



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Yost M-328

Date: June 18, 1987

In reply refer to: M-87-17 and -18

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Commandant
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Washington, D.C. 20593

About 0910 on July 30, 1986, the EMERALD SEAS, a Panamanian registered, 622-foot, 24,458-gross ton, passenger ship with 1,296 people aboard, was anchoring less than a mile offshore of Little Stirrup Cay, Bahamas, when a crewmember saw thick, black smoke coming out of an engine department storeroom. The storeroom contained acetylene, oxygen, argon cylinders, and plumbing parts. When the storeroom door was opened, more smoke poured out, so crewmembers retreated behind a watertight door. Shortly thereafter, there were two explosions and a fire. While passengers were assembled at their assigned lifeboats, the crew fought the fire. By 1005, the fire had been extinguished. U.S. Coast Guard helicopters evacuated 15 passengers and 2 crewmembers, who were taken to hospitals in Miami and treated for smoke inhalation and injuries. The ship arrived in Miami with the remaining passengers and crewmembers on July 31. Damage repair costs were estimated to be about \$300,000. The ship was returned to service on August 1, 1986. ^{1/}

The Safety Board considered three possible ignition sources for the fire in the engine department storeroom:

- (1) arcing or overheating of the electrical wiring,
- (2) spontaneous combustion of oily rags,
- (3) unattended burning acetylene torch.

If there was arcing or overheating of the electrical wiring, it was not serious enough to open the circuit breaker that protected the circuit before the explosion. Because the electrical power was still on, the chief engineer ordered electrical power secured in the Times Square area after the smoke was discovered. Later, Safety Board investigators found no evidence of an electrical problem. Spontaneous combustion of oily rags could have been a source of ignition; however, the chief engineer and the donkeyman testified that there were no oily rags in the engine department storeroom. The possibility of a lighted torch being left unattended could not be entirely ruled out although this seems rather improbable. Furthermore, the flame from the torch could have provided the heat necessary to degrade either the oxygen or acetylene lines to the torch and thus provide the fuel and/or the oxygen for rapid fire growth.

^{1/} For more detailed information, read Marine Accident Report--"Fire and Explosions Onboard the Panamanian Passenger Ship EMERALD SEAS in the Atlantic Ocean Near Little Stirrup Cay, Bahamas, July 30, 1986" (NTSB/MAR-87/04).

The explosions occurred when an oxygen cylinder, overheated or overpressurized by the fire, exploded and when the acetylene content in the room exceeded the explosive concentration limit of 2.5 percent in air. Because debris and other evidence that could have been used to determine the source of ignition was disturbed during overhaul or was thrown overboard by the time Safety Board investigators arrived at the vessel, none of these possibilities could be confirmed or ruled out.

Because a short piece of metal tubing was attached to one of the acetylene cylinders, and because there was no other damage to the cylinder, it is reasonable to assume that a regulator, hose, and torch had been attached to the cylinder. The valve on the cylinder was found in the open position after the fire and explosions, indicating that, if acetylene were in the cylinder at the time of accident, it was present at 250 psig and could pass through the regulator to an attached hose. If the hose or torch leaked, or if the torch gas release handle was depressed, acetylene would have been introduced into the atmosphere of the engine department storeroom.

Subsequently, the fusible plugs on most of the acetylene cylinders melted, releasing acetylene, and the rupture discs on the oxygen cylinders ruptured, releasing oxygen. As a result, both acetylene and oxygen contributed to the fire and explosions. The amount of acetylene and oxygen in the cylinders before the fire could not be determined. Acetylene was the only flammable material reported to be in the engine department storeroom that would have produced thick, black smoke.

After the door to the engine department storeroom was opened, the smoke was so dense that it caused the crewmembers to retreat behind a fire door and a watertight door. The fact that the first explosion was reported soon after the door was opened indicates that the intensity of the fire before the door was opened may have been restricted by the available oxygen in the atmosphere of the engine department storeroom. Opening the door introduced additional oxygen into the storeroom, probably causing the acetylene-rich atmosphere to burn more intensely and/or to explode. As the fire heated the cylinders, causing the relief devices to open, additional acetylene and oxygen would have been released, further intensifying the fire.

Most of the fusible plugs on the acetylene cylinders melted, and the rupture discs on the oxygen cylinders ruptured as they were designed to do when exposed to fire. The testimony of the chief engineer indicated that an oxygen cylinder, split open lengthwise, was among the debris thrown overboard. A lengthwise split in a pressurized cylinder is normally associated with an overpressure failure. However, since the cylinder was not recovered, the type of failure could not be verified. Consequently, the cause of the failure cannot be determined.

The holes in the oxygen and acetylene cylinders examined after the accident were not typical of overpressure failures in cylinders. The damage appears to have occurred after the pressure was released or the cylinders were empty. The walls of the oxygen cylinder with the hole appear to have thinned before the hole was created. A concentrated flame or heat source, like a torch, would have been necessary to melt holes in the cylinders, assuming that the cylinders were not damaged before the fire. The force of the explosions may have moved the cylinders, causing the flame to be directed at other cylinders, including the oxygen cylinder with a partially melted area. The USCG chief petty officer who boarded the EMERALD SEAS from the FARALLON stated that he saw an acetylene cylinder with a 1- to 1 1/2-inch hole and no valve fitting. The Safety Board was unable to determine the cause of the hole and the missing valve fittings.

As a Panamanian-registered ship, the EMERALD SEAS was not required to store the acetylene and oxygen cylinders in compliance with any U.S. hazardous materials standards, nor were there any international regulations for these ships stores. The stowage of these gases in accordance with Compressed Gas Association (CGA) Pamphlet P-1 or National Fire Protection Association (NFPA) standards, however, would have reduced the magnitude of the fire.

Since oxygen is necessary for the combustion of flammable materials, storing the acetylene and oxygen cylinders separately would have helped to decrease the fire's intensity. Limiting the quantity of acetylene and oxygen that could be stored aboard the vessel would have decreased the amount of acetylene and oxygen available to burn and explode. If all of the cylinders had been full, 1,800 cubic feet of acetylene may have been aboard, three times that allowed aboard U.S. passenger ships by 46 CFR Part 147.

While this accident does not justify treating acetylene and oxygen when carried as ships stores in the same manner as they would be treated if they were carried as cargo, it demonstrates that when hazardous materials are stored improperly or in excessive amounts, they can jeopardize the safety of ships, their passengers, and crewmembers. The Safety of Life at Sea (SOLAS) 74 should be amended to provide for the safe stowage of all hazardous materials carried as ships stores.

Smoke created two major problems during the emergency: reduced visibility in passageways and smoke inhalation. Several passengers had difficulty finding their way because smoke reduced visibility in the passageway. In addition, 40 passengers and 1 crewmember suffered smoke inhalation. These problems were aggravated when the ship's ventilation system continued to operate, spreading the smoke until the ventilation system was shut down.

There are two ways to stop ventilation: a crewmember in the immediate vicinity of a fire shuts down the ventilation by using a control near the ventilation motors or a crewmember, alerted to the fire by an alarm, can trip the main ventilation switch from the bridge. Either action can cause a critical time delay in an emergency. In this accident, the air-condition engineer shut down the ventilation system in the Times Square area only after a considerable amount of smoke had spread throughout other areas of the ship that would not otherwise have been involved in the incident. The delay was sufficient to be almost fatal for at least 2 passengers and to cause smoke inhalation to 38 other passengers and 1 crewmember.

The ship's automatic system for closing ventilation dampers is actuated by heat. The heat actuator closes the damper by melting a fusible link; however, before the heat becomes intense enough to melt a fusible link, large amounts of smoke can, as this accident demonstrated, be carried from the fire to other areas of the ship. To prevent smoke from spreading during a fire, smoke detectors should be installed to shut down the ventilation system automatically in the vicinity of the fire when the detector is activated. Such a smoke detector should be installed as part of the local control for the ventilation system. The individual smoke-activated ventilation switch should be installed in addition to any other ventilation shutdown system on the ship. Shutting down ventilation in this manner would be accomplished quickly without depending on local or remote operation from the bridge after a fire or smoke has been detected.

On August 21, 1985, as a result of its investigation of the fire aboard the Bahamian passenger ship SCANDINAVIAN SUN, 2/ the Safety Board made the following recommendation to the USCG:

2/ Accident Report—"Fire Aboard the Bahamian Passenger Ship M/V SCANDINAVIAN SUN, Port of Miami, Miami, Florida, August 20, 1984" (NTSB/MAR-85/08).

M-85-60

Propose to the International Maritime Organization an amendment to SOLAS 74 to require that heat or smoke detectors be made a part of each automatic fire door release switch on passenger ships so that the door will close when the detector is activated. (Class II, Priority Action)

On November 27, 1985, the USCG responded that:

This recommendation is concurred with. The Coast Guard has already initiated research to determine the feasibility of incorporating this requirement into domestic regulations. Such systems are available commercially for land-based installations. The Coast Guard will bring this recommendation to the attention of the International Maritime Organization (IMO) with a view towards improving the SOLAS requirements. The next meeting of the IMO Fire Protection Subcommittee is scheduled for February 24-28, 1986, at which time we will attempt to broach this subject. The Coast Guard will apprise the Safety Board of any significant developments on this subject.

On March 25, 1986, the Safety Board responded that it was pleased that the Coast Guard was bringing this recommendation to the attention of the IMO at the next meeting of the Fire Protection Subcommittee, scheduled for February 1986. Safety Recommendation M-85-60 has been classified as "Open—Acceptable Action" pending notification of the results of the Coast Guard's efforts.

The purpose of this recommendation is to incorporate smoke detectors in the fire door release mechanisms so that the individual fire door would close automatically when the detector is activated, thus minimizing the spread of smoke or fire. By installing smoke detector-activated mechanisms to close fire doors and ventilation systems automatically, much of the present danger of spreading smoke aboard large passenger vessels can be eliminated.

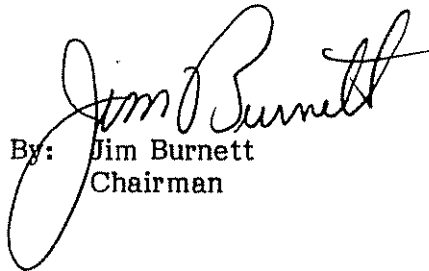
Therefore, as a result of its investigation, the National Transportation Safety Board recommended that the U.S. Coast Guard:

Propose that the International Maritime Organization amend SOLAS 74 to require regulations for the stowage of dangerous materials as ships stores similar to those in 46 CFR Part 147 or similar to standards such as those published by the Compressed Gas Association and the National Fire Protection Association. (Class II, Priority Action) (M-87-17)

Propose that the International Maritime Organization amend SOLAS 74 to require that smoke detectors be made part of each local ventilation system to shut down the ventilation system automatically when the detector is activated to prevent the spread of smoke. (Class II, Priority Action) (M-87-18)

Also as a result of its investigation, the Safety Board issued Safety Recommendations M-87-19 and -20 to Admiral Cruises, Inc.

BURNETT, Chairman, GOLDMAN, Vice Chairman, and LAUBER and NALL, Members, concurred in these recommendations.


By: Jim Burnett
Chairman