notice of proposed rulemaking completely revises the April 9 proposal by requiring the machinery spaces of inte-

grated tug/barge combinations and tankers over 1,600 gross tons to be attended when underway in the navigable waters of the United States. Requiring a licensed engineer on watch in the machinery spaces will ensure that faults in the engineering systems will be noticed and addressed without delay. Consequently, this proposed rule should decrease the likelihood of casualties.

DATE: Comments must have been received on or before December 1, 1992, by the executive secretary, Marine Safety Council (G-LRA/3406), Coast Guard headquarters.

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.

For further information, contact: LCDR Paul Jewell, project manager, OPA-90 staff, between 7 a.m. and 3:30 p.m., Monday through Friday, except holidays. Telephone: (202) 267-6746.

Advance notice of proposed rulemaking

CGD 88-103, Controlling the marine asbestos hazard (46 CFR part 197) RIN 2115-AD16 (October 7).

The Coast Guard is considering incorporating into its regulations the guidance it has issued as advisories on exposure to asbestos aboard certain vessels and at outer continental shelf facilities and deepwater ports. Since asbestos is a carcinogen, any exposure to its airborne fibers may be hazardous. If adopted as a final rule, the regulations will establish both limits on exposure and procedures for controlling exposure.

DATE: Comments must be received on or before February 4, 1993.

ADDRESS: Comments may be mailed to the executive secretary, Marine Safety Council (G-LRA-3406) (CGD 88-103), Coast Guard headquarters, or may be delivered to room 3406 between 8 a.m. and 3 p.m., Monday through Friday, except federal holidays. Telephone: (202) 267-1477.

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

For further information, contact: LCDR Charles F. Barker, project manager, Merchant Vessel Inspection and Documentation Division. Telephone: (202) 267-1181.

Final rule

CGD 86-036, Updating approval and carriage requirements for breathing apparatus (46 CFR parts 35, 77, 96, 108, 160, 167, 169 and 195) RIN 2115-AC30 (October 23).

This final rule updates the requirements for approval and carriage of respiratory equipment aboard merchant vessels. The current rules cite outdated agencies and schedules, and allow the carriage of obsolete equipment. This final rule reflects current practice and removes unsuitable equipment from merchant vessels.

DATE: This final rule was effective on November 23, 1992.

For further information, contact: LCDR Charles F. Barker, project manager, Merchant Vessel Inspection and Documentation Division. Telephone: (202) 267-1181.

Proposed rule

CGD 88-079a, Commercial fishing industry vessel regulations (46 CFR part 28) RIN 2115-AD12 (October 27).

The Coast Guard is proposing regulations for United States commercial fishing industry vessels on topics that were separated from the final rules, published in the *Federal Register* on August 14, 1991 (56 FR 40364). These topics generated the most public concern and were separated from the final rules in order for them to be adequately addressed. These topics include: stability for fishing vessels less than 79 feet long; requirements for survival craft on fishing vessels carrying less than four individuals on board; operating within 12 miles of the coastline and outside the boundary line; and administration of exemptions authorized by 46 U.S.C. 4506 in relationship to high vessel density and limited duration fisheries.

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Additionally, these proposed regulations address four other topics, two of which were specifically mentioned in the preamble to the final rule as topics that would be addressed in this supplemental rulemaking. The additional topics addressed are: the Aleutian Trade Act; acceptance criteria for instructors and course curricula; termination of unsafe operations; and stability for load line assignment.

These proposed regulations are intended to improve the overall safety of commercial fishing industry vessels.

DATE: Comments must have been received by December 28, 1992.

ADDRESS: Comments may be mailed to the executive secretary, Marine Safety Council (G-LRA/3406) (CGD 88-079a), Coast Guard headquarters, or may be delivered to room 3406 between 8 a.m. and 3 p.m., weekdays, except holidays. Telephone: (202) 267-1477.

The executive secretary maintains the public docket for this rulemaking. Comments will become part of this docket, available for inspection or copying in room 3406. A copy of the material listed in "Incorporation by Reference" of this preamble may be inspected in room 1308.

For further information, contact: LCDR Tim Skuby, Merchant Vessel Inspection and Documentation Division, Telephone: (202) 267-2307.

Proposed rule

CGD 92-045, Recreational boating safety equipment requirements (33 CFR part 175) RIN 2115-AE26 (November 9).

The Coast Guard proposes to change a number of federal requirements and exemption for carriage of personal flotation devices on recreational vessels. This rulemaking project will provide the recreational boating public with clearer and more appropriate requirements for carrying personal flotation devices, and promote a safer recreational boating environment.

DATE: Comments must be received on or before January 8, 1993.

ADDRESS: Comments may be mailed to the executive secretary, Marine Safety Council (G-LRA/3406) (CGD 92-045), Coast Guard headquarters, or may be delivered to room 3406 between 8 a.m. and 3 p.m., weekdays, except holidays. Telephone: (202) 267-1477.

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

For further information, contact: Mr. Carlton Perry, Auxiliary, Boating and Consumer Affairs Division. Telephone: (202) 267-0979.

Interim Rule

CGD 92-014, State access to the oil spill liability trust fund for removal costs under OPA 90 (33 CFR part 133) RIN 2115-AE19 (November 13).

This rulemaking implements the provisions of the Oil Pollution Act of 1990 (OPA 90) concerning the procedures by which the governor of a state can request payments of up to $250,000 from the Oil Spill Liability Trust Fund for removal costs required for the immediate removal of a discharge, or the mitigation or prevention of a substantial threat of a discharge of oil.

This action is a temporary measure needed primarily to provide a procedure by which the governor of a state can request payments from the fund. This interim rule will be replaced by a more comprehensive rule that addresses, in addition to requests by governors, formal agreements between the states and the Coast Guard providing specific procedures for fund use.

DATES: This rule was effective on November 13, 1992. Comments must be received on or before February 11, 1993.

ADDRESS: Comments may be mailed to the executive secretary, Marine Safety Council (G-LRA/3406) (CGD 92-014), Coast Guard headquarters, or may be delivered to room 3406 between 8 a.m. and 3 p.m., weekdays, except holidays. Telephone: (202) 267-1477. Comments will become part of the public docket and may be inspected or copied in room 3406.

For further information, contact: Mr Donald Taylor, project manager, National Pollution Funds Center. Telephone: (703) 235-4805.

Public information capabilities
CHALLENGED

The Santa Clara I lies at anchor at the port of Charleston.

By PAC Glenn E. Rosenholm
Background

The Public Information Assist Team (PIAT) was a special detachment under Coast Guard headquarters for 13 years before being incorporated into the National Strike Force Coordination Center in Elizabeth City, North Carolina, in September 1991. Now with double its former staff, PIAT's primary mission, providing crisis media relations assistance to federal on-scene coordinators, remains unchanged, but it has assumed additional responsibilities.

As an integral part of the National Strike Force, PIAT members are now trained responders who can assist in pump and boom deployments, and suit up for hazardous chemical releases at the outbreak of a major spill. They also provide complete photo, video and graphics services to support the Coast Guard's environmental response program.

The *Santa Clara I* incidents launched several PIAT firsts:

- a member donned a personnel protective equipment level "B" moon suit and entered an explosive atmosphere to document on video dangerous cleanup activities;
- four members responded almost simultaneously to two separate chemical responses stemming from the same vessel; and
- the team developed graphics, slide show and video presentations on location while assisting a federal on-scene coordinator.

Here is how it happened: *Continued on page 32*

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At MSO/Group Philadelphia

Take an unusually fierce Nor'easter, a rare underway mishap and add the potential danger of a hazardous materials release, and you have the ingredients of front page news.

When it became known that the containers of 414 25-gallon drums of highly toxic arsenic trioxide washed overboard from the *Santa Clara I* off southern New Jersey, the nearest Coast Guard marine safety office (MSO) in Philadelphia, Pennsylvania, was propelled into the spotlight. (Two aspirin-size tablets of arsenic trioxide can kill an adult human being, and the quantity lost could devastate shell fish beds and other marine life on the coastal bottom.)

Soon after word of the incident spread, MSO/Group Philadelphia began holding daily news conferences and answering 50 to 75 media calls a day. This increased public information effort could have interfered with the critical hazardous material response operations already underway. PIAT assistance was requested and within hours, a public affairs specialist was dispatched from Elizabeth City.

The public affairs specialist's first action was to channel all media requests to two lines, going to him and the MSO public affairs officer. By reducing the spokespersons to two, the outgoing message was standardized, decreasing the possibility of error and providing continuous media assistance.

Media interest in the event was primarily regional, including broad coverage in Pennsylvania, New Jersey, New York, Maryland and Delaware. It was soon apparent that the one driving issue behind public interest in the event was the possibility of people and aquatic life being poisoned directly or indirectly by accidental water intake, shellfish ingestion of or skin contact with arsenic trioxide.

Video camera footage taken by PIAT shows responders in level A exposure suits carefully sweeping powder off the deck.

(Left) A National Strike Force responder is monitored after working on the Santa Clara I in an exposure suit.

(Below) Responders move along the decontamination line, removing gear.

At MSO Charleston

Very shortly after the storm-tossed *Santa Clara I* arrived at Charleston, South Carolina, Coast Guard inspectors discovered the vessel was a danger to the surrounding community because of the spilled magnesium phosphide in the number one hold.

Public affairs specialists were summoned from the National Strike Force Coordination Center to provide media relations assistance both at the federal on-scene coordinators office at MSO Charleston and on site at the *Santa Clara I*. Their efforts focused on public safety -- the fact that indeed there was a dangerous substance aboard which could adversely affect the local public; and what the federal, state, local and commercial responders were doing to mitigate the situation.

The public affairs specialists also provided boat rides for media representatives so that they could take close-up shots of the vessel. Media representatives were also permitted to dress out in Level A exposure suits to learn first-hand of the difficulties involved in working with hazardous chemicals.

One public affairs specialist helped develop a site safety plan for the incident responders, using graphics for eye-catching detail. He also dressed out in a Level B hazardous material exposure suit to video tape responders at work in the hold. As a member of the National Strike Force, he had received special hazardous material response training, and thus was able to enter the threatening atmosphere of the *Santa Clara I* and record actual response efforts for the media.

The wide variety of public affairs assistance provided by PIAT members would not have been possible less than two years ago.

Photographs accompanying this article were taken by PIAT members.

PAC Glenn E. Rosenholm is a member of PIAT at the National Strike Force Coordination Center, 1461 U.S. Highway 17 North, Elizabeth City, North Carolina 27909-3241.

Telephone: (919) 331-6000.

Marine board of inquiry

conclusions and recommendations

In May 1992, the Ports and Waterways Safety Act Board of Inquiry concluded that the proximate cause of the cargo loss aboard the *Santa Clara I* was the failure to adequately secure containers and cargo on deck. Possible contributing causes included mechanical weaknesses in the cargo securing system and operational weaknesses.

Container securing

On the *Santa Clara I*, containers are supported on the hatch covers and outboard on elevated deck pedestals. Each hatch holds eight stacks of 40-foot containers and another eight of 20-foot containers, all stowed lengthwise.

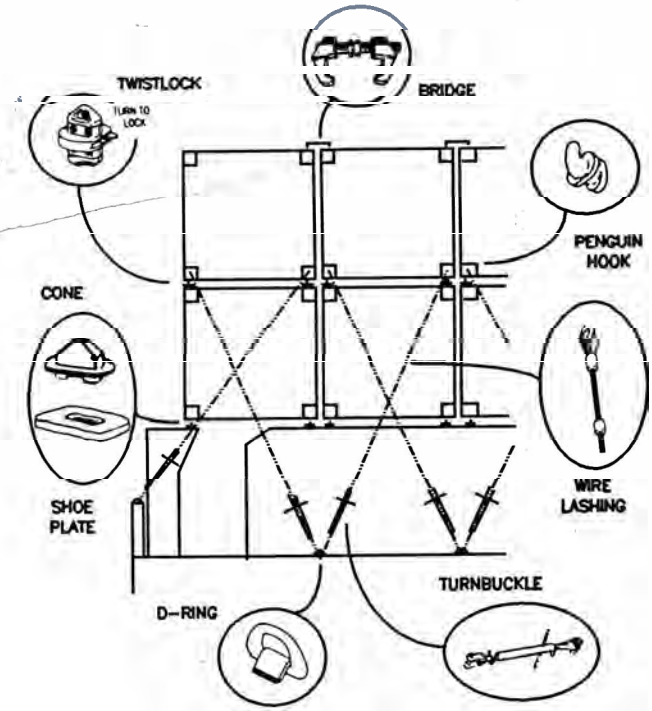
The ship is fitted with a basic stack-lash system, dating to its initial construction in 1973, and extended with the retrofit of deck pedestals. Overall, most components of the securing system appeared to represent standard and sturdy construction, with ample load capacities under tension and shear.

The apparently well-designed system breaks down in the on board application by the crew. There was no Cargo Securing Manual on board, so stowage and securing was done based on experience. None of the crew members had had specific formal training in the subject. Upon inspection, there was an increasing mismatch between parts and improvised installations.

Securing system components

- *flat shoe plates* fitted on the hatch covers and pedestals;
- *cones* set in place in the recess of the shoe plates;
- *bottom tier of containers* placed on the cones, which fit up into the corner fittings of the container;
- *twistlocks* fitted between the bottom and second tier;
- *bridges* fitted athwartships at the tops of adjacent container stacks;
- *penguin hooks* fitted into the bottom corner fittings of the top container, or, in the case of a one-high stack, the top corner of a single container;
- *wire lashings*, with press-fitted stoppers every few feet and eyes at either end, fitted over the penguin hooks and run diagonally down toward the deck; and
- *turnbuckles* tying lashings to D-rings on deck, or on the hatch covers or pedestals, providing tension control for the lashings.

Stack-lash restraint system



Mechanical weaknesses which may have contributed directly to loss of deck cargo --

A) Inadequate number of wire lashings to overcome static and dynamic loads on the container stow;
B) mismatched and improvised lashing gear; (The most obvious irregularities were the use of an incorrect type of turnbuckle for wire lashings and the unconventional use of penguin hooks with wire rope lashings.)
C) improper (inverted) installation of wire lashings, placing unreinforced eyes over penguin hooks;
D) pairing of penguin hooks with wire lashings, possibly weakening the connection to the corner fitting of the container;
E) use of already damaged lashing gear;
F) weak stowage arrangement of outboard 20-foot containers in 40-foot spaces, leaving one end of each container stack unsecured;
G) deficient lashing of the machinery on deck, minimizing restraints against transverse sliding;
H) insufficient number of clips on machinery lashing; and
I) unsecured hatch covers, permitting small lateral movements of entire stow and slackening of the securing system.

Two types of turnbuckles -- cylindrical claw on left and rigid hook on right.

Failed deck pedestals on Santa Clara I.

Operational weaknesses which may have contributed to the casualty--

A) failure to follow recommended international standards for providing stowing and securing instructions (a Cargo Securing Manual) aboard ship;
B) lashing under time pressure underway into heavy weather, reducing the crew's standard of care and reducing the extent of actual lashing and securing;
C) keeping too many varieties of securing gear on board, complicating the job for lashing gangs or crew;
D) excessive GM, causing increased dynamic forces on the cargo, greater likelihood of synchronized rolling with the seas, and, thus, greater chance of large roll angles and green water on deck;
E) failure to properly assess the storm, its movement and relative winds;
F) failure to take early action in deteriorating weather to avoid putting the ship in danger with safe alternatives; and (The master should have navigated to put the ship in a position where he could have reduced speed, improved his heading in relation to the weather, and avoided heavy rolling and green water on deck.)
G) failure to effectively counteract synchronous rolling, pounding and accompanying violent motions of the ship by reducing speed and/or changing course.

Other possible contributors--

A) an apparent structural weakness in the material of the fiberglass-reinforced plastic containers, strained from heavy, dense cargo, compounded by stowage below other heavy containers; and

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B) inadequate blocking and bracing of the contents of the containers.

Controls

Regulatory controls and oversight programs leave significant gaps in safety for the carriage of containerized dangerous cargo in United States waters. International Maritime Organization (IMO) and classification society rules and guidelines systematically outline good cargo securing methods. However, neither the United States nor Panama has implemented the IMO guidelines by regulation. (If the vessel operator had carefully applied these guidelines, the casualty may have been prevented.)

Pollutant stowage

The stowage of marine pollutants, such as arsenic trioxide, on deck instead of under the deck may present an unacceptable risk. In some conditions, such as the introduction of green water on deck, the forces may be so great that damage to deck-stowed cargo is unavoidable. However, the alternatives may present equally compelling safety problems associated with stowage in confined and inaccessible spaces, in the event of a fire, for example, and substantial monetary costs to the industry. This requires more deliberate study.

Reporting failure

Failure by the crew and owner representatives to report and mitigate a known spillage of magnesium phosphide (and other hazardous cargoes) in Baltimore exposed the crew and shoreside personnel to a substantial health threat, and left unchecked a safety hazard affecting the ports of Baltimore and Charleston.

Recommendations

1) **Develop a regulatory package to implement IMO Resolution A.714(17), Code of Safe Practice for Cargo Stowage and Security, for all vessels transiting United States waters with dangerous cargo.**

2) **Propose that IMO improve Resolution A.714(17) in view of the detailed findings of this inquiry, and recommend that it be made mandatory under the (Safety of Life at Sea) SOLAS Convention for ships carrying cargoes addressed by the International Maritime Dangerous Goods Code.**

3) **Develop a compliance inspection program for securing gear and arrangements, addressing the need for complete securing before a ship leaves the dock or enters pilot waters inbound.**
   a) **Propose to the International Association of Classification Societies that they make the design, construction and maintenance of container securing systems a condition of class for all container-carrying vessels.**
   b) **Consider using the National Cargo Bureau to assist in operational inspections to take advantage of existing expertise.**

4) **Examine the failure and repair history of fiberglass-reinforced plastic containers to determine their suitability for continued, unrestricted use.**

5) **Develop an inspection program for assessing the adequacy of blocking and bracing inside containers, and enforcing existing regulations on packing.**

6) **Initiate a quantitative risk analysis regarding on-deck stowage of marine pollutants in coordination with the IMO Subcommittee on the Carriage of Dangerous Goods.**

7) **Refer the case to the Department of Justice for the pursuit of any available criminal and civil penalties concerning the owner's failure to notify the Coast Guard of spilled hazardous materials below deck in Baltimore.**

On May 14, 1992, the commandant of the Coast Guard approved all recommendations made by the board of inquiry.

Scenes from the Santa Clara I clean up.

The three members of the board of inquiry were CAPT John F. McGowan, now chief of the Merchant Vessel Personnel Division; CDR Roger B. Peoples, now executive officer of MSO Galveston; and CDR Richard R. Kowalewski, now chief of the Strategic Planning and Analysis Branch of the Planning Staff.

These conclusions and recommendations were taken from the board of inquiry report published on May 18, 1992, by the Marine Investigation Division of the Office of Safety, Security and Environmental Protection. Copies are available through the National Technical Information Service, Springfield, Virginia 22121.

U.S. Department
of Transportation

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