SS SANTA CLARA CASE STUDY

An Environmental and Transportation First

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and from
discussions with people who were at the USCG Philadelphia Captain of the Port Office at the time

The fateful voyage of
Santa Clara I

The *Santa Clara I, a* 479-foot container ship, began on December 2, 1991 what was supposed to be a routine run from Valparaiso, Chile, with calls in Chile, Peru, Ecuador and the United States ports of Philadelphia, PA; New Haven, CT; Port Elizabeth, NJ; Baltimore, MD; Charleston, SC and Miami, FL. 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 (first account)[1]

Why the incident is so unique
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 re ported 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 Baltimore 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 unwillingness by the owner of the vessel to step forward and call attention to the gravity of the problem. 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. Crewmembers, 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 forth coming 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 (second account)[2]

Even a casual observer would have noticed that there was something wrong with the *Santa Clara* l 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 approximately 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 Mary land 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 shock waves 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 1* 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, producing poisonous, flammable phosphine gas

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)* 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 be cause 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 con tractor also called for the deactivation of a limited quantity of the magnesium phosphide on site. This plan would have required two Mary land 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 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 inert 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.

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. 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 pro vided 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"

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Operation arsenic trioxide response (account three)[3]
unique and successful

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. Due to the sensitivity of the case and it being the first 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 from congressional and federal agencies. All of these factors make this CERCLA re-sponse 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 inter-modal 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. 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.

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."

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 L.* The manifest listed its contents as wood and lumber, which is why it remained afloat. How ever, 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 in creased 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 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 Ad ministration (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 nighttime operations. 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 de fined 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
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 con tents. 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 re located 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.

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 Seaward 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 over pack 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.

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 land filling 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 land filling 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 land filled in Pinewood, South Carolina. The shipment of the decontaminated chemical containers was in compliance with all appropriate federal, state and local requirements.

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 en sure 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 Nation al 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 (account four)[4] UNPRECEDENTED

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. *(Seepage 27 [or 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 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.

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.* An 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 safe guard 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 Clara1* 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.

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,

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. 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.

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. 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 favor able weather window in daylight.

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 am. 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 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.

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 I at the powder's surface, with much higher spikes 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.

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 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 con trolled 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 down ward 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* Ito 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-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 re sources 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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Public information capabilities (account five)[5]
CHALLENGED

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 re leases at the outbreak of a major spill. They also provide complete photo, video and graphics ser vices 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:

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 shellfish 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.

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 videotape 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.

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SOME QUESTIONS AND POSSIBLE DISCUSSION POINTS

We have all read this case so it is inappropriate to restate what has been covered in the case. Apply knowledge and experience to explain/synthesize/analyze and draw conclusions or make recommendations.

1. Can you give at least five short reasons that this case should/ should not be assigned in this class?

2. If the businesses directly involved and the authorities had functioned as they should, what actions should have been taken to minimize and/or prevent this maritime near disaster? Be very specific and exclude the part of the master of the ship or of the crew; they are not part of the issues for this discussion.

3. From a pragmatic perspective what systemic shortcomings are highlighted in this case and where should corrective efforts be focussed to minimize the possibility of a similar event occurring? Examine the entire journey of the materials not just the ship.

4. Are there any significant differences in the telling of this ‘story’ from the perspectives of the various participants (account 1 is by the Chairman of the Board of Inquiry; account 2 is by an involved Coast Guard Officer at the Port of Charleston; account three is by officers who played varying roles, but not necessarily on scene roles in this case; account four is by the most senior Officers involved in the cleanup – the Captain of the Port of Charleston & the Commanding Officer of the Strike Team; account five is by the Public Affairs representative).