# DEPARTMENT OF TRANSPORTATION

# COAST GUARD

## MARINE CASUALTY REPORT

SS EDGAR M. QUEENY - S/T CORINTHOS; COLLISION AT MARCUS HOOK, PENNSYLVANIA ON 31 JANUARY 1975 WITH LOSS OF LIFE

U.S. COAST GUARD
MARINE BOARD OF INVESTIGATION REPORT
AND COMMANDANT'S ACTION

ACTION BY

NATIONAL TRANPORTATION SAFETY BOARD

REPORT NO. USCG/NTSB MAR-77-2
RELEASED

TECHNICAL REPORT DOCUMENTATION PAGE

| 1. Report No. USCG/NTSB-MAR-77-2 | 2. Government Accession No. | 3. Recipient's Catalog No. |
|---|---|---|
| 4. Title and Subtitle Marine Casualty Report - SS EDGAR M. QUEENY Collision with the Liberian S/T CORINTHOS, Marcus Hook, Pennsylvania, 31 January 1975 | | 5. Report Date October 27, 1977<br>6. Performing Organization Code |
| 7. Author(s) | | 8. Performing Organization Report No. |
| 9. Performing Organization Name and Address<br>National Transportation Safety Board<br>Bureau of Accident Investigation<br>Washington, D.C. 20594; and<br>U.S. Coast Guard, Washington, DC. 20590 | | 10. Work Unit No. 2209<br>11. Contract or Grant No. |
| 12. Sponsoring Agency Name and Address<br>NATIONAL TRANSPORTATION SAFETY BOARD<br>Washington, D. C. 20594 | | 13. Type of Report and Period Covered<br>Marine Casualty Report<br>31 January 1975<br>14. Sponsoring Agency Code |

15. Supplementary Notes

16. Abstract At 0029, on January 31, 1975, the U.S. Registered tankship SS EDGAR M. QUEENY, laden with chemical and petroleum products, was maneuvering into Marcus Hook channel of the Delaware River in Pennsylvania, when it collided with the Liberian tanker S/T CORINTHOS which was moored and discharging a bulk cargo of crude oil at the British Petroleum Company dock. The port anchor of the QUEENY slightly penetrated the port side plating of the CORINTHOS at an angle of about 39° into one or more of the wing cargo tanks, which were being pumped and were approximately half full. Almost immediately, a series of increasingly intense explosions began in the CORINTHOS, and the vessel was engulfed in flames. Twenty-six persons were killed or are missing and 11 were injured in this accident. The QUEENY suffered minor damage but the CORINTHOS was destroyed. The Delaware River was polluted by oil about Marcus Hook. Property damage was estimated to be $20 million.

The National Transportation Safety Board determines that the probable cause of the casualty was the SS EDGAR M. QUEENY pilot's failure to safely execute a turn into Marcus Hook channel. Contributing to the cause were the master's delay in assuming control of the vessel for 4 minutes after he first doubted the probable success of the turn, and the pilot's attention being divided between intership communications and conning.

| 17. Key Words | 18. Distribution Statement |
|---|---|
| Collision; explosion; fire; maneuvering; conning; anchors; terminals; tankship; chemical carrier; crude oil cargo; lifesaving; waterways; channels; piloting; vessel control; flammable cargo; firefighting training; lifeboats; navigation; rate of turn indicator; harbors; pollution. | This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151 |

| 19. Security Classification (of this report) | 20. Security Classification (of this page) | 21. No. of Pages | 22. Price |
|---|---|---|---|
| UNCLASSIFIED | UNCLASSIFIED | | |

NTSB Form 1765.2 (Rev. 9/74)

SS EDGAR M. QUEENY - S/T CORINTHOS; COLLISION
AT MARCUS HOOK, PENNSYLVANIA ON 31 JANUARY 1975
WITH LOSS OF LIFE

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SS EDGAR M. QUEENY COLLISION
WITH THE LIBERIAN S/T CORINTHOS
MARCUS HOOK, PENNSYLVANIA
31 JANUARY 1975

ACTION BY THE NATIONAL TRANSPORTATION SAFETY BOARD

This casualty was investigated by a U.S. Coast Guard Board of Investigation which convened at Philadelphia, Pennsylvania, on February 4, 1975. A representative of the National Transportation Safety Board observed part of the proceedings. The National Transportation Safety Board has considered only those facts in the investigation record which are pertinent to the Safety Board's statutory responsibility to determine the cause or probable cause of the casualty and to make recommendations.

## SYNOPSIS

At 0029, 1/ on January 31, 1975, the U.S. registered tankship SS EDGAR M. QUEENY, laden with chemical and petroleum products, was maneuvering into Marcus Hook channel of the Delaware River in Pennsylvania, when it collided with the Liberian tanker S/T CORINTHOS, which was moored and discharging a bulk cargo of crude oil at the British Petroleum Company dock. The port anchor of the QUEENY slightly penetrated the port side plating of the CORINTHOS at an angle of about 39° into one or more of the wing cargo tanks, which were being pumped and were approximately half full. Almost immediately, a series of increasingly intense explosions began in the CORINTHOS, and the vessel was engulfed in flames. Twenty-six persons were killed or are missing and 11 were injured in this accident. The QUEENY suffered minor damage but the CORINTHOS was destroyed. The Delaware River was polluted by oil above and below Marcus Hook. Property damage was estimated to be $20 million.

The National Transportation Safety Board determines that the probable cause of the casualty was the SS EDGAR M. QUEENY pilot's failure to safely execute a turn into Marcus Hook channel. Contributing to the cause were the master's delay in assuming control of the vessel for 4 minutes after he first doubted the probable success of the turn, and the pilot's attention being divided between intership communications and conning.

1/ All times herein are eastern standard time based on the 24-hour clock.

## FACTS

### The Casualty

The CORINTHOS was moored starboard side to the British Petroleum Company dock at Marcus Hook, Pennsylvania, at 1530 on January 30, 1975, to complete the discharge of her cargo of 407,000 barrels of crude oil. The dock was orientated in the direction of 057° - 237°T. (See Figure 1.)

The tanks were sounded, cargo hose connections were made, and pre-discharge inspections were completed by 1745, when permission was granted to the CORINTHOS officers to commence the discharge of cargo. All side tanks were to be pumped simultaneously. Pumping continued, conforming with requests from the dock, for more than 6 hours without problem. The watch on deck consisted of a mate, a pumpman, and an assisting able seamen.

At a dock on the other side of the river, the QUEENY completed discharging part of her cargo at a Monsanto Co. dock. The vessel was moored port side to so it was necessary to make a 180° turn upon leaving the dock as it proceeded upstream to the next discharge facility. The mate checked and set the bridge clocks and the course and engine order recorders, checked the steering gear, and made other routine preparations for getting underway. The watchstanders and the line handlers were called and, by 2354, the order was transmitted to the engineroom to "standby engines." The ship draft leaving the berth was 36 feet forward and 36 feet 10 inches aft.

The pilot was on the bridge and assumed the maneuvering control of the vessel. The master was also on the bridge. At the request of the owner, the tug TANDA 12 was standing by to assist the QUEENY and remained off the starboard quarter awaiting directions from the pilot. The watch in the engineroom was supervised by the first assistant engineer. The line handlers were supervised by the first officer on the bow and the chief mate on the stern.

The weather was clear and cold, visibility was at least 8 miles, and the tide was flooding at 1.6 knots.

Just before 0005, all lines were cast off. The pilot ordered the rudder hard left, the bow thruster on full right, and the engine dead slow ahead. At 0006, the QUEENY cleared the dock in a slow turn to the right. The rudder was then shifted to right full. While the QUEENY remained in the vicinity of the dock, the pilot used the vessel's engine alternately to go ahead and astern to swing the bow toward Marcus Hook channel and to clear Marcus Hook Anchorage buoy D to port. As the bow cleared the dock and the space between the bow and the dock increased, the TANDA 12 was ordered to a position on the port bow to assist the QUEENY to swing to starboard. The TANDA 12 was in position and was pushing at 0010.

MARCUS HOOK, PENNSYLVANIA
AREA of ANCHORAGE, BRITISH PETROLEUM and MONSANTO DOCKS
COLLISION of S.S. EDGAR M. QUEENY and S/T CORINTHOS
31 January 1975

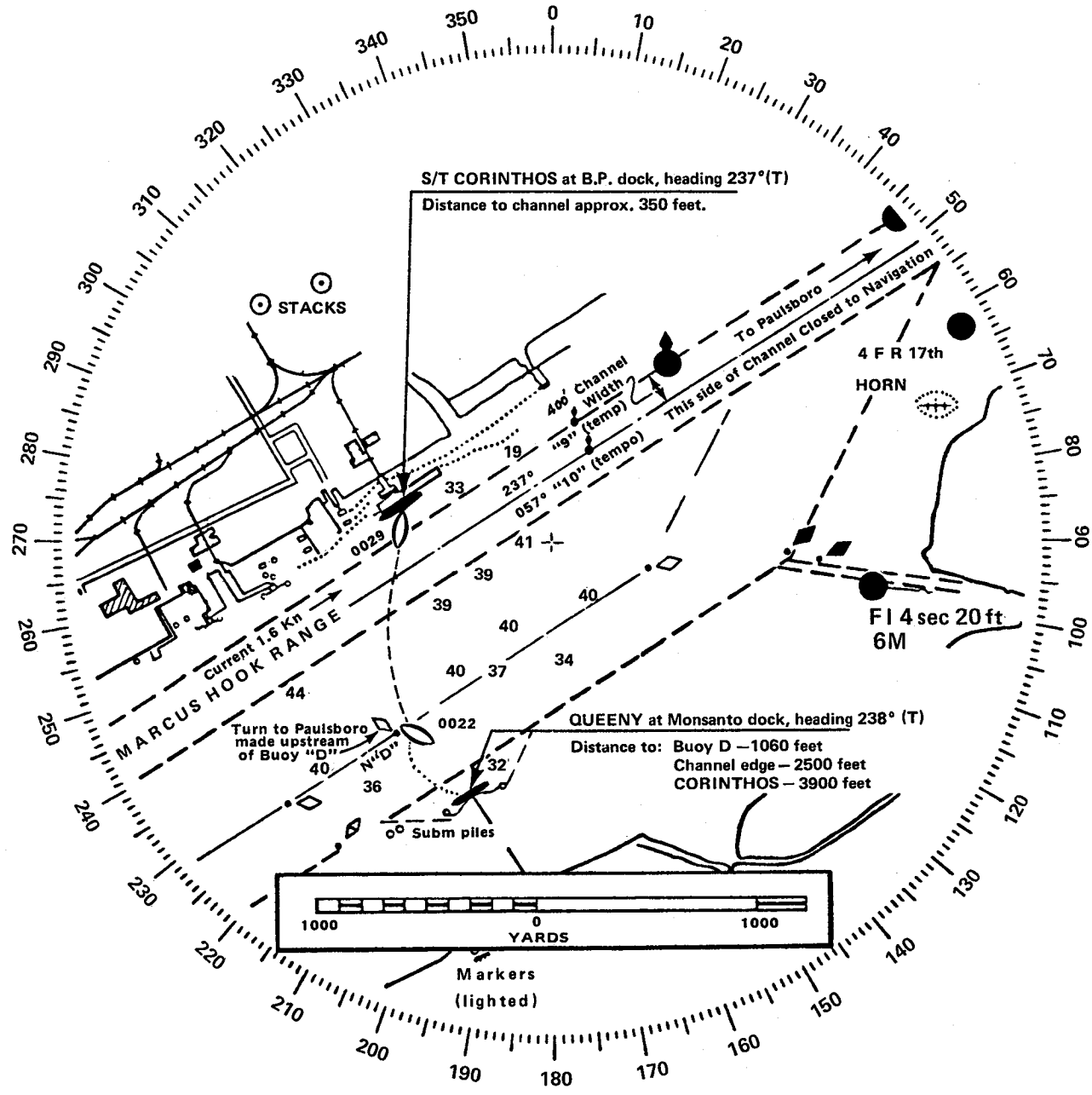


FIGURE 1

Plan of accident site

Between 0006 and 0019, the pilot used 12 different engine orders and the QUEENY changed heading from 238° to 272° while the bow moved about 300 yards toward buoy D on a swing intended to settle on a course of 057° in Marcus Hook channel. During this period, the pilot made a call on channel 13 with his portable radio to check the river traffic. The pilot had stationed himself on the port bridge wing and the master was on the starboard bridge wing. The mate remained inside the wheelhouse. As the QUEENY turned toward buoy D, the pilot used his portable radio to exchange information with the SS PENNSYLVANIA SUN, an upbound tanker which was some distance downriver.

At 0019, the engine was ordered half ahead as the QUEENY approached buoy D. The pilot released TANDA 12, and at 0022, the tug backed away and cleared the buoy on its port side by going between the buoy and the QUEENY. The QUEENY was about 35 yards from the buoy on a heading of 294° with the bow about 450 yards from its previously moored position when the tug was dismissed. Meanwhile, the master released all line handlers except one of the watch able seamen who remained on the bow as lookout. The anchors had been rigged to ride on the pawls and brakes as was customary in pilot waters.

After the dismissal of the tug, the master became concerned about the reduced rate of ship swing and the increasing speed the QUEENY was developing in crossing the river. The master told the pilot that he felt the QUEENY could not make the turn as it was being executed without danger to the CORINTHOS. The pilot assured him that there was room and that the QUEENY would make the turn. During this time, the pilot continued exchanging information by radio with the PENNSYLVANIA SUN from his position on the port bridge wing. At 0024, the master again voiced his concern about the pilot's maneuvering and recommended putting the engines astern but he received no response as the pilot was again engaged on the radio with the PENNSYLVANIA SUN. The QUEENY continued on the maneuver which was to result in collision with the CORINTHOS.

Just before the collision, the lookout on the bow telephoned the bridge and reported that the QUEENY was close to the CORINTHOS. The lookout then left his position and ran aft but was caught in the first explosion and fire. The mate on the bridge took the call but did not relay the telephone report to the pilot because the master had already ordered the engine full astern. The master ordered the engine full astern, at 0026, when the CORINTHOS appeared to be about two ship lengths from the bow of the QUEENY. The pilot, hearing the order, recommended a "double jingle" (emergency action) engine order, and that the anchor be dropped. The master concurred, rang the engine order and then used the intraship radio to order the release of the starboard anchor; but the bow lookout, having already left the bow and not having a radio, was unable to respond. The master then sounded the general alarm.

About 0029, the QUEENY collided with the CORINTHOS. Within seconds, an explosion occurred. The heading of the QUEENY at the time of contact was approximately 018°, making the angle between the vessels at contact approximately 39°.

The events that occurred after the collision are given in the U.S. Coast Guard Marine Board report.

## Injuries to Persons

The details of the data of the known dead, missing, and injured are contained in the Marine Board report and are summarized as follows:

| | CREW | | PASSENGERS | | |
|---|---|---|---|---|---|
| Injuries | QUEENY | CORINTHOS | QUEENY | CORINTHOS | Totals |
| Fatal | 1 | 3 | 0 | 0 | 4 |
| Nonfatal | 6 | 5 | 0 | 0 | 11 |
| Missing | 0 | 20 | 0 | 2 | 22 |
| None | 30 | 19 | 0 | 0 | 49 |

## Damage to Vessels

The CORINTHOS was a total loss and was scrapped. The QUEENY suffered only minor damage and the loss of an anchor.

## Other Damage

Many structures at the British Petroleum Company's dock were destroyed by the fire. More than $2,000,000 was spent to contain and clean up the oil spill. Total property damage was estimated to be $20,000,000.

## Crew Information

The QUEENY was manned by the required properly licensed and qualified crewmembers. The required pilot was properly licensed and was well qualified. The pilot had previously docked or undocked the QUEENY at least 100 times. He was one of a group of pilots commonly employed by the owners of the QUEENY to ride the vessel from port to port during the discharge of its cargo at several facilities. In contrast, most vessels employ a different pilot at each point or leg of a pilot waters itinerary. In this case, the pilot had joined the QUEENY 17 hours before the accident and had served as pilot during the voyage from Lewes, Delaware, to the docking at the Monsanto facility at 1300 on January 30; he was able to get adequate rest in the course of this duty assignment. The captain had served as regular master of the QUEENY for 4 1/2 years and had worked with the same pilot many times.

There were some irregularities in the licensing of some crewmembers of the CORINTHOS but those factors have no bearing on this accident.

Vessel Information

The vessels and their equipment are described in detail in the Marine Board report.

Waterway Information

Marcus Hook is about 16 miles downriver from the Walt Whitman Bridge in Philadelphia, Pennsylvania. The river at Marcus Hook is about 6,000 feet wide and includes a large mud flat area on the southeastern portion that extends some 2,100 feet into the river. Another 2,000 feet is reserved for an anchorage area. The main ship channel is normally 800 feet wide and the Marcus Hook channel range is on a 057° to 237° axis,but due to dredging operations, the channel width was reduced to 400 feet. On the northwestern bank, several facilities including the British Petroleum dock extend about 700 feet into the river. (See Figure 1.) The southeastern half of the channel in the Marcus Hook range was closed for dredging at a point 1,000 yards upstream from the Monsanto dock. The master and the pilot of the QUEENY knew about the closing.

Other Information

The weather was not a factor in the accident, nor are detailed descriptions of wreckage or medical and pathological data pertinent to the evaluation of this casualty.

Fire

There was an explosion on the CORINTHOS, followed by a fire which carried over to the QUEENY.

The details of firefighting efforts on the QUEENY and the CORINTHOS, and of survival factors, are given in the Marine Board report. The analysis of those aspects of the casualty will be based on the facts as stated in that report.

## ANALYSIS

The unique master/pilot relationship on the QUEENY was a key factor in the cause of this accident. The pilot's past performance while handling the QUEENY in a variety of situations had impressed the master to the point where he did not question the pilot's intentions. The master had a general perception of what type of operation to expect. He knew the direction intended, channel restrictions, available maneuvering

equipment, and the standard methods used by pilots to turn vessels. The master was also conscious of the requirement for him to monitor the operation. His own testimony revealed that he always remained in a position on the bridge to observe and evaluate the pilot's actions. This should have provided the safety check necessary to prevent the navigation of the vessel into a situation requiring emergency action.

Because the QUEENY always used one of a small group of pilots, a routine had been established whereby the pilot assumed his duties without further instruction when the master ordered the engineroom to "standby engines." These duties consisted of controlling the vessel movement until the master decided that the vessel could be handled by the crewmembers on watch.

The record does not indicate that the pilot and the master discussed the turning maneuver that led to the collision. In 1974, following an investigation of the SS AFRICAN NEPTUNE collision with the Sidney Lanier Bridge at Brunswick, Georgia, on November 7, 1972, the Safety Board recommended that the Coast Guard require that masters be informed of pilots' plans and that masters determine the critical points of maneuvers and plan for emergencies. 2/ Regulations requiring an exchange of information pertaining to the vessel's draft, maneuvering characteristics and peculiarities, etc., that may affect safe navigation, between the pilot and master became effective June 1, 1977. However, these rules, contained in 33 CFR 164.11, do not require a discussion of intended maneuvers. The Coast Guard has indicated that it may undertake further regulation in that regard by separate rulemaking. 3/

Departure from the Monsanto dock must be started with a sharp turn to avoid shoals and obstructions. The QUEENY usually accomplished this without tug assistance by using her bow thruster. That equipment is extremely useful when a vessel is not moving through the water or is moving slowly, since maximum thrust is available in the direction of the turn. For this particular undocking, a tug had been ordered and the pilot used it. Upon leaving the Monsanto dock, the pilot planned to turn the QUEENY a full 180° using the tug, bow thruster, and ship's engines to rotate the QUEENY initially at Marcus Hook Anchorage buoy D, until the vessel was perpendicular to the channel centerline, on a heading of 327°. The combined forces from the QUEENY's propeller, bow thruster, and the tug provided sufficient power to turn the vessel so that it remained upriver of buoy D. With the rudder hard right and bow thruster full right, the QUEENY had completed a swing of about 56° when, at minute 0022, the tug was ordered away. Three minutes earlier, at

2/ "SS AFRICAN NEPTUNE: Collision with the Sidney Lanier Bridge at Brunswick, Georgia on 7 November 1972 with Loss of Life" (USCG/NTSB-MAR-74-4).

3/ Federal Register Volume 42, No. 20, Monday, January 31, 1977, page 5957.

0019, the pilot had ordered the QUEENY's engine on half ahead to begin the acceleration to about 8 knots for the trip upriver. During that interval the pilot divided his attention between conning the QUEENY and exchanging navigational information with the PENNSYLVANIA SUN, an inbound tanker which was well clear of the maneuvering area.

From his position on the port bridge wing, the pilot used the Marcus Hook range lights and buoys to evaluate the progress of the vessel. At minute 0022, while the bow was alongside buoy D, the bridge of the QUEENY was about 1,500 feet from the channel centerline, with the range lights 3 1/2 miles away. The ship's long distance from the range lights resulted in a small rate of change in the spread angle between the lights and provided a poor indication of the QUEENY's progress across the river. The pilot was unaware of the length of time he spent conversing by radio after he dismissed the tug, or exactly when he was interrupted by the master.

The master first questioned the pilot concerning the safety of the maneuver about the time the QUEENY was clearing buoy D; he did not, however, challenge the pilot's response that the QUEENY would make a clear turn into the open side of the channel. The master then shifted his position from the starboard bridge wing so that he could continue to evaluate the progress of the turn. The master questioned the pilots' maneuver a second time, at 0024, with a recommendation that the engines be put astern but the pilot, who was again communicating with the PENNSYLVANIA SUN, was unresponsive. The master permitted the maneuver to continue. The doubt of the master was supported independently from another vantage point, by the lookout who called the bridge to advise that they were close to the CORINTHOS.

The conditions existing for maneuvering the QUEENY from the dock to the Marcus Hook Range channel were favorable. There was ample time to plan the maneuver at the dock; visibility, wind and current did not present any problems; the CORINTHOS was not moving; and the master and pilot aboard the QUEENY were qualified and familar with the handling of the ship. No new factors arose to affect the maneuver prior to the instant the master found it necessary to abort the turn.

Projections by a master or pilot as to the future positions of their ship in a turn with increasing ship speed are difficult to make because the ship's path has varying radii of curvature, and the ship moves in a direction somewhat different from where the bow is pointing. If the master or pilot cannot ascertain that the remaining part of a maneuver extending beyond the stopping distance of the ship will be safe, then the decision to stop must be made by the time that point is reached. Such doubt existed in this case, but the decision to stop the ship was delayed too long. In addition, the pilot's and master's initial goal of turning the QUEENY so as to align it in the useable half of the channel shifted to a goal of not striking the CORINTHOS. If they had regarded any overshooting of their original goal of alignment in the

channel as the criterion for evaluating the safety of their maneuver, one or both of them probably would have recognized the need to take corrective action much earlier.

A ship's turning capability is reduced when operating in shallow water as the QUEENY was doing. Most of the turning moment in this case was being produced by the reaction of the propeller wash striking the rudder. Some additional turning effect was created by the water velocity on the rudder due to the ship's speed and by the reaction due to the bow thruster. During the approximately 1 minute required to stop and reverse the propeller, a significant portion of the turning moment to the right was lost. On the other hand, ships with right-hand propellers normally have an increasing tendency to turn to the right when the propeller is reversed at medium to high speeds. This tendency can become a severe shear to starboard in shallow water. Without extensive full-scale or model testing, the behavior of a given ship maneuvering in shallow water cannot be predicted accurately. Without such detailed information the master and the pilot could not know whether backing, continuing at the set speed, or even increasing the engine speed in a momentary "kick" would provide the best means for avoiding the collision when it was recognized that the ship was in extremis.

After leaving buoy D the master and pilot made individual mental estimates of the ship's projected curved trackline. Since both the ship's rate of turn and speed were changing, it was difficult for the two of them to have a common understanding of the ship's rate of turn and how it was changing without instruments which could provide such data.

Some ships do have rate of turn indicators installed on the bridge. Besides providing the actual turn rate, they allow the operators to measure the effects of the bow thruster, rudder changes, or the use of a tug. Not only is this useful in more accurately projecting a curved trackline, but it can be used by masters and pilots to learn how certain vessels behave in shallow waters so that selection of emergency maneuvers can be made on the basis of previously measured ship responses. Such devices permit the detection of changes in turning rate even before it is discernible to the master or pilot and therefore allows for earlier corrective action.

Once contact between the vessels was made, even at the slow speed of the QUEENY, sufficient kinetic energy remained to force some part of the QUEENY, either her port anchor or bow, into one or more cargo tanks through the side plating of the CORINTHOS. Although the Coast Guard report's calculations show that under equilibrium conditions, the mixture of air and gases in the tanks would have been above the upper flammable limit, the atmosphere in the tanks could not have been in equilibrium once pumping out of the cargo had begun. If the QUEENY punctured the CORINTHOS hull in a region where the gases were within the flammable

limits, ignition and immediate release of the energy within these gases would have occurred. The resulting pressures would have destroyed the tank sides and top, permitting the spread of ignition to the adjoining tanks. The common header vent piping system also provided a possible additional means for flames to travel to nearby tanks.

If the QUEENY punctured the CORINTHOS hull in a region where the gases were above the flammable limit, ignition would still have occurred. However, instead of an immediate large energy release from a deflagration or explosion, a fire plume would have been emitted from the gas-air interface. This flame would have pulsated, introducing air into the tank. Depending on the size of the hole, and its distance from the flammable gases within the tank, a delay would have occurred before these flammable gases were ignited with the energy release. If the hole had been small and remote from the flammable gases, the fire plume possibly could have been extinguished due to the selfgenerated products of combustion within the tank.

The penetration of the QUEENY into the hull of the CORINTHOS was not deep. The QUEENY sustained little bow damage. This lack of deep penetration into the CORINTHOS' hull and the resulting explosion and fires indicate that passive protection to prevent penetration may be feasible. An anchor stowage design in which anchors are recessed to eliminate the projection of the flukes outside of the hull plating is one type of passive protection that could have affected the outcome of this collision. The arrangement on the QUEENY in which the anchor is stowed exterior to the hull plating is a standard design. The typical stowage in which the anchor protrudes from the hull when it is in the housed position has been a damage factor in many minor hull-scraping accidents. The loss of the anchor from the QUEENY demonstrates that it made a major contribution to the penetration of the hull of the CORINTHOS. In 1976, the Safety Board recommended that the Coast Guard conduct research toward the development of a nonpenetrating bow design. 4/ Recessing of the anchors should be incorporated in such development.

The hull penetration would have caused relatively minor damage if the wing tanks had been empty and free of petroleum vapors. However, such condition would have existed only if the wing tanks were dedicated ballast tanks or if the vessel had been constructed with sidewall double skin.

The intensity of the fire and explosion would have been less if the oxygen concentration above the liquid level in the wing tanks had been controlled. A reduced oxygen concentration can be maintained in cargo tanks with the application of an inert gas system. If the inerting gas blanket in the tank is sufficient and the ignition energy from the collision is of short duration, then even a puncturing of the tank in

4/ "SS C.V. SEA WITCH - SS ESSO BRUSSELS, Collision and Fire, New York Harbor, 2 June 1973" (USCG/NTSB-MAR-75-6).

the gas region will not cause the gases to ignite. However, after the opening has been made and some ventilation has taken place, if the ignition energy from the collision is still present or a new ignition source occurs, then a deflagration or explosion can occur. Either would be of less magnitude than if there had been no inerting, however.

The response of some of the crew in fighting the fire on the QUEENY indicated that they had good knowledge of the equipment and had the confidence necessary to fight such a fire. The response was indicative of the value of the training program they had completed during the voyage preceding the accident, which was conducted with the equipment aboard the QUEENY. Such shipboard programs are very productive in developing an effective firefighting capability which is especially important where bulk flammable cargoes are involved.

The firefighting efforts for the CORINTHOS quickly became a containment action. Thus, not extinguishing the flames avoided the problem of reflash and additional explosions from vapors coming in contact with the hot steel structure. This prolonged the firefighting but reduced the overall risk to the personnel involved.

The sudden and violent nature of the fire and explosions on board the CORINTHOS and the rapid spreading of the burning oil on the water were the major factors in the loss of life among the crew of the CORINTHOS. Persons could escape only by going down the mooring lines or by jumping into the water. The lifeboats could not be used because they were open and thus offered no protection from the fire, and the oil spilling from the ruptured cargo tanks was burning on the water below the boats' location. These escape problems were common to two other accidents investigated by the Safety Board. 5/ Encapsulated lifeboats or rescue equipment of the type installed on offshore drilling rigs have been used successfully in evacuations during fire and other casualties. The conversion or adoption of this type of lifesaving equipment could significantly reduce personnel casualties in similar accidents, especially on board tank vessels.

Congressional efforts and a Presidental message issued in March 1977, are currently being directed to require stringent standards for all vessels that carry oil into U.S. ports. Segregrated ballast and gas inerting systems would be required on existing and new tankers, over 20,000 deadweight tons (dwt), by July 1, 1980, under pending legislation.

5/ "SS C.V. SEA WITCH - SS ESSO BRUSSELS, Collision and Fire, New York Harbor, 2 June 1973" (USCG/NTSB-MAR-75-6).
"SS KEYTRADER AND SS BAUNE (Norwegian), Collision in the Mississippi River on 18 January 1974 with Loss of Life" (USCG/NTSB-MAR-77-1).

Recent Coast Guard proposed rules appearing in the May 16, 1977, issue of the Federal Register are designed to reduce the number of tanker casualties and oil spills in U.S. navigable waters. The proposed rules also call for improved emergency steering standards for tankers over 20,000 dwt as well as collision avoidance equipment for vessels over 10,000 gross tons.

When implemented, these initiatives should serve to reduce casualties and limit damage to ships, personnel, marine facilities, and the environment.

## CONCLUSIONS

### Findings

1. The EDGAR M. QUEENY was properly manned and capable of performing the proper maneuver to turn from the dock and to proceed upstream.

2. Both the pilot and the master were familiar with the vessel and its equipment and were capable of making the intended maneuver safely.

3. The master assumed that the pilot would check on the maneuver as it developed and saw no need to discuss it beforehand. Neither the master nor the pilot developed a definite plan to monitor the progress of the QUEENY by positive navigational means or to set intermediate position/heading requirements which would signal the probability that the turn would not be successful.

4. The pilot did not verify the progress of his maneuvering by using the navigation equipment and charts readily available, which would have alerted him to his error in judgment using only "seaman's eye" to conn.

5. The pilot's attention being divided between conning and communications allowed a hazardous situation to develop which resulted in a change in objective from aligning the ship in the channel to avoiding striking the CORINTHOS.

6. The master assumed control only as a last resort to avoid collision in extremis. If he had taken more positive action, when he first questioned the progress of the turn, his efforts could have been successful.

7. The typical anchor stowage arrangement on the QUEENY, in which the anchor protruded from the hull, provided the focal point for the forces which resulted in the penetration of the CORINTHOS' tanks.

8. Firefighting training of the QUEENY crew probably reduced the amount of ship damage and number of personal injuries.

9. Double-skin construction, dedicated side ballast tanks, or inert gas system in the CORINTHOS possibly would have prevented or limited the extent of explosions in this collision, thus minimizing damage, pollution, and perhaps loss of lives.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the casualty was the SS EDGAR M. QUEENY pilot's failure to safely execute a turn into Marcus Hook channel. Contributing to the cause were the master's delay in assuming control of the vessel for 4 minutes after he first doubted the probable success of the turn, and the pilot's attention being divided between intership communications and conning.

## RECOMMENDATIONS

As a result of its analysis of this accident, the National Transportation Safety Board made the following recommendations:

-- to the U.S. Coast Guard:

"Amend 33 CFR 164.11(k) to require that masters and pilots discuss beforehand and agree to the essential features and relevant checkpoints of maneuvers expected to be undertaken. (Class II, Priority Action) (M-77-33)

"Require a rate of turn indicator on the bridge of all ships of 10,000 or more deadweight tons. (Class II, Priority Action) (M-77-34)

"Develop and promulgate specifications for an enclosed, firesafe, self-contained lifeboat for installation aboard oceangoing vessels of 10,000 or more deadweight tons. (Class II, Priority Action) (M-77-35)

"Undertake rulemaking and IMCO initiatives to require that anchors be stowed in recesses in the hull so that there is no projection outside the hull plating. (Class III, Longer Term Action) (M-77-36)"

-- to the Maritime Administration, U.S. Department of Commerce:

"Expedite completion of its firefighting training curriculum and program, which should include basic firefighting training at shoreside facilities and follow-on training "on board" using shipboard systems and equipment, for merchant marine officers and seamen. (Class II, Priority Action) (M-77-37)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ [redacted]
Acting Chairman

/s/ [redacted]
Member

/s/ [redacted]
Member

/s/ [redacted]
Member

October 27, 1977

DEPARTMENT OF TRANSPORTATION
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16732/EDGAR M. QUEENY -
CORINTHOS
A-3Bd
19 AUG 1976

Commandant's Action

on

The Marine Board of Investigation convened to investigate the circumstances surrounding the collision between the SS EDGAR M. QUEENY and the S/T CORINTHOS at Marcus Hook, Pennsylvania on 31 January 1975 with loss of life

The record of the Marine Board of Investigation convened to investigate the subject casualty has been reviewed; and the record, including the findings of fact, conclusions and recommendations, is approved subject to the following comments.

REMARKS

1. The cause of the casualty was that the pilot did not take sufficient maneuvering action to make the turn safely. The pilot's action did not utilize all the vessel's maneuvering capabilities and tug services available. The contributing cause was the failure of the master to inform himself of the pilot's intended maneuvering action which led to his delay in taking timely corrective action. The combination of the pilot's error and the master's delayed action placed the vessel in a situation where a collision was unavoidable.

2. It is noted that the possibilities of the EDGAR M. QUEENY missing or colliding with the CORINTHOS if the engines had not been reversed are strictly hypothetical. However, it is imprudent to allow a close quarters situation to develop, especially between two vessels laden with hazardous or dangerous cargoes in confined waters, regardless whether a collision results or not. By doing so leaves no margin of safety should the vessel(s) experience a materiel failure or should any personnel error occur. The attempted maneuver executed by the pilot of the EDGAR M. QUEENY is considered to have been unsafe and imprudent.

3. With regard to Conclusion 12 had Able Seaman Harris possessed sufficient knowledge and experience to let go the anchor he could not have done so as he was not present on the bow when the order was given. Further his duty was bow lookout. The importance of unbroken vigilance on the part of the lookout is so great that he must have no other duty. In addition a vessel should have competent persons standing by the anchor when transiting confined waters. In this regard regulations have been published as a Notice of Proposed Rulemaking which will require vessels of this type to have persons available for rapid anchoring of the vessel in confined or congested waters.

4. The Navigation Safety Regulations published as a Notice of Proposed Rulemaking on 6 May 1976 contain a requirement for a pilot-master conference. These conferences will help to ensure the close cooperation required by the pilot and master in maneuvering the vessel, particularly if emergency action becomes necessary. Additionally the Coast Guard is considering amending its regulations to require minimum standards for tug assistance for operating in confined waters to reduce the potential for collisions, rammings, and groundings.

## ACTION CONCERNING THE RECOMMENDATIONS

1. Recommendation: Further investigation under the provisions of R.S. 4450, be conducted into the actions of Captain [redacted] for his part in the casualty.

Action: Further investigation was conducted and as a result suspension and revocation proceedings were initiated.

2. Recommendation: Further investigation under the provisions of R.S. 4450, be conducted into the actions of Pilot [redacted] for his part in the casualty.

Action: Further investigation was conducted and as a result suspension and revocation proceedings were initiated.

3. Recommendation: A copy of this report be forwarded to the Government of Liberia for their consideration of conclusion 24.

Action : A copy of this report will be forwarded to the Government of Liberia.

4. Recommendation: Consideration be given to amending Subpart 113.35 of Title 46 of the United States Code of Federal Regulations to require a positive lock or catch on dual purpose vessel engine order telegraph systems. Dual purpose systems are those which, in addition to controlling the engine speed and direction, also provide for another function such as transfer of control stations similar to that installed on board the EDGAR M. QUEENY.

Action: This recommendation is concurred with and a Notice of Proposed Rulemaking to implement it will be developed.

5. Recommendation: Consideration be given to changing Part 156 of Title 33 of the United States Code of Federal Regulations to require the inerting of all tankship cargo tanks, while such vessels are transferring crude oil at any facility located on the navigable waters of the United States.

Action: The necessary data needed to consider what appropriate action is to be taken with regard to this recommendation is currently being compiled by a special Tank Vessel Operations Task Group.

[redacted]

O. W. SILER
Admiral, U. S. Coast Guard
Commandant

DEPARTMENT OF TRANSPORTATION
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5943/EDGAR M. QUEENY/
CORINTHOS
18 February 1976

From: Marine Board of Investigation
To: Commandant (G-MVI/83)

Subj: Marine Board of Investigation; SS EDGAR M. QUEENY, O.N. 528567 and the S/T CORINTHOS, Liberian Registry, collision in the vicinity of Marcus Hook, Pennsylvania on 31 January 1975, with loss of life

## FINDINGS OF FACT

1. At approximately 0029 (EST) on 31 January 1975, the laden chemical carrier SS EDGAR M. QUEENY, O.N. 582567 collided with the Liberian Tanker S/T CORINTHOS during a period of nearly unrestricted visibility. At the time of the collision the latter vessel was discharging bulk petroleum products at the British Petroleum Dock #1 in Marcus Hook, Pennsylvania. The former vessel was attempting to complete a 180° turn that originated directly across the Delaware River from the point of collision. Immediately after the collision an explosion took place on the CORINTHOS which was shortly followed by successive explosions of increasing intensity. The ship was engulfed in flames after the initial explosion and thus the majority of the persons on board were unable to safely evacuate the vessel. A total of 25 persons who were on board the CORINTHOS at the time of collision lost their lives or remain missing as of this date. Five persons on the same vessel were reported injured as a result of the collision and subsequent fire that continued to burn for over 48 hours. One man on the EDGAR M. QUEENY lost his life and six men reported themselves injured as a result of the collision and/or subsequent fire. The EDGAR M. QUEENY incurred relatively minor damage. The CORINTHOS hulk on the other hand came to rest on the river bottom in the vicinity of where it was moored at the time of the collision. This casualty resulted in property damage estimated to be in excess of $20,000,000 and extensive pollution of the navigable waters of the United States.

2. Characteristics of Vessels Involved:

a. General Description:

| | | |
|---|---|---|
| Name: | SS EDGAR M. QUEENY | S/T CORINTHOS |
| Official No: | 528567 | 1916 |
| Nationality: | United States | Liberian |
| Service: | Tankship | Tanker |
| Gross Tons: | 19,046 | 30,705 |
| Net Tons: | 14,423 | 20,935 |
| Length: | 660.2 | 723.7 |
| Breadth: | 90 | 106 |
| Depth: | 48' 9" | 52' 35" |
| Year Built: | 1970 | 1963 |

| | | |
|---|---|---|
| Propulsion: | Steam | Steam |
| Document: | Consolidated Enrollment and License | Certificate of Registry |
| Horsepower: | 15,000 | 17,000 |
| Owners: | Bankers Trust Co.<br>16 Wall Street<br>New York, N.Y. 10005<br>as Trustee under that certain trust agreement dated as of August 1, 1970 for the benefit of First National City Bank. | Villaneuva Compania Naviera, S.A.<br>Panama, R.P. |
| Operators: | Keystone Shipping Co.<br>313 Chestnut St.<br>Philadelphia, Pa.<br>19106 | N.J. Goulandris (Agencies) Ltd.<br>Tea House, London Wall<br>London, E.C. 2 England |
| Last Inspected for Certification Date: | 18 April 1973 | N/A |
| Port: | Baltimore, Maryland | |
| Route: | Oceans | |
| Cargo: | 1. Flammable and combustible liquids of Grade B.<br>2. Flammable and combustible Class "B" or "C" poisonous liquids in tank 3 CF.<br>3. Caustic soda (50% solution, 1.51 specific gravity map.) in tanks 4C and 5C.<br>4. Acrylonitrile in tank 1CA. | Carriage of petroleum products having flash points below 60°C |
| Master: | Captain [redacted] | Captain [redacted] |
| License: | Master of Steam and Motor Vessels of any gross tons upon Oceans, Radar Observer. | Master (unrestricted) |

| | | |
|---|---|---|
| Pilot: | Captain [redacted] | N/A |
| License: | Master of Steam and Motor Vessels of any gross tons upon Oceans (Radar Observer); First Class Pilot, New York Harbor, Lower and Upper Bay, From Sea to the Battery; Hudson River to Albany; Staten Island Sound, Newark Bay and Tributaries; Rockaway Inlet and Jamaica Bay; East River to Execution Rocks; Long Island Sound; Execution Rocks to Watch Hill; Harbors on Long Island Sound; Manhasset Bay; Hempstead Harbor, Oyster Bay and Cold Spring Harbor; Huntington Bay and Harbor; Port Jefferson Harbor; Stamford Harbor; Black Rock Harbor; Bridgeport Harbor and Tributaries; New Haven Harbor and Tributaries; Connecticut River; Saybrook Bar to Hartford, Delaware Bay and River from Overfalls Lightship to Reedy Point, Buzzards Bay from Buzzards Bay Lightship to Cleveland Ledge. Rhode Island Sound and Block Island Sound between Buzzards Bay Lightship and Watch Hill, Rhode Island; Chesapeake and Delaware Canal from Newcastle Range, Delaware to Courthouse Point, Maryland. Chesapeake Bay Courthouse Point to Sand Point and Patapsco River and Branches to the Head of Navigation; Delaware River from Reedy Point, Delaware to Delair, New Jersey. Chesapeake Bay from Sandy Point, Maryland to Cape Henry, Virginia, Cape Cod Canal; Cape Cod and Massachusetts Bay, South Shore. | |

b. The CORINTHOS was a single deckhouse tanker traditionally identified as a "stem-winder". The deckhouse was located aft of all cargo tanks and contained all officer and crew accommodations. In addition, this enclosure also housed all propulsion machinery and was topped by the wheelhouse and other navigating spaces.

c. The cargo space on the CORINTHOS was separated into six tanks numbered fore to aft. The forwardmost tank was divided into port and starboard units and the remaining five tanks were further divided into port, starboard and center spaces for a total of 17 cargo tanks. The after cargo pump room was located immediately aft of No. 6 Center cargo tank, and just forward of the deckhouse.

d. The CORINTHOS was equipped with a radar but its status at the time of the collision was not determined by the Marine Board of Investigation (hereinafter referred to as the Board).

e. The EDGAR M. QUEENY is similarly a "stem-winder" with all of its personnel accommodations and propulsion machinery located aft of the cargo tanks. The vessel's wheelhouse and navigating spaces are located in the uppermost part of the deckhouse.

f. Over 20,000 tons of cargo carried on board the EDGAR M. QUEENY was highly toxic or volatile or both. Included in this dangerous cargo were relatively large quantities of phenol, gasoline, styrene monomer, methanol and vinyl acetate monomer (VAM). The cargo space containing these products is primarily separated into eight tank units which are numbered One through Eight from fore to aft. The units are further separated into multiples of from three to five tanks with no particular order or symmetry between successive tanks. Each tank is provided with a deep well pump which is used to discharge its cargo. The following table provides a detailed description of the individual tank arrangements:

Cargo Tanks Number 1

Port (P)
Center Forward (CF), Center Middle (CM), Center Aft (CA)
Starboard (S)

Cargo Tanks Number 2

Port (P)
Center Forward (CF), Center Aft (CA)
Starboard (S)

Cargo Tanks Number 3

Port (P) - Ballast only.
Center Forward (CF), Center Aft (CA)
Starboard (S) - Ballast only.

Cargo Tanks Number 4

Port (P)
Center (C)
*Starboard (S)

*Four (S) and Five (S) one common tank.

Cargo Tanks Number 5

Port (P)
Center (C)
*Starboard (S)

*Five (S) and Four (S) one common tank.

Cargo Tanks Number 6

Port (P)
Center Forward (CF), Center Aft (CA)
Starboard (S)

Cargo Tanks Number 7

Port (P)
Center (C)
Starboard (S)

Cargo Tanks Number 8

Port (P)
Center (C)
Starboard (S)

g. The EDGAR M. QUEENY is equipped with a Bird-Johnson Co. Bow Thruster unit. The unit is located approximately 50 feet from the bow and is enclosed in a tunnel-like athwartship tube approximately 4 feet above the keel. This arrangement permits a 1000 horsepower electric motor, equipped with a four blade variable pitch propeller, to exert either a right or left turning torque on the bow of the vessel. The motor driving this variable pitch propeller is an alternating current (AC) motor that is connected to the forward ship's service 1000 kilowatt (KW) generator. The optimum full load current on the motor is 1200 amperes with motor overcurrent protection based on that value. A time delay trip of approximately 10 to 15 seconds was reported for continuous loads of over 1200 amperes. The bow thruster unit has three controls which are all located on the navigating bridge deck level of the vessel. The main control stand is located in the wheelhouse approximately 8 feet to starboard and slightly forward of the steering stand. Its configuration is largely conventional in that a steel box-like enclosure

houses all controls and the actual manipulation of the controls is accomplished by a single lever located on the top of the stand. This lever is approximately ten inches in length and moves laterally to cause a resultant bow turning thrust in the same direction of lever movement i.e. lever moved right, bow swings right. The lever also controls the magnitude of this thrust with the increase in motor speed being proportional to the distance the lever is moved from the vertical or neutral position. A locking feature is incorporated in the lever which permits its user to lock it in a position which will maintain a given thrust direction and speed. Two satellite controls, one on each bridge wing, similarly control the thruster. Although these two units do not have a locking feature and are materially different in appearance from the master control, they are functionally its duplicate.

h. The EDGAR M. QUEENY main engine throttle is controlled by one of three distinct modes. Manual Control is the mode whereby the throttle is moved by hand and the remaining components of the vessel's propulsion plant are similarly controlled. Central Control represents the function whereby a control wheel on the engine room console electrically controls the throttle. The remaining propulsion equipment is regulated by other integrated control features of the control wheel. This mode is reported by ship's personnel to be the fastest and most efficient means of controlling the vessel's movement. The assessment is based on the proximity of engineering personnel to the console and their ability to supplement automatic functions with local control. This combination provides for a maximum efficiency at all times, which cannot be achieved by the inherent time delay constraints of an automatic operation. Bridge Control, as the name implies, is located in the wheelhouse and is functionally a duplicate of the automatic throttle and integrated plant controls found on Central Control. However, this bridge control lacks any supplemental means of enhancing the control efficiency. The unit itself shares the control console with the bridge engine order telegraph.

i. The selection of one of the three modes, either Manual, Central Control or Bridge Control, is accomplished by a selector switch, located on the engine room console. This switch can be shifted from Manual to Central Control or vice versa without the benefit of any additional devices or operations. However, a transfer to Bridge Control cannot be accomplished without a prerequisite matching of bridge and engine room engine order telegraphs positions. These positions, identified as Bridge Control on the face of both engine order telegraphs, are located immediately below the Full Astern position thus representing the next incremental change as the telegraph handles are moved further from the vertical or Stop position. Matching the engine room and pilot house telegraphs in the bridge control position aligns equipment interlocks in order that the selector switch can be shifted to the Bridge Control mode from the Central Control mode. A direct transfer from the Manual mode to Bridge Control

mode cannot be effected. On the other hand, it is possible to shift the selector switch from Bridge Control to Central Control irrespective of the telegraphs' position.

j. Included in the EDGAR M. QUEENY fire fighting equipment are five fixed foam P.B.C. -100 monitors which are connected to a relatively large capacity foam system. These monitors are accessible from the walkway that extends aft from the forecastle deck to the poop deck level of the deckhouse. The monitor platforms are arranged at frames 50, 57, 66, 75 and 81 on the upper deck so that they are able to provide coverage over the entire top of the cargo tanks. They are provided with fixed piping from the platforms to the mixing manifold and 4200 gallon foam tank which is located inside the deckhouse at the upper deck level.

k. Intership communications between the CORINTHOS and the EDGAR M. QUEENY did not exist prior to the collision in question. Furthermore, the only relevant identified intership communication of the EDGAR M. QUEENY was conducted on the pilot's portable radiotelephony equipment. This equipment enabled the pilot to both transmit and receive VHF Channel 13 transmissions on 156.65 Mhz. Although there is a fixed VHF installation located immediately inside of the port wheelhouse door, it was not being used during the ill-fated transit.

l. The EDGAR M. QUEENY has two radar sets installed inside its wheelhouse. One, an RCA model, was energized during the vessel's transit in question while the other radar, a Kelvin Hughes, was secured at the time. Operational characteristics of these two sets were not sought by the Board as there is no evidence that they were being utilized during the transit in question.

m. In the absence of a conflict between the CORINTHOS and the EDGAR M. QUEENY regarding the time of individual maneuvers or events, the Board chose to establish the EDGAR M. QUEENY wheelhouse clock time as the bench mark time for all events. The demeanor of the vessel's third mate, combined with the absence of contradictory evidence, prompted the Board to accept his description of checking the bridge clock with those of the engine room and chart house approximately 1 hour before the casualty. Moreover, a comparison of the engine and deck bell books reinforces the likelihood of relatively close respective clock times at any point in time. The Board made no effort to determine the accuracy of the time being kept on the EDGAR M. QUEENY nor was there a demonstrated need for such a determination.

3. Deceased, missing or injured:

a. EDGAR M. QUEENY Deceased:

(1) Harris, Arvie [redacted] Able Seaman
Address: [redacted] Port [redacted]
D.O.B. [redacted] Date of Death: 8 February 1975
Cause of Death: Thermal Burns

b. EDGAR M. QUEENY Injured:

(1) [redacted] Ordinary Seaman
Address: [redacted]
Date of Reported Injury: 31 January 1975

(2) [redacted] Steward Utility
Address: [redacted]
Date of Reported Injury: 31 January 1975

(3) [redacted] Bosun
Address: [redacted]
Date of Reported Injury: 31 January 1975

(4) [redacted] Wiper
Address: [redacted]
Date of Reported Injury: 31 January 1975

(5) [redacted] Ordinary Seaman
Address: [redacted]
Date of Reported Injury: 31 January 1975

(6) [redacted] Able Seaman
Address: [redacted]
Date of Reported Injury: 31 January 1975

c. CORINTHOS Deceased:

(1) Balalas, Georgios Passport, [redacted] 2nd Officer
D.O.B. [redacted] Date of Death: 31 JAN 1975
Cause of Death: Multiple Injuries

(2) Fergadakis, Christos Passport, [redacted] Pumpman
D.O.B. [redacted] Date of Death: 31 JAN 1975
Cause of Death: Drowning

(3) Katte, Evaggelia Passport, [redacted], Apprentice Radio Officer
D.O.B. [redacted] Date of Death: Body recovered 1 February 1975
Cause of Death: Drowning

d. CORINTHOS Missing:

(1) [redacted] Passport, [redacted] Able Seaman
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(2) [redacted] Passport, [redacted] Bosun
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(3) [redacted] Passport [redacted] Wiper
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(4) [redacted] Able Seaman
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(5) [redacted] Passport, [redacted] Deck Boy
Address: [redacted]
Missing 31 JAN 1975

(6) [redacted] Passport [redacted] Mess Boy
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(7) [redacted] Passport [redacted] 3rd Engineer
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(8) [redacted] Passport, [redacted] Cook
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(9) [redacted] Passport [redacted] Assistant Cook
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(10) [redacted] Passport, [redacted] Master
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(11) [redacted] Passport, [redacted] Wife of Master
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(12) [redacted] Passenger
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(13) [redacted] Passport, [redacted] Able Seaman
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(14) [redacted] Passport, [redacted] Radio Officer
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(15) [redacted] Passport, [redacted], 3rd Engineer
Address: Unknown
D.O.B. [redacted]
Missing 31 JAN 1975

(16) [redacted] Passport, [redacted] Able Seaman
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(17) [redacted] Passport, [redacted] Mess Boy
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(18) [redacted] Passport, [redacted], Deck Boy
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(19) [redacted] Passport, [redacted] Fireman
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(20) [redacted] Passport, [redacted] Mess Boy
Address: [redacted]
D.O.B. [redacted]
Missing 31 JAN 1975

(21) [redacted] Guest
Address: [redacted]
Age [redacted]
Missing 31 JAN 1975

(22) [redacted] Guest
Address: [redacted]
About [redacted]
Missing 31 JAN 1975

e. CORINTHOS Injured:

(1) [redacted] Passport, [redacted], 2nd Engineer
Address: [redacted]
Date of Reported Injury: 31 JAN 1975

(2) [redacted] Passport, [redacted] Third Engineer
Address: [redacted]
Date of Reported Injury: 31 JAN 1975

(3) [redacted] Passport, [redacted] Wiper
Address: [redacted]
Date of Reported Injury: 31 JAN 1975

(4) [redacted] Passport, [redacted], Chief Engineer
Address: [redacted]
Date of Reported Injury: 31 JAN 1975

(5) [redacted] Passport, [redacted], Electrician
Address: [redacted]
Date of Reported Injury: 31 JAN 1975

4. The weather at the time of the collision was good-to-excellent. There was no measurable wind direction or force and visibility was estimated at 5 to 10 miles. The air temperature was in the middle forties and the water temperature closely approximated the same value. Calculations derived from the United States Department of Commerce Publication Tidal Current Tables 1975, Atlantic Coast of North America indicate that the Delaware River current direction and velocity at 0030 on 31 January 1975 was approximately 060°T and 1.15 knots respectively at Marcus Hook, Pennsylvania.

5. The geographic area involved in the casualty in question was nominally the Marcus Hook, Pennsylvania Anchorage and the associated Marcus Hook reach of the channel. The channel had been restricted on or about 21 October 1974 in order that dredging could be accomplished. The restriction reduced the channel width from its normal 800 feet to 400 feet. The restricted area was marked on the downriver side by relocated buoy 9M (LLNR 2261) and temporarily established buoy 10M (LLNR 2261.50). The temporary location of both buoys, the former location of buoy 9M, and the entire relevant area is depicted on appended Figure 1. The specific locations that play major roles in the scenario of the casualty are described herein. The British Petroleum Dock #1 (hereinafter referred to as B.P. Dock #1) is located approximately 150 yards outside of the Marcus Hook Channel and it is oriented nearly parallel to the channel range of 237°T and 057°T. The pier itself is approximately 400 yards long and is permanently attached to the Pennsylvania shore line at the British Petroleum Refinery. Almost due south of the B.P. Dock #1 is the Monsanto Company Pier which is located on the New Jersey edge of the Marcus Hook Anchorage near Bridgeport, New Jersey. This pier is approximately 1400 yards distant from and nearly parallel with B.P. Dock #1. The identified channel assumes a slightly southerly angle about 6000 yards downstream as it extends into the Bellevue Range. This Bellevue Range reach of the river lies generally along a 215°T and 035°T line.

6. The CORINTHOS arrived at the British Petroleum Refinery at approximately 1530 (EST) on 30 January 1975 (all dates hereinafter shall assume the year 1975 unless specifically identified otherwise) for the purpose of discharging its cargo of crude oil. The vessel moored starboard side to B.P. Dock #1 with its bow secured to a downriver dock extension identified as the cell. Cargo receipts prepared by the CORINTHOS and the British Petroleum Refinery indicates that the vessel had approximately 407,000 barrels gross, of crude oil on board at the time of its docking. Approximately 255,000 barrels gross (all product volumes referred to hereinafter will be gross) were equally split among the six port side tanks and the six starboard side tanks. The remaining 151,000 barrels were stored in center tanks numbered 2, 3, 5 and 6.

7. The crude oil cargo of the CORINTHOS originated in what is identified as the Hassi Messaoud Field in the country of Algeria. An assay report dated May 1971 was provided by British Petroleum Refinery personnel as representing their latest information regarding the physical and chemical properties of the crude oil from that field. This assay was based on data developed in two technical manuals dated June 1962 and January 1964. Although this assay report did not purport to be one prepared from samples of the oil actually carried by the CORINTHOS, it did represent the most recent available information concerning the type of crude oil carried by that vessel. Although a standard United States Customs API gravity test conducted on 31 January 1975 at Philadelphia, Pennsylvania indicated an $^{o}$API 45.8 and a similar test in 1971 reflected a value of $^{o}$API 44.05 the increase is not considered significant. Crude oil from the Hassi Messaoud Field can be categorized as relatively light and volatile. The liquid phase of this product, by percentage of weight, consisted of about 1.5% dissolved gases, 26% gasoline, 21% kerosene, 22% gas oil, and the balance in residual components. The assay report reveals that this crude oil was essentially free from impurities such as water, salt and sediment. A relatively small quantity of sulfur compounds was similarly recorded in the 1971 report. Tests conducted on and subsequent to 31 January utilizing CORINTHOS cargo, indicate that the impurity and sulphur contents of the Hassi Messaoud Field Product have not materially changed. Other than the apparent flammability danger, this product presented no other major potential hazard.

8. The assay report in question reports its sample as having a Reid Vapor Pressure (RVP) of 8.9 pounds per square inch absolute (psia). This Reid Vapor Pressure would translate to a CORINTHOS cargo true vapor pressure of 4.2 psia after correcting for the difference in temperature of the cargo (44$^{o}$F) from that of the Reid Vapor Pressure test (100$^{o}$F). It then follows that the equilibrium concentration of flammable gas in one of the closed cargo tanks would be this true vapor pressure divided by one atmosphere or about 28.6%. Quantification of the different ullage gases at equilibrium can be closely estimated from the known weight percents of these gases in the liquid. These values indicate that the composition of the vapor phase closely approximates the following percentages: methane, trace, ethane,3.1%; propane, 14.1%; isobutane, 1.7%; n-butane, 7.2%; isopentane, 1%; n-pentane, 1.5%; for a total of 28.6%. The balance of any ullage gas would be air. These indicated values, expressed in volume percent at 44$^{o}$F and 1 atmosphere, provide the basis for defining the Upper Flammable Limit (UFL) and Lower Flammable Limit (LFL) as approximating 7.3% and 1.5% respectively. The mathematics of these derivations are simply the products of universally accepted upper and lower flammable limits for the individual gases described above and the proportionate volume of ullage gas that they represent. These established and commonly accepted individual upper and lower limits are contained in Table I. At equilibrium the concentration of these gases would be in excess of the upper flammable limit. Their proportionate volumes are self evident:

TABLE I

| | UFL | LFL |
|---|---|---|
| Methane - Not considered because of minimal concentration | | |
| Ethane - | 12.5 | 3.22 |
| Propane - | 9.5 | 2.57 |
| Isobutane | 8.44 | 1.8 |
| N-Butane - | 8.41 | 1.86 |
| Isopentane - | 7.8 | 1.32 |
| N-Pentane - | 8.0 | 1.4 |

9. Cargo discharging operations on board the CORINTHOS was the overall responsibility of the vessel's Chief Mate [redacted] Actual discharge operations at the time of the collision were under the supervision of the vessel's Second Officer [redacted] Mr. Balalas was being assisted on deck by pumpman Mr. C. Fergadakis and neither of the two men survived the casualty. Cargo transfer from the CORINTHOS was being accomplished by three cargo pumps of unidentified capacity that were located within the vessel's after pumproom. Three hoses bridged the CORINTHOS discharge manifold and B.P. Dock #1 immediately before and at the time of the collision. These hoses were connected dockside to two 16 inch and one 12 inch fixed pipes which were fitted with stop valves. The two 16 inch lines were then yoked together into a common 16 inch line near their respective valves. This common line, identified as Crude Oil Line No. 3, and the afore-described 12 inch line which is identified as Crude Oil Line No. 2 progressed northward up the dock approach. These two steel pipes terminated in respective motor operated valves at the head of pier approximately 150 yards away. Both valves were installed about 3 months prior to the collision in conjunction with an automation program. They were not yet electrically connected and must be operated manually at the time of the collision in question. Downstream distribution of products originating in these lines was accomplished by conventional shoreside manifolds and pumping systems which were not relevant to the casualty in question. There was no evidence that the transfer hose connections on the CORINTHOS nor dockside were leaking at any time before or at the time the vessel was struck by the EDGAR M. QUEENY.

10. The exact discharge pumping rate of the CORINTHOS cargo is unknown. However, from approximately 1745 (EST) on 30 January when the cargo transfer began until sometime about 2000 (EST) or 2100 (EST) the same day, the rate was reportedly increased. There is no indication how much this rate was increased, but it was clearly established that the refinery personnel were concerned that the rate to Refinery Tank 186 might exceed 10,000 gallons per hour. Their concern was precipitated by the initial empty condition of the tank which was fitted with a floating roof. Thus, an initial rapid flow of liquid might cause an uneven lift of the roof with resultant damage. British Petroleum Refinery records indicated that approximately 135,000 barrels of cargo had been offloaded from the CORINTHOS prior to the casualty.

Thus, an average pumping rate of approximately 20,000 barrels, per hour is indicated. The accuracy of this 135,000 value is supported by Mr. [redacted] assessment that the side tanks were about one half full.

11. The CORINTHOS was known to be fitted with a British Petroleum Refinery static line at the time of the collision. This ground wire was described as being a "3/4 inch braided copper wire" connected to the CORINTHOS starboard discharge manifold and to a permanent connection ashore. Although an eyewitness attested to the vessel connection, no such observation of a shoreside ground connection was provided. However, the description of this cable and its associated take-up reel suggests that it was an efficiently designed and well maintained piece of equipment. The vessel was not fitted with any type of inerting or flammable gas displacement system and thereby was utilizing an "open" type offloading system. This operating method requires that tanks being emptied must be open to the atmosphere in order that air may enter as the liquid level is drawn down. As the liquid level is reduced, the relatively heavy equilibrium gas mixture will layer over the liquid and thus suppress vapor evolution. This suppression in turn permits the concentration of flammable ullage gases to decrease as the distance between the liquid level and the tank tops increase. Thus, during the CORINTHOS offloading a concentration of gases within the flammable range would be found somewhere between the crude oil and the tank top. United States Code of Federal Regulations, as well as universally accepted practice, requires flame screens to be fitted to any tank openings. The Board was unable to determine what openings, if any, in the CORINTHOS cargo tanks were not covered (air tight) at the time of the collision. Moreover, the Board was unable to determine what open cargo tank openings, if any, were not fitted with flame screens at the time of the collision. However, the Board did observe numerous flame screens designed to be fitted to CORINTHOS ullage openings during its visit to the vessel's hulk on 8 February. The Board did not observe any flame screens capable of covering an open cargo hatch on this vessel.

12. Chief Mate [redacted] in effect described cargo offloading of the CORINTHOS as progressing routinely until sometime after midnight on 30 January. He indicated that he had just completed a round of the vessel and discovered that Messers Balalas and Fergadakis were actively engaged in this transfer operation with Mr. Balalas on deck and Mr. Fergadakis in the after pumproom. The effectiveness of the vessel's mooring was also checked by the chief mate prior to his entry into the dining room for coffee and something to eat. Shortly thereafter, in the early morning hours of 31 January, he described a "hard sudden vibration" which he initially assumed was a boiler explosion on board his vessel. Mr. [redacted] hurried to the open deck to secure the cargo operations and found the ship engulfed in flames forward of the deckhouse. During his stay on the deck, he became conscious of another vessel forward of the deckhouse. Although he was unable to positively pinpoint the part of the CORINTHOS that was in contact with the other vessel, he stated that it could have been between Cargo Tank No. 4 and Cargo Tank No. 5. Mr. [redacted] found himself unable to move forward because of the extensive

flames and thus continued to the stern of the vessel. At about this point in time, ½ to 1 minute after the initial explosion, another explosion of much greater magnitude took place on board the CORINTHOS sending flames an estimated 400 to 500 feet into the air. In addition to the flames, parts of the CORINTHOS, including valves and rivets, were propelled over one half mile from the stricken vessel.

13. Included in this debris was a section of CORINTHOS Cargo Tank No. 3 (starboard) that was estimated to weigh more than 100 short tons. The section of plate had sheared all of its rivets in the main deck crack arrester for a distance of about 40 feet. This crack arrester was located approximately 24 feet inboard of the vessel's starboard gunwale bar connection. Further attesting to the intensity of the explosion was the shearing of the gunwale bar to main deck weldment for the entire length of Cargo Tank No. 3 (starboard). This section landed on board the EDGAR M. QUEENY deck at a position just aft of the port cargo manifold and its associated hose handling gear king post. The trajectory of this huge section of the CORINTHOS cargo tanktop was described as floating up in the air and out towards the EDGAR M. QUEENY in a "slow motion" fashion. This was the description provided by Captain [redacted], Master and Pilot of the SS PENNSYLVANIA SUN, who observed the second explosion on board the CORINTHOS with binoculars at a distance of approximately 3 miles.

14. Arriving on the CORINTHOS stern, Mr. [redacted] found a growing number of its crew collecting amid a shower of debris from the explosion-rocked vessel. Included in those on the stern were the vessel's master Captain [redacted], his wife [redacted], his son [redacted] his uncle [redacted] and Mrs. [redacted]. The master ordered Mr. Peroulakis to lower the lifeboats and was advised by the chief mate that this was impossible because of the hot debris raining down. At this point in time the remaining mooring lines had broken as the CORINTHOS moved aft along the dock in response to the force exerted by the still moving EDGAR M. QUEENY which was fetched up in the CORINTHOS port side. The chief mate then ordered its crew on the stern to jump over the starboard side of the vessel in order to escape both the raging fire on board and the burning oil on the surface of the water alongside the vessel's port side. As the chief mate prepared to leave the ship on a mooring line, he requested that the master give up his son ([redacted]. The master failed to respond to the request and being unable to safely remain on board any longer, Mr. [redacted] went down the mooring line into the water. Swimming to the adjacent dock the chief mate managed to get out of the water and to aid three other crew members up onto the British Petroleum Dock No. 2. About this same time he observed the vessel's Radio Officer Mr. [redacted] floundering about in the water surrounded by flaming oil and he did not see this man again. The chief mate by this time had joined other members of the CORINTHOS crew and Mr. [redacted] a British Petroleum Refinery employee, at or near the Dock Shack No. 2. This shed is located near the extreme upriver

end of British Petroleum Dock No. 2 and no less than 250 yards from the dock approach. At some point in time, estimated to be anywhere between 6 and 20 minutes, Mr. [redacted] and the 14 members of the CORINTHOS crew who swam ashore ran along the inboard side of the dock to the dock approach and from there out on to the shore. From there they were taken to various hospitals for treatment.

15. Mr. [redacted] was the sole witness from the CORINTHOS called upon to give testimony before the Board. This action was indicated for both humanitarian and material reasons. Nineteen days had elapsed from the time of the casualty until adjournment of Board public hearings and both of the men known to be on watch at the time of the collision were deceased. Thus, all crew members known or presumed to be on deck at the time of the collision were deceased or missing on the date of adjournment. Furthermore, an aggrieved or passive role was early established for the CORINTHOS and its crew which went unchallenged by any other parties in interest to the investigation. Since the CORINTHOS crew's testimony would be restricted to establishing the identity of persons on board their ship at the time of collision, or providing details about crew members subsequent to the collision, their testimony regarding causal factors relating to the casualty was considered marginally relevant at best. In recognition of their role or part in the collision which claimed the lives of 20 of their former shipmates, the survivors pressed for an early dismissal in order that they might return to their homes in foreign countries.

16. The Board discovered that counsel for the CORINTHOS had prepared a composite account, developed on 31 January, of the whereabouts of all persons known or believed to be on the CORINTHOS on that date. The Board chose, for humanitarian reasons, to accept this composite report, under certain conditions, in order that the surviving crew members would not be subjected to the traumatic experience of providing details of their former shipmates and/or relatives demise. Of significant importance in consideration of this action was the fact that no request for the testimony of any of these surviving CORINTHOS crew members was received from any party in interest to the investigation prior to the Board's adjournment on 19 February. The scenario developed from the composite report described, and presented as finding 17 herein is not intended in any way to fix the responsibility for the death, reported injury, presumed loss, or rescue of any person. It does however, provide the best available source of information regarding the 22 persons who are reported missing as a result of the collision and subsequent fire. Identification and known details surrounding the loss of these 22 persons are set forth in finding 17 below. The composite also identifies five crew members as being ashore at the time of the collision. This group was comprised of Messers [redacted] and [redacted]. The bodies of three crew members identified as Mr. Georgios Balalas, Ms. Evaggelia Katte, and Mr. Christos Fergadakis, were recovered from the water on 1 February. Although Messers Balalas and Fergadakis whereabouts immediately before the collision is reasonably well documented, the same

observation is not true for Ms. Katte. The only information regarding this woman is a reported sighting on the CORINTHOS stern subsequent to the collision. The remaining 14 persons who were known to be on board and survived the casualty are Messers [redacted], and [redacted].

17. At the time the EDGAR M. QUEENY struck the CORINTHOS, there were 22 persons known or presumed to be on board the latter vessel who still remain missing. Surviving crew members reported observing a total of 10 persons who were last seen at or near the stern of the CORINTHOS subsequent to the collision in question and its resulting conflagration. Included in this total were Captain [redacted] his wife [redacted], his son [redacted], his uncle [redacted] Mrs. [redacted], Mr. [redacted] his wife [redacted] Mr. [redacted], Mr. [redacted] and Mr. [redacted]. No information was provided regarding four persons which included Mr. [redacted] Mr. [redacted] Mr. [redacted] and Mr. [redacted]. The remaining eight were reported in the following manner: Messers [redacted] and [redacted] were last seen jumping from the ship; Messers [redacted] and [redacted] were reported to be on fire or engulfed in fire while in the [redacted] was last seen entering the engine room; Mr. [redacted] was reported as going under the ship; Mr. [redacted] was last seen in his room after reportedly being awakened.

18. Mr. [redacted] who was a yard pumper and gauger employed by the British Petroleum Refinery boarded the CORINTHOS prior to its offloading cargo. His responsibility was that of taking ullages preparatory to cargo pumping. Mr. [redacted] related that no cargo or ullage openings were open at approximately 1630 (EST) on 30 January. As each tank was gauged it was opened and subsequently closed after the ullages were obtained. Mr. [redacted] also observed, among other things, the discharge hoses being connected to the starboard cargo manifold, the blanked off port cargo manifold, and the after pumproom. He indicated that he observed no evidence of leakage although he acknowledged that there was no pressure on the discharge manifolds at the time of observation. He, as well as other British Petroleum witnesses, was certain that any leak at the hose/manifold connection would be readily visible to dockside refinery personnel.

19. There were three British Petroleum Refinery employees known to be on British Petroleum Docks #1 and #2 at the time the CORINTHOS suffered its first explosion at approximately 0029 (EST) on 31 January. Messers [redacted] and [redacted] were in a shed identified as Dock Shack No. 1 that was approximately 20 feet from the CORINTHOS hull. Mr. [redacted] who had departed the described shed approximately 4 minutes earlier, was on the inshore side of British Petroleum Dock #2 about 150 yards distant from the other two men. In addition to these men, a Mr. [redacted] was also engaged in the cargo offloading of the CORINTHOS and was located in a pumphouse 1 to 1½ mile from that vessel. Mr. [redacted] was the midnight to 8 o'clock British Petroleum Refinery shift foreman in overall charge of the ship's discharge of cargo.

20. As Mr. [redacted] stood on British Petroleum Dock #2 talking to the captain of an American Dredging Company towboat, he heard a scrape or crunch that was immediately followed by an explosion. Mr. [redacted] turned around and found the CORINTHOS engulfed in flames. Observing flames that he estimated to be 500 feet in the air, he dodged behind a shed on that end of the dock. As he remained behind this Dock Shack No. 2, a second explosion rocked the CORINTHOS hull approximately 30 seconds later. This explosion was noticeably more severe than the first and was accompanied by a rain of debris from the CORINTHOS. Mr. [redacted] is unclear at this point as to when he first observed a group of survivors from the CORINTHOS on the dock. At some time after this group joined Mr. [redacted] another explosion of great magnitude took place on the CORINTHOS. Burning fuel poured from the stricken vessel and covered the water surface on both the inboard and outboard sides of the vessel. Deciding that it would be foolhardy to attempt to swim to shore from the dock, Mr. [redacted] and the group of survivors began running towards B.P. Dock #1 on the shoreside of the pier. As the group continued toward the dock approach they were joined by a smaller group of CORINTHOS crew members who had fled from the burning ship. During the course of Mr. [redacted] exit from the pier, he observed the EDGAR M. QUEENY laying alongside of the CORINTHOS with its bow headed downriver or nearly so. He described the stern of the EDGAR M. QUEENY as being between 200 and 300 feet away from the CORINTHOS. Meeting the group as they came on to the shore from the dock approach was Mr. [redacted] foreman, Mr. [redacted] Mr. [redacted] placed some of the survivors in his jeep whereupon he drove them to the British Petroleum Refinery main gate. Awaiting ambulances transported these men, as well as the others who had made their own way to the gate, to nearby hospitals.

21. Mr. [redacted], who came on duty at 0000 (EST) on 31 January, described himself as being responsible for the movement and storage of the crude oil being offloaded from the CORINTHOS. He was unable to describe any conditions in the vicinity of the CORINTHOS because he had not yet visited the dock area since the CORINTHOS docked. At the time of the collision in question, he was located just outside of the refinery Ship Unloading Pumphouse. Mr. [redacted] first became aware that something was amiss when he was knocked down by an explosion of unknown origin. After he regained his footing, he discovered that the CORINTHOS was on fire. The foreman immediately ordered, by use of his two-way radio, valves near the tank closed in order that the tanks could be isolated from the burning vessel. Mr. [redacted] identified the afore-described explosion as the initial one and also the only one that he was specifically conscious of until he arrived at the scene of the burning ship about 1 mile distant. Arriving at the head of B.P. Dock #1 approximately 10 minutes later, the shift foreman discovered refinery personnel closing all shoreside valves associated with piping that extended onto the pier occupied by the burning CORINTHOS. Included in these valves were the motor operated valves (MOV) described in Finding 9 above which he ultimately helped close. Although Mr. [redacted] did not remember any other specific explosions prior to arriving at the dock, he was vaguely aware of their existence. However, after arriving at the head of the pier, he was again knocked to the ground by an explosion that took place while he was engaged in closing the dockside valves. At some undetermined point in time, while these dockside valves were being secured, Mr. [redacted] and the group of CORINTHOS survivors arrived on shore having fled the now fire-surrounded pier.

22. The EDGAR M. QUEENY moored port side to the Monsanto Dock, which is located near Bridgeport, New Jersey, at approximately 1248 (EST) on 30 January. At the time the vessel docked, it was under the command of Captain [redacted] with Captain [redacted] serving as its required pilot. During his employment on board the EDGAR M. QUEENY Captain [redacted] was serving under the authority of his federal pilot license. Both pilot and master were familiar with the vessel and had participated in its docking and/or undocking maneuvers many times. Captain [redacted] stated that he had been the vessel's regular master since August 1970. The pilot indicated that he had personally participated in at least 100 of the vessel's individual docking/undocking maneuvers. The vessel remained at the Monsanto Dock throughout the afternoon of 30 January. At sometime after 2300 (EST) that same date the vessel began preparations to proceed up the river to Paulsboro, New Jersey. Third Mate [redacted] preparatory to getting underway on the same evening, tested all navigational gear and synchronized the wheelhouse and chartroom clocks with those of the engine room at approximately 2330 (EST) on 30 January. Included in the equipment tested was the engine order telegraph at both the bridge and engine room location.

23. Captain [redacted] and Pilot [redacted], satisfied that the EDGAR M. QUEENY was ready to get underway, ordered the vessel's lines let go from the dock. At the time of this undocking, the master and pilot were on the bridge; Third Mate [redacted] was manning the engine order telegraph; and Quartermaster [redacted] was at the helm. In the engine room at this time was First Assistant Engineer [redacted] at the engine controls with Third Assistant Engineer [redacted] and Engineman [redacted] nearby to assist him. At and in charge of the forecastle docking station, was First Officer [redacted] who had Able Seaman [redacted] there to assist him. In charge and located at the after docking station was Chief Officer [redacted] with members of the ship's crew similarly assisting him to undock the vessel.

24. The last EDGAR M. QUEENY line was cast off the dock at approximately 0006 (EST) on 31 January (all times expressed hereinafter shall assume this date unless indicated otherwise) and the vessel began to move away from the dock by the use of its engines on central control and the flooding tide. As the ship continued its entrance out into Marcus Hook Anchorage, Mr. [redacted] completed his preparations for docking the vessel in Paulsboro and subsequently retired to his room. At the time he proceeded to his room, as well as after he arrived there, he was in possession of an energized small "walkie talkie radio." This small VHF transceiver was one of several units used solely for intraship communications. During this period of time, the EDGAR M. QUEENY continued to back and fall until 0010 (EST) when it had sufficiently cleared the dock to enable the tug M/V TANDA 12 (O.N. 268418) to ease up to the port bow of the maneuvering tankship.

25. At about the same point in time that the TANDA 12 engaged the EDGAR M. QUEENY, Captain [redacted], the master of the upbound SS PENNSYLVANIA SUN (O.N. 280202), contacted the former ship on VHF Channel 13 (156.65 Mhz) to determine the other ship's intentions. Upon being advised during the brief radio exchange with Pilot [redacted] that the EDGAR M. QUEENY was proceeding upriver, Captain [redacted] continued on his way up the Bellevue Range. Meanwhile, on board the EDGAR M. QUEENY, the bow thruster was providing right thrust at its full load rating of 1200 amperes. Shortly thereafter, at approximately 0019 (EST), the ship's engines were placed on One Half Ahead. The vessel's rudder was also now hard right as it began to increase its velocity over the ground. The combined torques of the right rudder, bow thruster and the now pushing tug resulted in an expected significant increase in the rate of change of the EDGAR M. QUEENY heading. As the vessel headed up on Marcus Hook Anchorage Buoy D (L.L. pg. 304), approximately 100 yards distant, Captain [redacted] dismissed Mr. [redacted] from his bow station thereby leaving Mr. Harris alone as a bow lookout. At the time Mr. [redacted] left the bow station both anchors were ready for "letting go" to the degree that only their individual riding pawls and brakes were restraining them. Thus, to drop an anchor it was only necessary to lift the riding pawl and release the hand brake. At approximately 0022 (EST) Buoy "D" was about 30 yards distant and bearing well to the left of the bow. At this time the ship's heading was about 294°T and swinging to the right at a rate of approximately 19° per minute. The Pilot Captain [redacted] chose this time to release the tug from the port bow of the EDGAR M. QUEENY with the understanding that the TANDA 12 would stand-by at Paulsboro. Captain [redacted] at this time was on starboard bridge wing while the pilot was on the port wing of the bridge. The master felt no concern regarding the tug's dismissal because in the past the same pilot had made this same crossing without a tug by simply backing and filling as he kept the vessel's stern near Buoy "D". The master noticed that the vessel's rate of swing materially decreased after the tug disengaged itself.

26. The EDGAR M. QUEENY continued to accelerate forward as this decrease in rate of swing became apparent with actual rates of 6° and 4° recorded at 0023 (EST) and 0024 (EST) respectively for each of the 1 minute periods of time just elapsed. The failure of Pilot [redacted] to continue backing and filling while close aboard Buoy D caused Captain [redacted] to become apprehensive as he considered the vessel's northward advance unsafe in relation to its heading change. He voiced his concern to Pilot [redacted] about what he considered the "closeness" of the situation and was reassured by the pilot, "Captain, she should make that okay" or words to that effect. Although the exact time of this exchange is unknown both the EDGAR M. QUEENY master and pilot were known to be in effect, maneuvering the vessel by "seaman's eye". Similarly both men were aware of the channel restriction and the location of Buoys 9M (LLNR 2261) and 10M (LLNR 2261.50). Both buoys and the Marcus Hook Range were the principal "seaman's eye" aids being utilized by these men. In any regard, Captain [redacted] apprehension deepened as he observed the relative position of Buoy D and the well lighted CORINTHOS. At approximately 0024 (EST) Captain [redacted] again voiced his concern to Pilot [redacted] by stating, "Captain, I think we better go astern, because we will be very close on this maneuver" or words to that effect. The master received no

response from Pilot [redacted] who was again engaged in a radio exchange with Captain [redacted] of the PENNSYLVANIA SUN regarding the intentions of the EDGAR M. QUEENY. Concluding that the efficiency of the bow thruster would be greatly increased by a reduction in the vessel's advance and concerned with the proximity of the CORINTHOS, which he estimated to be 2 shiplengths distant, Captain [redacted] ordered the EDGAR M. QUEENY engines full astern.

27. Mr. [redacted] rang up the full astern order on the engine order telegraph at sometime between 0025 (EST) and 0026 (EST) whereupon it was promptly acknowledged by the engine room. Pilot [redacted] heard the signal of the telegraph and upon reassessing the position of EDGAR M. QUEENY was heard to make some remark regarding the closeness of the CORINTHOS and immediately thereafter ordered "better ring her up double jingle" or words to that effect. The master promptly concurred and Mr. [redacted] executed the proper signal on the engine order telegraph by repeating the full astern order. This signal was promptly acknowledged by the engine room.

28. First Assistant [redacted] was at the engine throttle station in the EDGAR M. QUEENY engine room when the full astern order was received. By 0026 (EST) the vessel's propeller had come to a complete stop and by 0027 (EST) the propeller was turning approximately 70 revolutions per minute (RPM) astern, the full astern rating. At about this same time, a double jingle signal was received in the engine room but it had little impact on the operation of the engines as Mr. [redacted] already had the throttle open as far as he could safely do so. Meanwhile, up in the wheelhouse, the master and pilot watched helplessly as the EDGAR M. QUEENY continued to close with the moored CORINTHOS. As the vessel's propeller reached its full astern speed there was an accompanying significant decrease in the ship's swing to the right. Whereas the heading change was 19° from 0026 (EST) to 0027 (EST) there was only a 12° change from the time the propeller began its effective reverse bite at 0027 (EST) until 0028 (EST).

29. Captain [redacted] observed the bow of his ship easing closer and closer to the CORINTHOS and in response to Pilot [redacted] recommendation that the starboard anchor be dropped, he ordered through his "walkie talkie", "let go the starboard anchor." There was no response from the forecastle as its sole occupant had fled only seconds earlier in the face of a certain collision. Chief Mate [redacted] overheard the master's order regarding the anchor while he was in his ([redacted]) stateroom. Sensing danger, he rushed to his stateroom porthole whereupon seconds later he saw the bow of the EDGAR M. QUEENY "touch" the CORINTHOS with an immediate explosion resulting therefrom. Captain [redacted] had, in final acknowledgement that collision of his ship was imminent, sounded the general alarm at the time of, or immediately before, the first explosion. In a reflexive action seconds after the explosion, Mr. [redacted] rang up "Stop" on the engine order telegraph. This order was immediately answered by the engine room shortly after 0029 (EST) with the propeller stopped within 30 seconds.

30. After the first explosion, Mr. [redacted] sent the third assistant engineer to start the after fire pump and the engineman to start the forward fire pump. Chief Engineer [redacted] rushed to the forward porthole of his office after the first explosion and observed a wall of flame between himself and the stricken CORINTHOS. Mr. [redacted] in the meantime, was attempting to get on deck. The second explosion on board the CORINTHOS caused the door through which Mr. [redacted] was attempting to exit, to become inoperative. The chief mate proceeded into the officers' mess hall and observed the whole EDGAR M. QUEENY forecastle on fire. Mr. [redacted] finally made his way to the poop deck in the vicinity of the starboard lifeboat and commenced preparing the boat for lowering.

31. Back on the bridge, Captain [redacted] noted that the shaft revolution indicator was indicating zero (0) R.P.M. and he called to Mr. [redacted] for "Full Astern." Mr. [redacted] signalled down to the engine room for full astern on the engine order telegraph and the master himself took the bridge telegraph control handle immediately thereafter and moved it to emphasize to the engineers that he wanted full astern. The first assistant received the full astern order on the engine order telegraph and promptly acknowledged the signal. Before he could open the throttle however, he received a "Bridge Control" signal on the telegraph. In accordance with standard practice Mr. [redacted] called the bridge on the ship's installed telephone system to confirm the request for transfer of engine control from the engine room to the bridge. Failing to get any response from the bridge, Mr. [redacted] shifted the throttle control selector switch to the Bridge Control position. The first assistant engineer continued to try to contact the bridge as there was no indication that anyone on the bridge was exercising control over the vessel's engines. This transfer to bridge control took place at approximately 0030 (EST) and was followed shortly thereafter by another explosion of great intensity. Seconds later Mr. [redacted] received another signal of some undetermined function and thus he moved the selector switch from the Bridge Control position. Before he could answer this latest signal from the bridge, he received a full astern bell which he began to respond to. As he initiated action on the latest engine order, he received another signal on the telegraph for bridge control. Having unsuccessfully transferred control earlier he again attempted to contact the bridge for clarification and was successful in contacting the third mate. Establishing the fact that full astern was desired he again opened the throttle and the EDGAR M. QUEENY propeller began turning in reverse at approximately 0031 (EST). As the engines began turning astern, Mr. [redacted] who was unaware that Captain [redacted] had been manipulating the telegraph handle in an effort to emphasize his need for full astern, again called the bridge to remind them that the engine order telegraph was in the Bridge Control position. By this time Mr. [redacted] had the boat lowered to the rail of the embarkation deck and had ordered First Officer [redacted] to hold it there while he [redacted] attempted to collect the crew.

32. Meanwhile, Captain [redacted] and Pilot [redacted] were attempting to free the ship through the use of rudder, bow thruster, flooding tide and ship's engines. As the ship slowly twisted its stern upriver and away from the blazing CORINTHOS, Captain [redacted] observed numerous fires on his own vessel including a large fire on the forecastle. As the EDGAR M. QUEENY continued to back upriver and away from the raging inferno, Captain [redacted] called over his "walkie talkie" for Mr. [redacted] to "go to the monitors, get the monitors going" or words to this effect. Responding to this call, Mr. [redacted] ran forward to man the monitors closely followed by the one crewmember, Quartermaster [redacted] who heard and/or responded to the chief mate's order to those in the general vicinity to assist in putting out the fires. Mr. [redacted] who did not hear the conversations that took place between the master and chief mate went from the boat to the bridge. Arriving there he was urged by the master to go help fight the fire. Mr. [redacted] returned to the boat area to find about 10 people in it with Boatswain [redacted] standing in the middle of it shouting "Lower the boat" or words to that effect. The first officer shouted into the boat that there was water on deck and that he wanted the others to go with him. The only acknowledgement of his request came from the boatswain who, along with others, did not get out of the boat. Mr. [redacted] then hurried forward and joined the chief mate and Mr. [redacted] on the catwalk. At some undetermined point in time Mr. [redacted] had lined up the necessary equipment to provide foam to the monitors and all three of the men on the catwalk began covering the deck with foam as they put out the numerous small fires caused by burning cargo from, or burning parts of, the CORINTHOS.

33. Quartermaster [redacted] from his place in the wheelhouse observed the pitifully small group of men fighting the fire and questioned the master if he wanted him [redacted] to go forward and help. As the quartermaster proceeded out on to the deck in response to Captain [redacted] affirmative answer, he observed Mr. [redacted] in a badly burned condition. Mr. [redacted] returned to the bridge and advised the master of the injured man's condition and shortly thereafter the quartermaster joined the chief mate, the first officer and Mr. [redacted] in their efforts to extinguish the fires on the EDGAR M. QUEENY.

34. The EDGAR M. QUEENY continued to back away from the CORINTHOS until 0041 (EST) at which time the moving ship was approximately parallel to the blazing CORINTHOS. As the four men on the catwalk slowly made their way forward they discovered that the bulk of the fires confronting them were being fed from cargo from the CORINTHOS or in some cases simply burning parts of the other vessel. For example, they discovered a very large section of steel plate burning as it lay lodged over deepwell pump house No. 4. The plate was later identified as a major portion of the tanktop of CORINTHOS' Cargo Tank No. 3 (S). The four men continued spraying the EDGAR M. QUEENY deck with foam as they moved forward along the catwalk from monitor to monitor. At some time during their progress they were joined in their efforts by Chief Pumpman [redacted]. By now the TANDA 12 had come alongside the moving ship's starboard lifeboat that was trailing in the water still secured to one of the boat falls. As the tug came alongside the other ship, several members of the crew climbed aboard from

the lifeboat while assisting Mr. [redacted] onto the tug at the same time. Captain [redacted] of the TANDA 12 after being advised of Mr. [redacted] condition proceeded into the Sun Oil docks where he delivered over Mr. [redacted] to an awaiting ambulance. In the meantime, back on the EDGAR M. QUEENY, the only remaining fire was the relatively large one on the forecastle. With the vessel's forward motion creating a relative wind that successfully opposed the foam being discharged from the foremost monitor, it had been necessary to connect a hose to fight the flames being fed by the ship's polyethelene mooring line on the forecastle.

35. As the EDGAR M. QUEENY continued down the river Captain [redacted] was advised by the master of the PENNSYLVANIA SUN that the channel was blocked by other ships. Captain [redacted] questioned Pilot [redacted] regarding a safe anchorage and based on the pilot's recommendations began maneuvering to anchor in the Marcus Hook Anchorage Area 7. The fire on the forecastle was extinguished only minutes before Mr. [redacted] went up on the bow to stand by the starboard anchor. At approximately 0100 (EST) the EDGAR M. QUEENY starboard anchor was dropped and by 0113 (EST) the vessel was swinging upriver in the close proximity of Marcus Hook Quarantine Buoy C (L.L. pg. 304). This position was near the eastern extremity of the anchorage and as the tide changed shortly thereafter, there was a strong possibility that the anchored vessel would drift down onto Buoy C or become grounded on the edge of the anchorage. Thus, at 0305 (EST) the EDGAR M. QUEENY began shifting its anchorage and by 0345 (EST) the vessel was safely anchored.

36. The fire on board the CORINTHOS and the waters surrounding it continued to rage unchecked during the early morning hours of 31 January. The Marcus Hook Range reach of the Delaware River was closed to all river traffic at 0156 (EST). By 0207 (EST) Raccoon and Darby Creeks, located near Bridgeport, and the CORINTHOS were surrounded by oil prevention booms. By 0400 (EST) at least 10 vessels were on the scene of the burning vessel and were either fighting the fire or engaged in other activities associated with the conflagration. Ultimately, 22 floating units participated in firefighting operations in the vicinity of the CORINTHOS from the waterside. Included in these units were Coast Guard vessels, U.S. Naval vessels, three fireboats and several towboats. Approximately 90 pieces of firefighting apparatus were utilized by shoreside firefighting companies. Efforts to timely extinguish the fire were not successful and a controlled burning of the CORINTHOS and its cargo was accepted as the most practical means of combating the massive pollution precipitated by the collision in question and subsequent breaching of the CORINTHOS hull. At 0955 (EST) the Delaware River was reopened to one way traffic. Firefighting efforts under the control of the Captain of the Port, Philadelphia, were restricted to checking any spread of flame from the area of the burning ship during the morning of 31 January. At 1338 (EST) the river was again closed to traffic because of actual and potential fire danger. The CORINTHOS continued to work upriver and downriver alongside of the B.P. Dock #1 under the combined effects of small shipboard explosions and the tidal currents. The fire continued to rage until at approximately 1515 (EST) the CORINTHOS broke in half and

immediately sank close aboard the dock with little of the after deckhouse or accommodation spaces remaining above water. The CORINTHOS settled to the bottom with its bow secured to B.P. Dock #1 and its stern approximately 50 yards from the same pier. The Marcus Hook Range reach of the Delaware River was subsequently reopened to one way vessel traffic at 1705 (EST).

37. During the preparation of Figure 1 appended hereto, the Board determined that the EDGAR M. QUEENY rudder was hard right at the time that the vessel struck the CORINTHOS. The Board recognizes that this presumption conflicts to some degree with the testimony of the Helmsman Mr. [redacted]. One part of Mr. [redacted] testimony alternately indicates that he observed the rudder amidships at or before the time of collision. Comparing the description of one of his observations with other events it is obvious that he was describing a condition that existed for several minutes before the collision. Repeated questioning by Board members, and others participating in the hearings, also elicited from Mr. [redacted] an acknowledgement that the observation could have been made after the collision. The Board chose to discount his testimony regarding this point since it could not be corraborated and because of his tentative and contradictory accounts.

38. The Board examined the EDGAR M. QUEENY course recorder tracing (original) and magnified copies thereof. The results obtained from this examination were used in the preparation of Figure 1. The results of this examination were also used to establish times and results of certain events leading up to and subsequent to the casualty. The preciseness of the cited examination is considered to be within the margin of error expected for a course recorder and/or gyrocompass and/or any cumulative error therefrom.

39. The EDGAR M. QUEENY course recorder recording described in Finding 38 is of fine quality, presents no signs of alterations, and was subject to more verifications both before and subsequent to the casualty than any other navigational instrument/equipment material to the instant collision. For these reasons it was considered by the Board as the best available source for establishing that vessel's position or heading at any given point in time. The Board determined however, that the tracing in question is approximately 1 minute slow from the ship's time (local zone) and therefore 1 minute has been added to any described event as determined by this tracing. This correction is based on a Board member's observation of the described 1 minute error approximately 1 hour subsequent to the collision, the undisputed testimony regarding time checks prior to the vessel getting underway on the night of 30 January and Third Mate [redacted] description of how he placed the unit in operation. Although the zone tracing clearly represents an error of at least 2 minutes there is no evidence that Mr. [redacted] did not start the course trace at approximately minute 2340 as he so testified. The vernier control adjustments required to accurately establish the pen and tracing time relationship combined with chart room clock characteristics (1 minute increments) to make the 1 minute error clearly understandable and an

acceptable proof of reliability. The tracing in question has three distinct discontinuities located between the 10 minutes boundaries of 0020 and 0030. An examination of the reverse side of the original tracing reveals that these three trace marks are deep indentation caused by sudden thrusts of the course pen. These trace indentations appear at the approximate tracing points represented by 011° and minute 0028+; 020° and minute 0028.5+; and 026° and minute 0029.

40. The following table was developed from the Board's interpretation described in Finding 39 above:

| Minute (Corrected) | Heading |
|---|---|
| 0020 | 272.5°T |
| 0021 | 278°T |
| 0022 | 294°T |
| 0023 | 302°T |
| 0024 | 306°T |
| 0025 | 315°T |
| 0026 | 325°T |
| 0027 | 344°T |
| 0028 | 356°T |
| 0029 | 011°T |
| 0030 | 026°T |
| 0031 | 029°T |
| 0032 | 028°T |

41. An assumed EDGAR M. QUEENY's speed was established for the sole purpose of preparing Figure 1. This speed was estimated by solving the simple equation of motion along the ship's heading for the velocity which resulted from propeller thrust. The computed velocity was then combined vectorally with current velocity to get a desired resultant velocity. To arrive at a meaningful system of speed input to the simulated path of the EDGAR M. QUEENY, the following entering arguments were utilized:

Hypothesis I: That, the bow thruster and side rudder force resulted in rotational motion only and not in translation.

Hypothesis II: That, at minute 19.5, the propeller responds to a command of 60 R.P.M. ahead with the ship velocity at that time being zero.

Hypothesis III: That, at minute 22, Buoy "D" is abeam of the port-hand side of the bow section of the EDGAR M. QUEENY at a distance of 30 yards.

Hypothesis IV: That, at minute 29 plus, the bow of the EDGAR M. QUEENY struck the portside of the CORINTHOS in the way of No. 5 cargo tank.

Hypothesis V: That, based on a propeller pitch of 18.33 feet, an assumed thrust coefficient of .23 and an assumed thrust obstruction of .2 is reasonable.

Hypothesis VI: That, no greater degree of accuracy is purported in Figure I, than that implied in any one of the aforegoing five hypothesis or any cummulative variation derived from five hypothesis collectively.

The table below represents the arithmetical solution of the equation of motion given Hypothesis I through VI above:

| Minute | Speed (Knots) |
|---|---|
| 0021 | .7 |
| 0022 | 1.4 |
| 0023 | 2.2 |
| 0024 | 2.8 |
| 0025 | 3.7 |
| 0026 | 4.2 |
| 0027 | 4.41 |
| 0028 | 3.13 |
| 0029 | 1.9 |

42. The Board recalled Chief Engineer [redacted] as a witness at his own request. During the course of this voluntary appearance he described a 7 day firefighting course for the EDGAR M. QUEENY officers and crew. This training was conducted during the instant trip that terminated at the Monsanto Dock in Bridgeport, New Jersey on 30 January. Mr. [redacted] described this training as providing him with an insight into the vessel's firefighting equipment that he did not possess before. In short, he credited his training, as opposed to chance, as the influence that guided him to do "what he had to do" in the EDGAR M. QUEENY's hour of need. Chief Engineer [redacted] demeanor during his appearance can only be described as outstanding. His display of professional knowledge, candor and sincerity did not pass unnoticed by the Board.

43. An unusual master/pilot relationship existed between Captains [redacted] and [redacted]. Unlike most pilot situations whereas the pilot will simply board the ship for an hour or so, Captain [redacted] would be on board the EDGAR M. QUEENY for a period of time that oftimes extended into a week as he accompanied the vessel from city to city on the east coast of the United States. Thus, Captain [redacted] had occasion to observe the pilot in not only a relatively large number of maneuvers but also in a

relatively large number of different places. In short, a chance to evaluate the pilot under a significantly differing set of environmental and human factors. An evident sense of mutual trust between pilot and master was reflected in their contradictory testimony regarding events which led up to the collision in question. Although much of their testimony was diametric, it was completely lacking in any pique or personal attack directed at the other principal.

44. Both Captain [redacted] and Pilot [redacted] testimony addressed the issue of their wakefulness and/or alertness just prior to the collision. Captain [redacted] in his testimony described a period of sleep of about 6 hours ending at 0400 (EST) on 30 January. Supplementing this sleep was a rest period of unspecified duration between 1300 (EST) and 2300 (EST) on the same date. Captain [redacted] related that he retired at approximately 2030 (EST) on 29 January and awoke at sometime shortly before 0200 (EST) the following day. Departing his home at approximately 0200 (EST) on 30 January, he drove to the pilot station at Lewes, Delaware, arriving there at 0625 (EST) the same day. From the station he boarded the EDGAR M. QUEENY as its pilot at 0718 (EST) on 30 January and continued in this capacity until the vessel docked in Bridgeport, New Jersey at 1300 (EST) the same day. Retiring shortly thereafter he slept until approximately 1700 (EST). He accounted for an additional 5 hours rest between dinner and the time that he arose before midnight that same evening.

45. It was apparent from testimony elicited during Board public hearings that neither Captain [redacted] nor Captain [redacted] felt any need to utilize the services of a tug in their crossing from the anchorage to the channel. On the contrary there was significant testimony to indicate that they did not desire such services. The master, after determining that his employer had specifically ordered the tug's services, went on to pointedly question his employer's representative as to why the EDGAR M. QUEENY needed a tug.

46. Documents and testimony received during the course of the Marine Board of Investigation revealed that the CORINTHOS ship's officers listed below were serving in capacities for which they were not licensed during the vessel's instant trip from Bejaia, Algeria to Marcus Hook, Pennsylvania.

| NAME | CAPACITY | LIBERIAN LICENSE |
|---|---|---|
| [redacted] | Chief Mate | Second Mate |
| | Second Mate | Third Mate |
| | Second Engineer | Third Engineer |
| | Third Engineer | None |
| | Third Engineer | None |

47. Pollution of the Navigable Waters of the United States as a result of the casualty was widespread. Heavy concentrations of crude oil were evident as far down the Delaware River as Delaware City with heaviest concentrations in the immediate Marcus Hook area. Direct costs associated with pollution cleanup and containment are in excess of $2,000,000 dollars. A comprehensive pollution report reflecting the Coast Guard on scene coordinator's investigation of the incident has been filed under separate cover.

48. The Board inspected the EDGAR M. QUEENY on 8 February and 26 March to determine the extent of damage suffered by the vessel in the collision and subsequent fire. The observed damage was largely restricted to the port bow, the forecastle and No. 4 port cargo tank. Included in the forecastle damage were broken and missing rails, deck plating punctured from above, severed mast forestay, fractured parts on starboard anchor windlass and large sections of port and starboard apron bulwarks. All damaged plating or appurtenances were canted, sheared or dished in a direction that indicated damage was caused by a force or forces external to the enclosed spaces of the forecastle. In short, the damage was inflicted by something other than an internal EDGAR M. QUEENY explosion. The port anchor shank was broken off approximately 5 feet above the crown and flukes, leaving only a short section of the shank in the hawsepipe. Several punctures were evident aft of the heavy hawsepipe reinforcement. The punctures were at the approximate location of where the anchor flukes would ride if the anchor was in the position reported by the vessel's first officer. The after surface of the hawsepipe itself, between its opening and the afore-described punctures, was noticeably scraped and scored. Its upper, lower and forward surfaces were not similarly defaced. Approximately 4 feet above and aft of the port hawsepipe was an indention in the hull plating that varied from 1 to 2 inches in depth. This indention continued aft for a distance of at least 20 feet and was accompanied by some upset internals. The configuration and depth of the indention clearly indicated that it was caused by contact with a relatively rigid heavy section protrusion on the CORINTHOS or on another unidentified object. Upon comparing the hulls of the two vessels the Board determined that the indentions in the EDGAR M. QUEENY hull were approximately the same distance above the waterline as the CORINTHOS port accommodation ladder. The 100 ton plus section of CORINTHOS tanktop deck plating caused a large puncture in the port side plating as it landed on the EDGAR M. QUEENY. The puncture was in the way of No. 4 port cargo tank and was approximately 4 feet high by 10 feet long. The removal of the deck plating was accomplished while the vessel remained in the Marcus Hook Anchorage. Fourteen days were required to perform this delicate and time consuming task. The remaining repairs were completed on 4 April to the satisfaction of the Officer in Charge Marine Inspection, Baltimore, Maryland.

49. Subpart 113.35 of Title 46 of the United States Code of Federal Regulations, which sets forth the minimum requirements for vessel engine order telegraph systems, does not address the issue of utilizing a vessel's engine order telegraph to shift control stations. This system is merely described as one that provide "an efficient means for transmitting engine orders from the wheelhouse to the engine room and of transmitting acknowledgement of engine orders from the engine room to the wheelhouse."

50. United States Coast Guard Notice of Proposed Rulemaking (CGD 74-127) dated 21 April proposes in part to add a new Subpart 32.53 to Title 46 of the Code of Federal Regulations which pertains to the construction and equipment of tank vessels of the United States. Included in this subpart is 32.53-10 which requires that each tankship of 100,000 deadweight tons and over must have an approved inert gas system. The section continues by requiring that the cited system "must be designed to eliminate the need for fresh air in the tanks during normal operations."

## CONCLUSIONS

It is concluded that:

1. The proximate primary cause of the casualty was the failure of the EDGAR M. QUEENY's Master (Captain [redacted] to timely exercise positive control over the vessel's maneuvers although he had reason to doubt the efficacy of the vessel Pilot's (Captain [redacted]) control. Captain [redacted] apprehension was assertively displayed during an initial exchange with Pilot [redacted] regarding the position of the vessel shortly after the tug M/V TANDA 12 disengaged itself. Although the exchange clearly reflected Captain [redacted] feeling of impending danger, he chose to accept the pilot's assurance that the vessel would safely complete its turn and thus deprived his vessel of critical maneuvering time. Captain [redacted] continued reliance on the pilot after the collision reflected an unusual display of confidence which is presumed to be a function of mutual trust between the two.

2. A principal contributing cause of the casualty was the casual and imprudent attitude displayed by the EDGAR M. QUEENY's Pilot (Captain [redacted] toward the potentially dangerous turn in the river. Evidence of this casualness is provided by his decision to dismiss the assisting M/V TANDA 12, notwithstanding the fact that he knew of the Marcus Hook Channel restriction and the nature of the cargo being carried on his vessel. Further manifestation of this attitude is found in his disregard of Captain [redacted] apprehension regarding the EDGAR M. QUEENY's rate of swing during the turning maneuver.

3. The maneuver in which the EDGAR M. QUEENY was engaged from approximately 0005 (EST) on 31 January to the time of collision was within the vessel's capabilities. Since there was no evidence of any machinery or equipment malfunction or derangement two self-evident options for a safe river crossing were available and indicated by the circumstances of the restricted channel and nature of the vessel's cargo. A backing and filling operation at Buoy D until the vessel was shaped up on its entrance into the Marcus Hook Channel would have avoided the casualty. Moreover, the collision probably would not have occurred if the services of the M/V TANDA 12 had been retained until the EDGAR M. QUEENY had shaped up properly on the Marcus Hook Range.

4. Based on existing information it is not possible to positively determine if the EDGAR M. QUEENY would have cleared the CORINTHOS if the engines of the underway vessel had not been reversed. Such a determination would require bow thruster test data and vessel characteristic data that was not available to the Board. Moreover, variable human factor inputs such as Pilot [redacted] ability to increase the vessel's speed, further complicates the resolution of this question.

5. Based on existing information the EDGAR M. QUEENY may have cleared the CORINTHOS if Captain [redacted] had placed his vessel's engines astern at the time he first expressed apprehension to Pilot Sorensen regarding the turn. Captain [redacted] assessment of approximately 2 ship lengths separation between the two vessels was traveled in 3 minutes of time. This period included approximately 1 minute of reaction time and 2 minutes of full astern engine revolutions per minute (R.P.M.). The most conservative estimate of the effect of 1 additional minute at this full astern speed probably would have been adequate to provide a sufficient margin of time to avoid the collision.

6. The inability of the Board to assertively resolve the questions set forth in conclusions 4 and 5 above does not adversely affect the intent or purpose of the subject Marine Board of Investigation. Since the Board considers the causes of the casualty to be essentially psychological in nature, any recommendations emanating from discrete solutions to those questions would require a duplication of human behavior dispositions and traits that is not possible.

7. The deaths of Arvie Harris, Georgios Balalas, Christos Fergadakis and Evaggelia Katte were directly or indirectly caused by the EDGAR M. QUEENY, O.N. 528567, and CORINTHOS, O.N. 1916, collision on 31 January. Further, that 22 persons are believed to be missing and are presumed dead as a result of said collision. Included in the identity of these 22 persons [redacted]

8. The initial contact between the two vessels occurred when the bow of the EDGAR M. QUEENY eased alongside of the No. 5 port cargo tank of the CORINTHOS at an angle of approximately 49°. Corraborating testimony of both CORINTHOS and EDGAR M. QUEENY personnel place the latter's bow just forward of the former's deckhouse and aft of its port cargo manifold immediately after the initial explosion. An almost simultaneous holing of the same cargo tank occurred as the flukes of the EDGAR M. QUEENY port anchor pierced the CORINTHOS hull. This conclusion is supported by visible damage to the EDGAR M. QUEENY port bow as well as the broken portion of its port anchor shank found within the port hawsepipe. The fetching up of the flukes would have exerted a moment on the anchor shank that is considered consistent with the scored surface of the hawsepipe opening and the hull puncture aft of the hawsepipe. Moreover, the shape and flare of the EDGAR M. QUEENY bow alone would not provide the "grappling effect" necessary to move the CORINTHOS aft along the face of the dock in the manner described by Chief Mate [redacted]. Further support of this conclusion is found in the final position assumed by the section of CORINTHOS' No. 3 starboard cargo tank top on the deck of the EDGAR M. QUEENY. The undisputed eyewitness account of this large plate

section floating or flying directly across the stricken vessel, combined with its final resting place on the EDGAR M. QUEENY, categorically locates the EDGAR M. QUEENY port king post upriver of the CORINTHOS' No. 3 cargo tank at the time of the second explosion.

9. The intensity of the initial explosion on board the CORINTHOS and the rapid flame propagation resulting therefrom, combined to make emergency firefighting measures virtually impossible. Moreover, the short time lapse between the first explosion and the much more severe second explosion would have defeated any original efforts at saving the ship. After the devastating second explosion there were no possible measures that could have saved the CORINTHOS.

10. The initial contact between the CORINTHOS and EDGAR M. QUEENY took place at approximately 0029 (EST) on 31 January ship's time. The establishment of this time is based on the analysis of the course recorder and engine recorder tracings. The Board determines that the three indentions in the course recorder tracing that appear at 011°T, 020°T and 026°T were caused by shocks associated with the first, second and third explosions respectively on board the CORINTHOS. The importance of the engine recorder tracing in this conclusion turns on Mr. [redacted] testimony that he ordered the engines stopped seconds after collision. There is no evidence that Third Mate [redacted] actions in stopping the EDGAR M. QUEENY engines at the time of the collision caused or contributed to the cause of the collision. Because of the Board's conclusion that the vessel's port anchor pierced the CORINTHOS hull and recognizing that the anchor flukes may have subsequently assumed any position, no determination is made as to what impact his actions may have exerted on the outcome of this vessel's post-collision maneuvers. However, the deleterious psychological influence of his actions on Captain [redacted] is readily apparent in the master's immediate post-collision behavior.

11. The EDGAR M. QUEENY's Master and/or pilot should have ordered an anchor dropped at the time the vessel's engines were placed astern at approximately 0026 (EST) on 31 January. Their concurrence that a "double jingle" astern order was necessary was a tacit agreement on both men's part that they were in a situation so dangerous that only the utmost in defensive maneuvers was in order.

12. Able Seaman [redacted] could be expected to possess sufficient knowledge and experience to drop the EDGAR M. QUEENY anchor if so ordered by the vessel's master. The degree of preparation for letting the anchor go described by First Officer [redacted] is considered sufficient for permitting any able seaman to accomplish this task with the barest of instructions from the vessel's bridge, if such instructions were necessary.

13. Common ordinary luck was a principal influence responsible for averting a catastrophic conflagration and/or release of toxic fumes in the Marcus Hook area of uncontrollable magnitude. A lack of wind isolated the fire from the British Petroleum Refinery and the array of similar surrounding refineries and also permitted the EDGAR M. QUEENY to remain alongside of the CORINTHOS inferno for at least 8 minutes and escape relatively unscathed.

14. Inerting the CORINTHOS' cargo tanks as these tanks were being emptied might have prevented the initial explosion and/or successive explosions propagating from tank to tank. Although an over-rich mixture of ullage gas might have been present before the vessel's hull was breeched, such a condition would change in proportion to the ingress of air into the breeched tank or tanks. A rapid reduction in the concentration of the flammable portion of the ullage gas would place the mixture within the flammable limits. This now explosive concentration only required a spark from the tearing metal for ignition. An inerted tank on the other hand may not have ignited as readily, or as violently, if at all.

15. The recent fire fighting training described by Chief [redacted] may have materially assisted in the EDGAR M. QUEENY's survival. The timely and apparent trouble-free operation of the vessel's fire fighting foam system is credited to the chief engineer's recent training in the system's equipment. On the other hand, there is no evidence that the cited training materially assisted the men actively engaged in the fire fighting operations on deck. These seemingly anomalous opinions regarding the value of the fire fighting training is due in a large part to the known psychological phenomena i.e., differing human behavior. The Board offers no opinions as to what motivated five men to go forward and fight the fire and what motivated other crew members to refrain from joining them. On balance, however, the Board was so taken with Chief [redacted] appearance as a witness that his assessment that the training was invaluable is accepted without challenge.

16. There is no evidence that either the master or pilot was physically unable to effectively perform their duties during the transit from the Monsanto Dock to the point of collision. On the contrary both men described periods of sleep and rest that are considered adequate in both terms of length and time.

17. Captain [redacted] tenacity and sense of responsibility to his ship was a principal factor in preventing the loss of the EDGAR M. QUEENY and an untold number of its crew. His presence of mind and ability to muster sufficient crew members to extinguish the fires on board his vessel is a tribute to his sense of command responsibility. Standing by his station on the bridge in the face of certain danger, Captain [redacted] with the assistance of Pilot [redacted] maneuvered his ship from the burning CORINTHOS in the finest tradition of the sea.

18. Pilot [redacted] continued assistance in freeing the EDGAR M. QUEENY from its incredibly dangerous situation and his subsequent assistance in safely anchoring the vessel reflected his strong sense of professional responsibility.

19. First Engineer [redacted] actions subsequent to the first explosion were in the finest tradition of the sea. Remaining at his station in spite of his limited knowledge of the ship's condition was a principal force behind the survival of the EDGAR M. QUEENY and reflects heroic action worthy of public recognition.

20. The performance of Chief Officer [redacted] First Officer [redacted] Quartermaster [redacted] Quartermaster [redacted] and Chief Pumpman [redacted] during fire fighting operations on board the EDGAR M. QUEENY on 31 January is considered heroic and deserving of public recognition.

21. Third Mate [redacted] devotion to duty displayed by remaining at his station after the collision is deserving of public recognition.

22. There is evidence of negligence on the part of Captain [redacted] Master of the EDGAR M. QUEENY in connection with the collision of that vessel and the CORINTHOS on 31 January.

23. There is evidence of negligence on the part of Captain [redacted] Pilot of the EDGAR M. QUEENY in connection with the collision of that vessel and the CORINTHOS on 31 January.

24. There is evidence that the CORINTHOS was not manned in accordance with Liberian manning scales at the time it arrived at the British Petroleum Refinery in Marcus Hook, Pennsylvania on 30 January.

25. There is no evidence that any Coast Guard personnel or representative or employee of any other United States governmental agency or any other person caused or contributed to the cause of the casualty.

## RECOMMENDATIONS

It is recommended that:

1. Further investigation, under the provisions of R.S. 4450, be conducted into the actions of Captain [redacted] for his part in the casualty.

2. Further investigation, under the provisions of R.S. 4450, be conducted into the actions of Pilot [redacted] for his part in the casualty.

3. A copy of this report be forwarded to the Government of Liberia for their consideration of Conclusion 24.

4. Consideration be given to amending Subpart 113.35 of Title 46 of the United States Code of Federal Regulations to require a positive lock or latch on dual purpose vessel engine order telegraph systems. Dual purpose systems are those which, in addition to controlling the engine speed and direction, also provide for another function such as transfer of control stations similar to that installed on board the EDGAR M. QUEENY.

5. Consideration be given to changing Part 156 of Title 33 of the United States Code of Federal Regulations to require the inerting of all tankship cargo tanks, while such vessels are transferring crude oil at any facility located on the Navigable Waters of t[redacted]

[redacted]

Captain D. F. HALL, USCG
Chairman

[redacted]

Member

[redacted]

Commander, D. F. SMITH, USCG
Member and Recorder

# COAST GUARD MARINE BOARD OF INVESTIGATION

## S/T CORINTHOS/SS EDGAR M. QUEENY COLLISION

Marcus Hook, Pennsylvania 31 January 1975

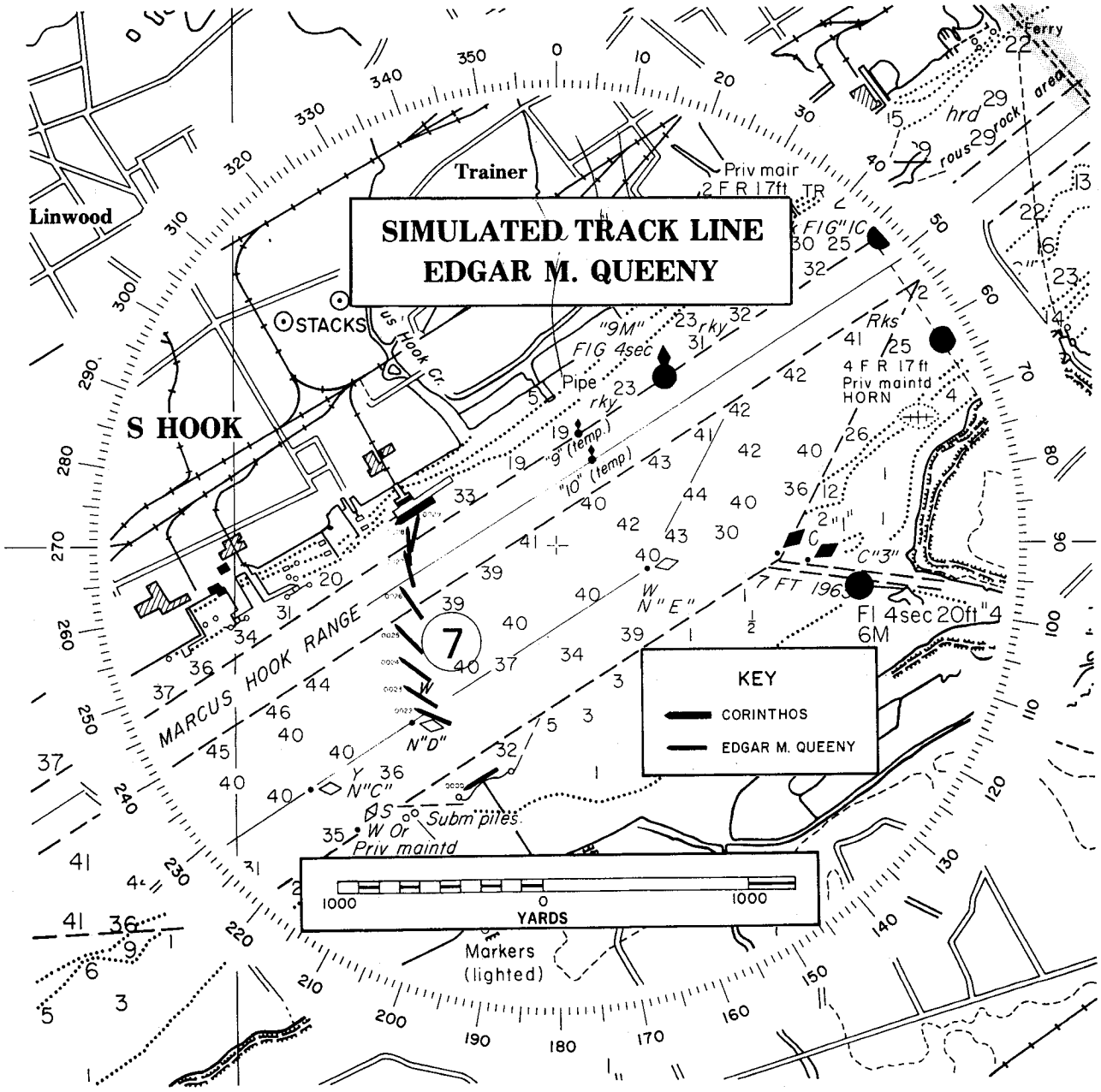


FIGURE 1