

CRUISE SHIP FIRE
Port Canaveral, FL
March 9, 1984



FIRE INVESTIGATIONS

NATIONAL FIRE PROTECTION ASSOCIATION

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Investigation Report

Scandinavian Sea Cruise Ship Fire
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March 9, 1984

Prepared by

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In Cooperation with

Federal Emergency Management Agency/
United States Fire Administration

and

National Bureau of Standards/
Center for Fire Research

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ABSTRACT

At approximately 7:30 p.m. on Friday, March 9, 1984, the Scandinavian Sea was on a daily cruise approximately 5 miles off the east coast of central Florida when a fire in a crew cabin was discovered by a crew member. He telephoned the ship's bridge and reported the fire. Officers on the bridge immediately mobilized the ship's fire brigade. Crew members attempted unsuccessfully to extinguish the fire, first using portable hand extinguishers and then with 2 1/2-inch hose lines. While these initial attempts to suppress the fire were being made, the captain alerted the 744 passengers onboard to the fire and returned the ship to a terminal at Port Canaveral.

The Scandinavian Sea arrived at the cruise ship terminal in Port Canaveral at approximately 9:30 p.m. where land-based fire department units were standing by. While members of the ship's crew assisted all 744 passengers in safely disembarking the ship, land-based fire crews boarded the ship and, guided by other members of the ship's crew, initiated fire suppression operations. Before the 40-hour fire suppression operation was completed, the fire had spread vertically within the no. 1 main vertical zone from A deck (deck of fire origin) heavily damaging the main, upper and lounge decks.

Six factors were identified during the investigation which contributed significantly to the magnitude of this incident. These critical factors were:

- The failure to extinguish the fire in its incipient stage;
- The fuel loading of the cabins in the area of initial fire involvement;
- The failure of fire station hoses onboard the ship when fire crews attempted to place these lines in service;
- The incompatibility of the ship's fire station (standpipe) hose connections with land-based fire department hose couplings;
- The lack of a detailed contingency plan for fire fighting operations onboard ships docked at Port Canaveral;
- The lack of training of the land-based fire department units in shipboard fire fighting tactics.

INTRODUCTION

The National Fire Protection Association (NFPA) investigated the Scandinavian Sea cruise ship fire in order to document and analyze significant factors that resulted in the lengthy fire suppression operations and severe damage to the ship. The study was conducted under a major fires investigation agreement with the Federal Emergency Management Agency/United States Fire Administration (FEMA/USFA) and the National Bureau of Standards/Center for Fire Research (NBS/CFR).

The agreement, funded by all three organizations, provides for the investigation of technically significant fires by the NFPA's Fire Investigation and Applied Research Division to document and analyze incident details and report lessons learned for fire prevention purposes.

The NFPA became aware of the Scandinavian Sea cruise ship fire on March 9, 1984. Tom Klem, Director, Fire Investigations and Applied Research Division, and Tom Timoney, Fire Protection Specialist, traveled to Port Canaveral to document the facts related to this fire. An initial four days of on-site study and follow-up data collection are the basis for this report and NFPA's analysis of the event. Entry to the fire scene and data collection activities were made possible through the cooperation of the National Transportation Safety Board (NTSB) and the United States Coast Guard (USCG).

The NTSB is an independent federal transportation accident investigation agency. The Board's mission is to determine the probable cause of transportation accidents and to formulate safety recommendations to improve transportation safety. The United States Coast Guard Marine Board of Investigation headed by Captain George F. Ireland held hearings to determine probable cause of the fire and determine significant factors impacting on the final result. Investigative reports of this incident are being prepared by

both the NTSB and the USCG. NFPA investigators were assigned to the NTSB investigative team comprised of marine experts. The investigation team was headed by Paul Esbensen, Investigator In-Charge.

This report is another of NFPA's studies of fires having particularly important educational or technical interest. The information presented is based on the best data available immediately after the fire incident and that obtained during subsequent follow-up. This report describes fire protection considerations of the Scandinavian Sea cruise ship and presents findings on the contributing factors to the loss of property based on the NFPA's analysis of the data collected and observations during the on-site investigation. It is not NFPA's intention that this report pass judgment on, or fix liability for, the property damage to the Scandinavian Sea.

The assistance of Paul Esbensen and Bill Woody of the NTSB-Marine Accident Division in the technical development and review of this report is recognized and appreciated. In addition, the assistance of Lieutenant Jack Burns and members of the Cape Canaveral Volunteer Fire Department in the on-site data collection phase is recognized and appreciated. A special thanks to Charles Keller, Marine Field Service Specialist, for his review of this report.

BACKGROUND

Scandinavian World Cruise Line offered daily cruises on the m/s Scandinavian Sea which departed Port Canaveral at 11:00 a.m. for a "cruise to nowhere," returning at 10:00 p.m. Daily cruises aboard the Scandinavian Sea offered a variety of entertainment and recreational activities which included an onboard casino. In order for the casino to operate legally, the ship had to sail beyond the three-mile coastal water limit.

The Scandinavian Sea's port of registry was Nassau in the Commonwealth of the Bahamas. The Bahamian government is a party to the International Convention for the Safety of Life at Sea (SOLAS) 1974, a treaty which establishes minimum safety standards for ships.

Foreign passenger vessels that trade in the United States are required to comply with the safety standards found in the 1974 Safety of Life at Sea Convention (SOLAS). This convention (or treaty) details specific measures, design features, and life saving arrangements that passenger vessels must meet. The vessel's flag state, in this case the Commonwealth of the Bahamas, is required to insure that the vessel is designed, built, and continually maintained to those standards. The United States Coast Guard as part of its responsibility conducts what are referred to as "control verification examinations" on a periodic basis. The United States Coast Guard inspection program is conducted to insure continued maintenance of the SOLAS standards. If the vessel is in compliance with the certificate issued by the flag state, the Coast Guard issues a control verification certificate. Inspections by the United States Coast Guard do not take the place of the required flag state inspections, but are designed to supplement them. The United States Coast Guard made a "control verification examination" of the Scandinavian Sea on January 20, 1984 and issued a control verification certificate valid until March 21, 1984.

The SOLAS standards are designed to provide minimum levels of life safety at sea. Ships and crews are equipped through a series of active and passive fire protection systems to combat fires while at sea. Examples of active fire protection systems onboard ships include fire detection and alarm systems, standpipe and hose systems, portable fire extinguishers, and fixed fire extinguishing systems protecting specific high hazard areas.

The passive fire protection systems encompass the structural assemblies that are built into the ship itself. The passive systems combine the use of structural steel assemblies protected with thermal insulation coverings which are designed to retard the spread of fire from compartment to compartment and deck to deck for the time interval required to isolate and extinguish a fire or allow for safe abandonment of the vessel. Horizontal spread of a fire is retarded by fire-rated bulkheads which divide the decks of a ship into main vertical zones referred to as MVZ's. SOLAS standards require these fire-rated bulkheads be spaced so as to limit the maximum length of a main vertical zone (MVZ) to 40 meters (131 feet).

Critical to the success of both the active and passive fire protection systems in a fire situation are the prompt actions of the crew. Selected crew members are trained in shipboard fire fighting techniques which include the use of fire fighting equipment, self-contained breathing apparatus (SCBA), and the understanding of the role of the passive fire protection systems in the containment of a fire.

The 490-foot, 10,736 gross ton m/s Scandinavian Sea was built in the United Kingdom. The keel of the ship was laid in 1969 and the ship was delivered to its owners in August 1970. The registered dimensions of the ship are 468.5 feet by 65.7 feet by 16.5 feet. Prior to initiating the daily cruise program from Port Canaveral in 1982, the \$30 million Scandinavian Sea underwent approximately 10 million dollars of interior renovations.

Following this renovation work, the ship had accommodations for 1,062 passengers and 175 crew members.

The Scandinavian Sea's hull was of welded steel construction. There were three decks below the main deck, designated A through C, and four decks above the main deck (see Diagram #1). The ship was divided into six main vertical zones (MVZ) by fire resistant bulkheads and steel decks. The greatest distance between these fire resistant bulkheads was approximately 100 feet. These fire resistant bulkheads were designed to have a "Class A-60" fire resistance rating.*

Construction materials found within the ship included corridor walls and cabin separations of 5/8-inch cement asbestos panels covered on both sides by a decorative plastic veneer. In occupied portions of the ship, a suspended ceiling was located approximately 19 inches below the deck above. Panels in the suspended ceiling system were 3/8-inch cement asbestos covered on both sides by a decorative veneer finish. Cabin doors throughout the ship were 1 1/8-inch cement asbestos covered on both sides by a decorative veneer.

Within crew and passenger cabins, combustible materials included wood closets and furnishings, synthetic foam mattresses, and clothing. Decks throughout occupied portions of the ship were covered with carpeting. In special areas of the ship such as the casino, dining rooms, and entertainment areas, combustibles included upholstered furnishings, gaming tables, and wood stud interior partitions.

*Bulkheads were constructed to prevent the passage of smoke and flame for one hour in a standard fire test.

Fire Protection Features

The Scandinavian Sea was protected throughout by a 64-zone fire alarm system which combined fixed temperature heat activated devices with manual alarm stations, located throughout the ship. Activation of any zone in the ship's fire alarm system would automatically sound a fire alarm on the ship's bridge and in the engine room. The zone from which the fire alarm signal was initiated would illuminate on the fire alarm annunciator panel located on the ship's bridge. Activation of the fire alarm system would also automatically release holding devices on the fire doors in the particular MVZ where the fire alarm signal was received.

One hundred forty-seven fire stations (hose cabinets) were located throughout the ship, providing protection on all decks. Each fire station contained a 2 1/2-inch gated hose connection and a 50-foot length of synthetic or unlined linen hose with an adjustable nozzle. Several of these stations also contained a reel of 1-inch rubber hose with an adjustable pattern nozzle. Water supply to the 1-inch hose reels was provided by the ship's sanitary water system. Onboard fire pumps supplied water to the fire main (standpipe) system which could also be supplemented by land-based equipment through two international shore connections located fore and aft on the ship.*

Ship's Fire Brigade

The emergency plan for the Scandinavian Sea detailed responsibilities of the mobile fire group in the event a fire was to occur onboard ship. The mobile fire group was broken down into three separate groups, each with a specific responsibility which included fire fighting, fire limitation, and search and rescue. Fire fighting was the responsibility of four, two-man

*An international shore connection allows land-based fire units to supply and/or supplement the water in a ship's fire main system through a two-piece connection regardless of any differences in threads that may exist between the ship and the land-based units.

teams whose members had been specifically trained in the techniques of shipboard fire fighting. The ship was equipped to provide 5 fire fighters with full protective clothing and 30-minute SCBA units. In addition, 10 spare 30-minute cylinders for the SCBA units were onboard.

It was the fire fighters' responsibility upon activation of the ship's fire alarm system to respond to the fire zone, don protective clothing and SCBA, and attack the fire with the extinguishing equipment located throughout the ship. The fire limitation group, also comprised of four, two-man teams, was responsible for preventing the spread of the fire to adjacent areas of the ship through heat transfer. The search and rescue group consisted of two, two-man rescue teams and a two-man first aid team. The search and rescue group's assignment was to evacuate adjoining zones to the fire zone, assist the fire fighters and fire limitation group as required, and provide medical aid to injured passengers or crew.*

Fire Fighting Technique

Upon notification of a fire onboard the ship, the fire fighting teams respond to the fire area and evaluate the situation. If the fire is in the incipient stage where the fire fighting teams equipped with protective clothing and SCBA could effectively attack and extinguish the fire, an aggressive attack is initiated utilizing the hand extinguishers and/or 2 1/2-inch handlines located at fire stations throughout the ship.

In incidents where the fire is already established and/or initial attempts to extinguish the fire are unsuccessful, resulting in the build up of intense heat and thick smoke in the passageways, the MVZ in which the fire is located

*Taken from the Emergency Plan of Scandinavian World Cruises - M.V. Scandinavian Sea.

is sealed to eliminate the supply of oxygen. This is accomplished by verifying that the fire rated doors and the dampers in the HVAC system in the MVZ are completely closed. The fire limitation teams monitor the decks and bulkheads in the area surrounding the fire to insure that the fire does not spread to these areas by heat conduction through the bulkheads and decks.

Public Fire Protection

The city of Cape Canaveral encompasses an area of approximately 1.9 square miles with a population of 7,000 people. Port Canaveral covers an area approximately three square miles and provides facilities for approximately 200 leasing tenants. Fire protection for both the city and the port is provided by the Cape Canaveral Volunteer Fire Department. The fire department has a 100 percent volunteer force of 30 fire fighters and operates three engine companies from a single main station.

Fire protection at Port Canaveral is provided by the Cape Canaveral Volunteer Fire Department under a contract between the Port Authority, the city of Cape Canaveral, and the Cape Canaveral Volunteer Fire Department. Under this agreement, the fire department has both fire prevention and fire fighting responsibilities. The fire prevention responsibilities included the periodic inspection of the fire hydrants located throughout the Port area by the fire department and the city.

Specifically stated in the contract in effect at the time of the incident was "the city and the fire department shall not have the responsibility to provide fire protection on the water or to ships in the Port basin if docked from the waterside or to board any ship, but will cooperate with the Coast Guard and other parties to such extent as may be practical and feasible in fire fighting activities." The Cape Canaveral Volunteer Fire Department had responded to other fire incidents of smaller magnitude involving ships at Port Canaveral.

THE INCIDENT

At approximately 11 a.m. on Friday, March 9, 1984, the Scandinavian Sea departed Port Canaveral for a scheduled eleven-hour cruise with 744 passengers and 201 crew members onboard. At approximately 7:30 p.m., a crew member in the area discovered a fire in cabin 414 of A deck. He telephoned the ship's bridge and reported the fire and then attempted to suppress the fire with portable extinguishers. His attempts to suppress the fire with both a pressurized water extinguisher and a dry chemical extinguisher were unsuccessful and he was driven from the area of cabin 414 by heat and smoke.

Upon receiving telephone notification of the fire on A deck, officers on duty on the bridge sounded the fire alarm in the crew's quarters to mobilize the fire brigade. After being informed of the fire's location, members of the fire team responded to A deck. Officers on duty on the bridge, using a public address system, then instructed passengers to move to the open air portions of the upper decks of the ship. Crew members not specifically involved in fire brigade operations, assisted passengers in moving to the open air portions of the ship and began issuing them life jackets. Once the passengers were assembled on the upper decks, officers on the bridge, using the public address systems, advised passengers of the magnitude of the fire and the actions to take in disembarking the ship once it returned to a terminal at Port Canaveral.

Immediately after receiving telephone notification of the fire, officers on the bridge shut down the ship's heating, ventilation and air conditioning system and dispatched crew members to verify that all the remote control dampers in the fire zone had closed. These crew members found that all the remote control dampers in the no. 1 MVZ had operated and were closed.

Fire Brigade Operations

Members of the ship's fire brigade responded to A deck following activation of the fire alarm system. First arriving brigade members without protective clothing or SCBA attempted to advance a 2 1/2-inch handline through the fire door at frame 153 toward cabin 414. While fire brigade members were attempting to utilize this 2 1/2-inch handline, the nozzle separated from the unlined linen hose and the initial fire attack with a handline was delayed while fire brigade members attempted to repair the handline. A second handline was then advanced through the fire door at frame 153 and although brigade members were able to attack the fire in the cabin, they were driven from the area by intense heat and smoke in the passageway. Later arriving brigade members, also without protective clothing, donned SCBA and also attempted to attack the fire in the area of cabin 414; however, they too were forced to retreat from the passageway due to the intense heat.

Because of the intense heat encountered in the passageway, a decision was then made by the chief officer to abandon any further attempts to extinguish the fire with hoselines and instead, seal off the area at the fire rated bulkhead at frame 153. The objective in sealing this portion of the No.1 MVZ was to halt the supply of oxygen to the fire from sources outside this portion of the No.1 MVZ which would result in reducing the intensity of the fire and ultimately extinguishment. However, fire brigade members left the two 2 1/2-inch hoselines lying in the passageway flowing water in the area of cabin 414. These 2 1/2-inch handlines were supplied from fire stations aft of frame 153 which prevented the fire door at frame 153 from being closed completely and allowed the fire to continue to receive oxygen from sources outside this portion of the No.1 MVZ through this opening.

The fire brigade then held their position at the fire rated bulkhead at frame 153 until the ship completed tying up at the cruise ship terminal and land-based fire fighters boarded the ship.

Fire Department Operations

At approximately 7:40 p.m., the Cape Canveral Volunteer Fire Department was requested by the Coast Guard to stand by at the Port Canaveral cruise terminal for a "possible ship fire." The Scandinavian Sea arrived at the harbor entrance at approximately 8:00 p.m. with smoke showing from the forward portion of the ship. The ship was then turned in order to present the starboard side to the dock to enable the gangway to be rigged. The Scandinavian Sea completed tying up at approximately 9 p.m., at which point the 744 passengers safely disembarked from the ship.

While the passengers were disembarking, land-based fire fighters boarded the ship and, guided by members of the ship's crew, initiated both search and rescue and fire fighting operations. Fire crews on Main Deck and B deck reported finding smoke and heat but were unable to locate any fire. Fire crews initiated the attack of the fire on A deck, entering through the fire door at frame 153. These land-based fire fighters first attempted to utilize the ship's 2 1/2-inch handlines; however, after several of these handlines ruptured, the decision was made to use fire department hose supplied from engine companies on the pier.

At approximately the same time, members of the ship's fire brigade attempted to gain access to A deck using the forward stairway at frame 179, but were forced back due to the intense heat. The decision was then made by the land-based fire crews to attempt to ventilate the fire area on A deck using the forward stairway. Two smoke ejectors supplied by a portable generator located on Main Deck were hung in the stairway to increase ventilation.

After ventilation operations began, fire crews advancing 1 1/2-inch handlines on A deck reported that smoke and heat conditions improved noticeably. Fire crews then located 3 separate cabin fires and were able to extinguish two of these fires. The two fires were in cabin 414 and in a cabin

across the passageway from 414. The third fire was in a cabin located at frame 181. Fire fighters described heat conditions in the passageway intensifying as they advanced handlines towards this cabin. While these fire fighters were extinguishing the fire in this cabin, they discovered the suspended ceiling was hot and began punching holes in the ceiling panels to enable them to extinguish fire in the area above the suspended ceiling and cool the steel deck using 1 1/2-inch handlines. Fire crews were working to extinguish fire in the concealed spaces of A deck when the ventilation of A deck was ordered halted by Coast Guard personnel. Shortly after ventilation of A deck was halted, fire crews were driven from the fire area by intense heat.

Coast Guard personnel had arrived on the scene at approximately 9:15 p.m. and began assisting the fire fighting operations. At 10:30 p.m., two officers from a Coast Guard vessel in port arrived onboard and assumed control of the operation, and the decision was made to cease the ventilation operations using the forward stairway at frame 179. At approximately 11 p.m., the fire was reported extinguished; however, within minutes fire was again discovered and smoke was observed coming from the forward side of the deck house. Within approximately 2 hours (Saturday - 1 a.m.) fire had extended to involve areas on the main deck and upper deck.

As the fire extended to involve other decks of the ship, the decision was made to flood the area on A deck over the ship's fuel tanks which contained an estimated 122,000 gallons of fuel oil. In addition, aqueous film forming foam (AFFF) was injected into the fuel tanks to further reduce the danger of explosion.

Fire fighting operations utilizing 1 1/2-inch handlines in the No. 1 MVZ, continued throughout the early morning hours and by Saturday at 10 a.m., fire equipment and crews from 11 separate fire departments were on the scene. In addition, three tug boats were operating 1,000 gpm streams in attempts to cool

the external surfaces of the hull. By Saturday afternoon, a 4° to 7° starboard list had developed on the ship and had become a serious problem. The Coast Guard On Scene Coordinator (OSC) had set a limit of a 10° list, above which it was decided the fire fighters would be operating at an unreasonable risk to their safety and the onboard fire fighting operations would be halted until the ship could be dewatered. A list of 20° was determined to be a dangerous stability situation. By 4 p.m. Saturday, the list had increased to 9° and the fire fighting operations were halted. Fire fighters then sealed the No. 1 MVZ forward of frame 153 except for dewatering and skin cooling operations.

At 6 p.m. on Saturday, the Coast Guard OSC called a meeting of the chiefs of the various fire departments and representatives of other agencies which had responded to the fire to establish a coordinated plan for continued operations and to identify a centralized point of control. At this meeting, fire fighting assignments by deck were given to each fire team leader, a control center was established, and the tactics to be used by fire teams working individual decks were developed. It was also decided that this coordinated attack would not begin until de-watering operations had improved the ship's list to between 3° and 5°.

At the 6 p.m. meeting, it was estimated the list would be in the 3° to 5° range by 11 p.m. Saturday night. However, at 11 p.m., despite 7 hours of continuous dewatering, the list had still not been sufficiently corrected. By 1 a.m. Sunday, the OSC made the decision to delay the coordinated operation until 7 a.m. Sunday morning.

After another series of delays, the final coordinated assault on all decks began at 10 a.m. Sunday morning. A NASA team scanned the ship with a special heat-sensitive camera and advised the fire crews of heat-laden areas. Fire

crews on the main deck were confronted with temperatures measured at 1250°F at the fire door at frame 153. Fire crews using piercing nozzles and 2 1/2-inch handlines were finally able to penetrate this fire door and the other involved decks within the No. 1 MVZ. By 1 p.m. Sunday, all decks of the ship were secure and ventilation had begun. The fire was officially declared extinguished at 6 p.m. Sunday.

Damage

The fire damage was extensive on all decks in the No. 1 MVZ. Combustibles consumed during the fire included personal belongings, cabin furnishings, and combustible interior construction materials. The fuel supply on A deck was almost completely consumed except for three cabins where the cabin doors had apparently remained closed throughout the fire. Throughout the area of fire involvement, 1/4-inch steel decking, stairway enclosures and fire-rated steel doors had buckled as a result of the intense heat. The ship's underwriters surveyed the fire damage, which they estimated to be in excess of \$26 million, and determined the Scandinavian Sea to be a constructive total loss.

Injuries

Ninety fire fighters were injured during the more than 40 hours of fire fighting operations. Eighty-four of these fire fighters were treated at the scene for smoke inhalation and heat exhaustion. Six others were transported to local hospitals where five were treated for smoke inhalation and the remaining fire fighter for a back injury.

ANALYSIS

At the time of this report, the cause of this fire remained undetermined. The crew member who discovered the fire in cabin 414 described finding a 2-foot circular area of the carpeting burning in the rear of the cabin. He was unable to extinguish the fire with portable hand extinguishers and notified the bridge before retreating from the area to don SCBA.

As the fire in cabin 414 grew from the incipient stage to involve bedding materials, furnishings, and personal articles, full cabin involvement occurred before the fire brigade could attack the fire with 2 1/2-inch handlines. With the door to cabin 414 open, intense heat and smoke quickly built up in the passageway in the A deck area forward of the fire-rated bulkhead at frame 153. The steel envelope created by the ship's hull, bulkheads, and decks not only prevented the rapid dissipation of the built-up heat, but also was a medium of fire spread to the surrounding areas, particularly the upper decks, through heat conduction and through fire rated doors opened during fire fighting operations.

The ship's fire brigade attacked the fire on A deck equipped with SCBA but without full protective clothing. They were able to advance a handline through the fire door in the fire-rated bulkhead at frame 153 and down the passageway to cabin 414. However, before they were able to extinguish the fire, they were driven from the area by intense heat. Because of the intense heat contained in the steel envelope of the A deck, members of the ship's fire brigade could not effectively attack and extinguish the fire in cabin 414, without being equipped with both SCBA and full protective clothing. The fire brigade then withdrew behind the fire-rated bulkhead at frame 153 and sealed openings in the No. 1 MVZ except for the two handlines which ran through the fire door. It was determined this fire door remained partially open,

throughout the time the ship was returning to Port Canaveral, allowing the fire to continue receiving oxygen and voiding the effectiveness of sealing the No.1 MVZ.

While the ship was returning to Port Canaveral, the fire brigade flowed water on the main deck to prevent carpeting and other combustibile materials in contact with the deck from igniting due to conducted heat. Despite attempts by both the fire brigade and land-based fire fighters to keep the steel decks above the fire cool; investigators later identified evidence of the ignition of combustibile materials such as a plywood closet assembly and wood studs in a casino wall partition in contact with upper decks of the ship by conducted heat.

Once the Scandinavian Sea docked at the cruise ship terminal and the 744 passengers disembarked, fire fighting operations were turned over to land-based fire departments. The effectiveness of the land-based fire fighters was handicapped by several key factors: their unfamiliarity with the ship, the lack of training in shipboard fire fighting techniques, the failure of unlined linen hose at fire stations onboard the ship when charged with water, and the incompatibility of the ship's fire station hose connections (United Kingdom couplings) with land-based fire department couplings.

The land-based fire fighters' unfamiliarity with the ship resulted in problems coordinating initial fire fighting operations with the ship's crew and the Coast Guard, and the assembling of accurate information on fire extension in the No. 1 MVZ.

The lack of training of the land-based fire department units in shipboard fire fighting techniques resulted in an initial aggressive attack of the fire with handlines while ventilating heat and smoke through the forward stairway at frame 179. Ventilating shipboard fires directly conflicts with the established shipboard fire fighting tactics of both the cruise line and the

United States Coast Guard crews; which emphasize sealing the area of fire involvement to discontinue the supply of oxygen to the fire and cooling the adjacent areas to prevent fire spread to these surrounding areas by heat conduction through the steel bulkheads and decks. The impact on the fire caused by initially ventilating A deck is unclear. Fire fighters reported heat and smoke conditions on A deck improved significantly during ventilation operations following them to attack 3 separate cabin fires and fires in the concealed spaces, although substantial heat did remain contained in the fire area of A deck forward of frame 153. It was not until after the ventilation of A deck was discontinued that fire fighters were no longer able to continue sustained firefighting operations and shortly after discovered fire extension to the main deck.

Once the fire began to extend to upper decks of the ship in the No. 1 MVZ, fire crews attempted unsuccessfully to conduct fire fighting operations on multiple decks in an unventilated space. The difficult conditions such as high temperatures, poor visibility, and difficulty in movement confronting firefighters attempting to attack the spreading fire on multiple decks of the ship, is evidenced by the length of time (approximately 40 hours) it took to extinguish the fire and the large number of firefighter injuries (approximately ninety) sustained during the operations. The difficult conditions confronting fire fighters attempting to attack the fire and the inability to extinguish the fire in its incipient stage, indicate that despite the minimal use of combustible materials in the ship's construction, the fuel loading of the cabins combined with the combustible construction materials contributed to the development of an intense fire. This fire would have easily been extinguished by an automatic sprinkler system or other fixed fire suppression system and removed the sole reliance for fire extinguishment from manual forces.

The failures experienced by fire crews attempting to utilize unlined linen hose at fire stations onboard the ship created two significant problems. Initially, it delayed the attack of the fire by the ship's fire brigade because the unlined linen hose they initially attempted to place in service failed when the line was charged with water and the nozzle separated from the unlined linen hose. When land-based fire fighters attempted to use unlined linen hose from several of the other fire stations, those hoses also failed. Because of the incompatibility of the ship's fire station hose connections with land-based fire department hose couplings, fire fighters were forced to stretch hose lines from apparatus on the dock through the ship to the fire area. This resulted in a delay in their initial attack and contributed to the spread of heat and smoke throughout large portions of the ship, through fire doors in bulkheads and stairway enclosures which were opened to allow the fire department hoses to pass through.

The United States Coast Guard completed a "control verification examination" of the Scandinavian Sea on January 20, 1984 and issued a control verification certificate valid until March 21, 1984. Included in this examination is a hydrostatic test of the ship's fire hose. Five lengths of fire hose were hydrostatically tested and one length failed. During the fire, the initial fire station hose advanced by the ship's fire brigade failed and at least eight other fire station hoses failed when land-based units attempted to use them.

The problems created by the lack of a detailed contingency plan for fire fighting operations onboard ships docked at Port Canaveral were evident throughout the fire. Had a contingency plan been developed prior to the incident, the responsibilities of the United States Coast Guard, the Cape Canaveral Volunteer Fire Department, and the Port Authority would have been clearly defined and understood. The need for the training of fire department

units in shipboard fire fighting techniques and specific problems such as the incompatibility of the Scandinavian Sea's fire fighting equipment with land-based fire department equipment would have been identified. The problems of coordinating fire fighting operations with several different organizations and the availability of the required fire fighting resources would have been studied. Soon after the fire, the Port Authority began developing a detailed contingency plan for emergencies in the Port.

The six factors identified during the investigation which contributed significantly to the magnitude of this incident were:

- The failure to extinguish the fire in its incipient stage;
- The fuel loading of the cabins in the area of initial fire involvement;
- The failure of fire station hoses onboard the ship when fire crews attempted to place these lines in service;
- The incompatibility of the ship's fire station (standpipe) hose connections with land-based fire department hose couplings;
- The lack of a detailed contingency plan for fire fighting operations onboard ships docked at Port Canaveral;
- The lack of training of the land-based fire department units in shipboard fire fighting tactics.

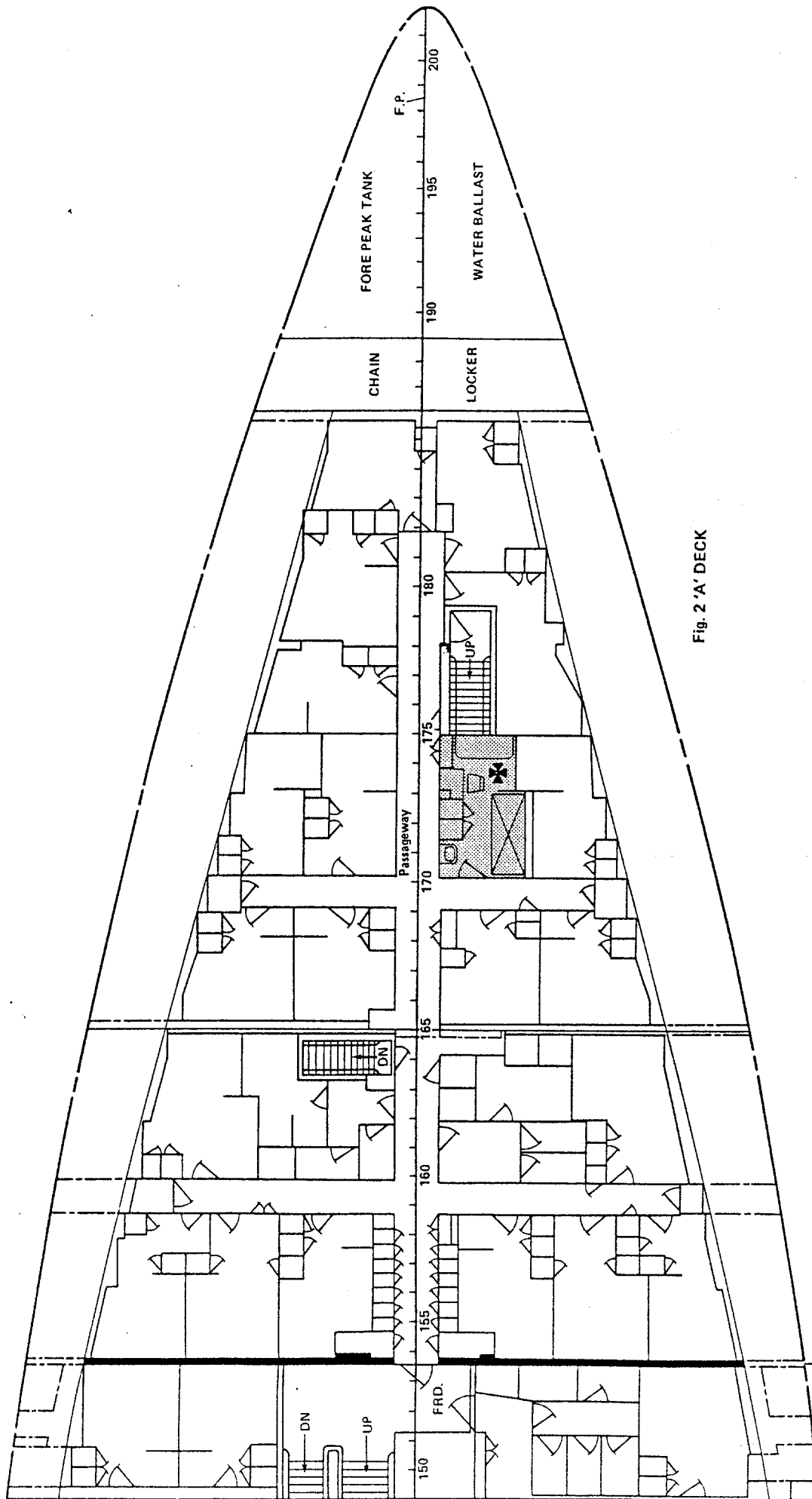
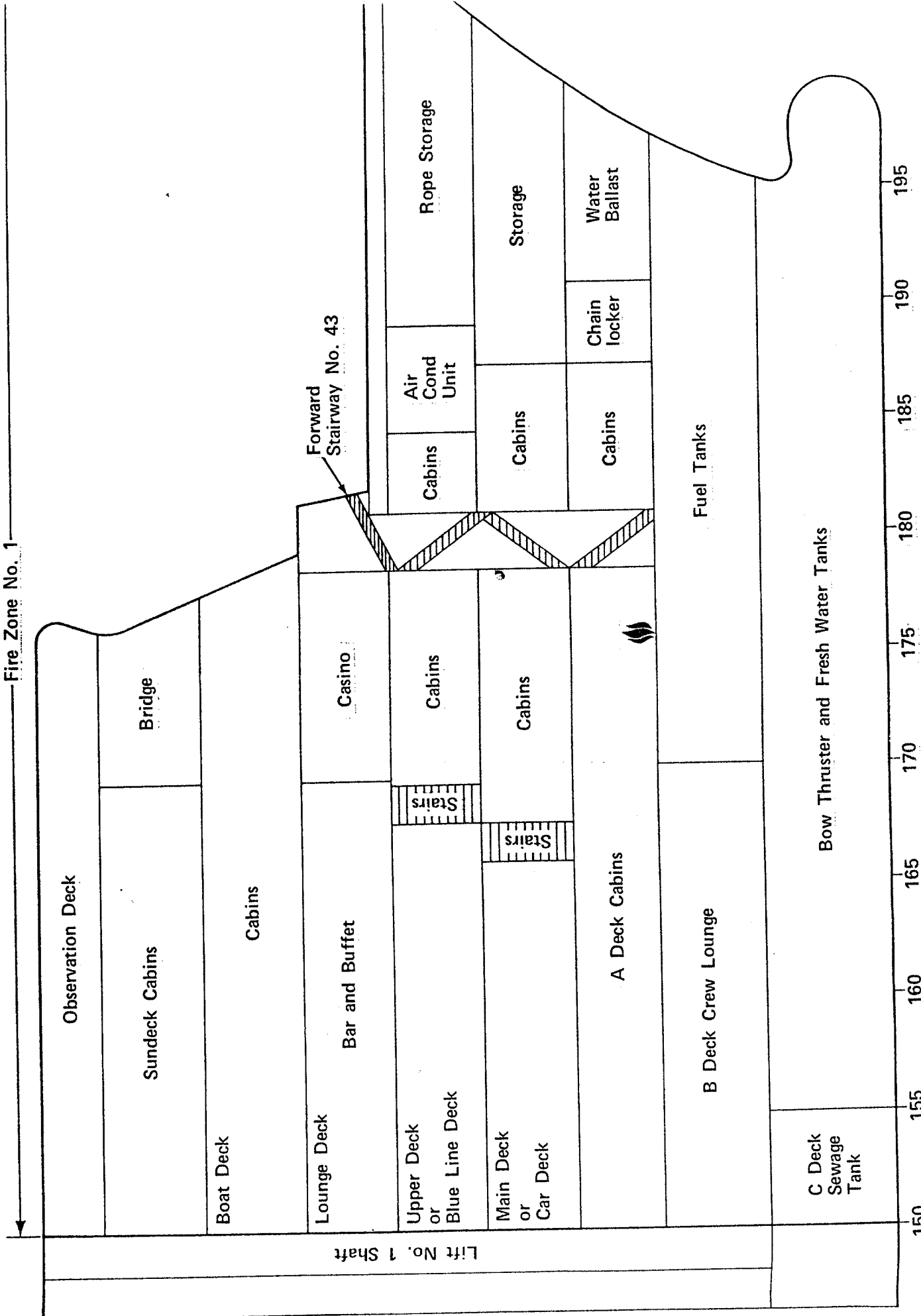


Fig. 2 'A' DECK

Frame #153

Fire Zone No. 1



☹ = Fire Origin

↑ (Bulkhead Lines)