UNITED STATES COAST GUARD

INVESTIGATION INTO THE CIRCUMSTANCES SURROUNDING THE FIRE ABOARD THE TANKSHIP

SEAL ISLAND

ON OCTOBER 8, 1994, IN ST. CROIX, U.S. VIRGIN ISLANDS, WITH INJURIES AND MULTIPLE LOSS OF LIFE

U.S. Department of Transportation
United States Coast Guard

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16732/MC94020954
4 APRIL 1997

SS SEAL ISLAND, L7326130, ENGINEROOM FIRE AT THE HESS OIL REFINERY, ST. CROIX, U. S. VIRGIN ISLANDS, CARIBBEAN OCEAN ON 8 OCTOBER 1994 WITH LOSS OF THREE LIVES AND SIX INJURIES

ACTION BY THE COMMANDANT

The report of the Investigating Officer and the forwarding comments of Commander, Seventh Coast Guard District have been reviewed. The report is approved subject to the following comments.

PREVENTION THROUGH PEOPLE LESSONS LEARNED

In keeping with the Coast Guard's Prevention Through People program, the analysis of this accident shows there are lessons that can be shared to prevent similar accidents. In this case, a temporary repair to stop a leak was made to the turbine generator's lube oil duplex strainer. Even though a permanent repair probably would have been a relatively simple replacement of an O ring, the temporary repair was left in place for several months to avoid taking the turbine generator off line. The temporary repair, although effective in stopping the leak while the turbine generator was operating, defeated the normal operation of the assembly and increased the risk for a leak to occur while changing the lube oil strainer. If a proper, permanent repair had been made promptly, this accident would not have happened.

ACTION ON RECOMMENDATIONS

RECOMMENDATION 1: That the Coast Guard and Republic of Liberia review the need to amend the marine safety regulations and SOLAS rules to require an automatic water mist fire suppression system in enginerooms of oceangoing vessels.

ACTION: We concur. Commandant (G-MSE) will continue to review the need for and practicality of mandatory use of water mist fire suppression systems in machinery spaces of oceangoing vessels. The Coast Guard has suggested to various committees of the International Maritime Organization (IMO) that automatic water based fire suppression systems would be beneficial in machinery spaces. The USCG has further urged the Maritime Safety Committee (MSC) of the IMO to put a complete revision of practices for protecting machinery spaces on the agenda of the subcommittee on fire protection. The MSC only partially agreed with the U.S.

request and the project was rolled into the work of an ongoing task group preparing a comprehensive rewrite of SOLAS Chapter II/2. Ultimately, the U.S. expects the IMO to adopt performance standards which will not specify water mist systems for machinery spaces but which will result in their selection in applications where appropriate.

RECOMMENDATION 2: That the Coast Guard and Republic of Liberia review the need to amend the marine safety regulations and SOLAS rules to require the construction of engine control rooms on vessels, which provide a safe haven for the engineers with a supply of air for the ventilation/air conditioning systems from the atmosphere vice directly from the engineroom, a control room of air tight construction, and/or a space under positive pressure, the fans operating off the emergency bus that would prevent the introduction of smoke from fires in the engineroom.

ACTION: We concur. Arrangements allowing engineers time to shut down or control certain machinery from the control room during the initial moments of a fire are desirable. In addition, control rooms, which are likely to be manned during a fire, or entered by an escaping crew during a fire, should be arranged such that they have air supplies independent of the main machinery spaces which may be subject to heavy smoke. The recommendation is further supported by the events of the August 1995 engine room fire onboard the passenger vessel Regent Star during which the on watch crew in the engine control room were quickly confronted with smoke. Commandant (G-MSE) will continue to review the need for, and practicality of, mandatory construction and ventilation arrangements for engine control rooms.

RECOMMENDATION 3: That the Coast Guard and Republic of Liberia review the need to amend the marine safety regulations and SOLAS rules to require a high intensity emergency lighting system located at deck level in enginerooms to mark the means of egress. Photoluminescent and electroluminescent systems should also be tested in smoke conditions to determine if they provide adequate lighting to mark the means of egress.

ACTION: We concur. We will continue to review the need for, and practicality of, mandatory installation of deck level lighting to mark main machinery space means of egress. In addition, Commandant (G-MSE) will seek opportunities to facilitate industry partnerships to help determine the effectiveness of current electroluminescent and photoluminescent lighting systems.

RECOMMENDATION 4: That the Coast Guard and Republic of Liberia review the need to amend the marine safety regulations and SOLAS rules to require escape trunks with self closing doors, emergency lighting and an external supply of air at every major level in the engine rooms of ocean going vessels.

ACTION: We concur. Commandant (G-MSE) will continue to review the need for, and practicality of, mandatory installation of escape trunks (with self closing doors, emergency lighting, and an external air supply) serving every major deck level of enginerooms of ocean going vessels.

RECOMMENDATION 5: That the Coast Guard and Republic of Liberia initiate rulemaking to amend the marine safety regulations to increase the number of self contained breathing apparatus and spare cylinders required for ocean going vessels. The Coast Guard and Republic of Liberia should propose to the (IMO) a similar amendment to the SOLAS rules.

ACTION: We agree with the intent of this recommendation, however, initiation of U.S. rulemaking and amendment to SOLAS is not sufficiently justified by a single casualty. Although a regulatory change is not warranted at this time, the intent of this recommendation may be realized through effective voluntary measures. Commandant (G-MSE) will propose, to the National Fire Protection Association's committee on merchant vessels, voluntary measures for the carriage of additional self contained breathing apparatus sets and spare cylinders on ocean going vessels. Commandant (G-MSE) will subsequently transmit those measures to the IMO subcommittee on fire protection.

RECOMMENDATION 6: That the Coast Guard and Republic of Liberia initiate rulemaking to amend the marine safety regulations to require emergency escape breathing apparatus be provided in engine rooms, pumprooms or other vessel spaces where personnel normally would be working and could be exposed to smoke or noxious fumes and located in way of escape routes. The Coast Guard and Republic of Liberia should propose to IMO a similar amendment to the SOLAS rules.

ACTION: We agree with the intent of this recommendation. However, initiation of U.S. rulemaking and amendment to SOLAS is not sufficiently justified by a single casualty. Although regulatory change is not warranted at this time, the intent of this recommendation may be realized through effective voluntary based measures. Commandant (G-MSE) will propose, to the National Fire Protection Association's committee on merchant vessels, voluntary measures for the carriage of self contained breathing apparatus equipment. As a note, the IMO subcommittee on fire protection may be more receptive to a requirement of mandated carriage, as the subject of EEBDs has been on the subcommittee's agenda for several years at the request of the CG. The Coast Guard will likely propose voluntary carriage requirements as an interim step before asking for mandatory carriage.

RECOMMENDATION 7: That the Coast Guard and Republic of Liberia initiate rulemaking to amend the marine safety regulations to require, at a minimum, monthly fire drills where the fire is simulated in the engine room and the crew is required to use the emergency escape trunks provided in reduced lighting conditions. The Coast Guard and Republic of Liberia should propose to IMO a similar amendment to the SOLAS rules.

ACTION: We agree with the intent of this recommendation. However, initiation of U.S. rulemaking and amendment to SOLAS provisions is not sufficiently justified by a single casualty. Although regulatory changes are not warranted at this time, effective voluntary based measures may accomplish the goals of this recommendation. Rather than a prescriptive requirement for a monthly engine room fire drill or for testing emergency machinery using all available starting and

power systems, Commandant (G-MSE) favors the development of guidelines for planning meaningful fire drills of all types. Commandant (G-MSE) will ask the IMO to develop standards for regular fire drills in machinery spaces. Commandant (G-MSE) will also propose to a standards making organization such as the National Fire Protection Association that nonregulatory industry standards for the conduct of fire drills be developed. Commandant (G-MSE) will subsequently transmit the developed measures to the IMO's subcommittee of fire protection.

RECOMMENDATION 8: That the Coast Guard and Republic of Liberia initiate rulemaking to amend the marine safety regulations to require the testing of emergency machinery during weekly/monthly drills using all the starting systems available. The Coast Guard and Republic of Liberia should propose to IMO a similar amendment to the SOLAS rules.

ACTION: We agree with the intent of this recommendation, however, existing regulations give the USCG adequate authority to require comprehensive inspection and testing of emergency equipment. Additional, federally mandated inspection and testing requirements need not be developed for every conceivable type of equipment arrangement and failure. The goal of increased comprehensive inspection and testing of starter systems can, and should, be achieved through non-regulatory measures such as industry standards, educational programs supporting the Prevention Through People program and COTP policies. SOLAS Regulation III/19.4.4, adopted in May 1996 and entering into force July 1, 1998, already requires that fire drills be planned for the various emergencies that may occur. Commandant (G-MSE) favors the development of guidelines for planning meaningful drills incorporating all of the available emergency systems including various starting systems for emergency machinery and equipment. Commandant (G-MSE) will propose to a standards making organization such as the National Fire Protection Association the development of recommended practices for testing and inspection of shipboard fire protection systems.

RECOMMENDATION 9: That the Coast Guard and Republic of Liberia initiate rulemaking to amend the marine safety regulations to require an oil deflector between the lube oil strainer and heated surfaces of piping and equipment or require the oil strainers be installed a safe distance away from sources of ignition and heated surfaces. The Coast Guard and Republic of Liberia should propose to IMO a similar amendment to the SOLAS rules.

ACTION: We agree with the intent of this recommendation. However, rulemaking on this issue is not yet appropriate given the absence of data on the practicality and effectiveness of fuel oil deflector devises on commercial vessels. Commandant (G-MSE) will work with the Navy and those commercial operators who have experience with spray shields to study the feasibility and effectiveness of these devices. Commandant (G-MSE) will take the results of the study, if favorable, to the IMO in support of a requirement for fuel oil deflectors for all ships.

RECOMMENDATION 10: That the Coast Guard and Republic of Liberia initiate rulemaking to amend the marine safety regulations to require international shore connections at marine transportation related, and designated waterfront facilities which are compatible with their fire hoses and hydrants ashore.

ACTION: We concur. IMO Resolution A.470(XII) concerning international shore connections (shoreside) urges all governments to provide international shore connections at all port facilities. Both 33 CFR 126 (Handling of Explosives or Other Dangerous Cargoes Within or Contiguous to Waterfront Facilities) and 33 CFR 154 (Facilities Transferring Oil or Hazardous Materials in Bulk) will be appropriately revised.

RECOMMENDATION 11: That the Coast Guard and Republic of Liberia review the need to initiate rulemaking to require marine transportation related and designated waterfront facilities to ensure tugs of adequate horsepower be provided at all times, within a minimum response time, to tow any dead ship away from a facility.

ACTION: We agree with the intent of this recommendation. Given the availability of tugs in some ports in support of OPA90 requirements and the requirements for port contingency plans, inclusion of a tug response analysis in port contingency plan is desirable. However, initiation of a rulemaking project is not justified at this time. We will continue to review casualty histories to determine the need for such requirements.

RECOMMENDATION 12: That guidance be provided to Coast Guard marine inspectors to test emergency machinery using all the starting systems available during their boarding examinations and inspections.

ACTION: We concur. Commandant(G-MSE) will work to ensure that Coast Guard marine inspectors and classification society surveyors receive guidance to test emergency machinery using all of the starting systems available during boarding examinations and inspections. Appropriate guidance will be added to the Marine Safety Manual.

RECOMMENDATION 13: That Coast Guard Marine Safety Office, San Juan, Puerto Rico develop a firefighting contingency plan for St. Croix.

ACTION: We concur. A copy of this report will be forwarded to Commanding Officer, MSO San Juan, for information and appropriate action.

RECOMMENDATION 14: That American Bureau of Shipping review guidance to their surveyors to ensure they are instructed to test emergency machinery using all the starting systems available during their surveys.

RECOMMENDATION 15: That Amerada Hess survey all of its waterfront facilities and refineries and ensure the availability of international shore connections so fire fighting water can be supplied from shore.

RECOMMENDATION 16: That Atlantis Agency Corporation and HOVIC determine tug requirements (number of tugs and horsepower) to safely move dead ships from their waterfront facilities and to ensure their availability at all times.

RECOMMENDATION 17: That Atlantis Agency Corporation include in their fire safety training the science of fire including the concentrations of heat and noxious smoke at the upper levels of a space, and the concentration of oxygen at the lower levels of the space so their crew's can make more informed decisions on how to safely escape from a burning space. Included in this training should be familiarization with normal and emergency means of egress.

RECOMMENDATION 18: That Atlantis Agency Corporation consider the periodic review of the first assistant engineer's work book by management in an effort to correct its nonconformity with its ISO 9002/ISM program to detect unauthorized/improper repairs in the engineroom. Atlantis Agency Corporation should also review its management oversight so it can properly monitor if the shipboard engineers are conducting routine maintenance on its critical equipment and machinery including the diesel generator.

RECOMMENDATION 19: That Atlantis Agency Corporation review how the instructions are posted for the low pressure CO2 system on its two remaining VLCCs. If the instructions are on the cover, they should be relocated to the bulkhead adjacent to the remote control box so they will be visible during the operation of the system.

RECOMMENDATION 20: That Atlantis Agency Corporation review the fire safety plans for the SAINT LUCIA and MT. CABRITE, and update them, if necessary, to accurately reflect the safety equipment and emergency escape trunks on board these vessels.

RECOMMENDATION 21: That HOVIC review its fire contingency plans, resolve any discrepancies and develop an incident command system for all fire scenarios at its refinery and marine terminal. The command system should also include the integration of shoreside and vessel personnel from company owned and independent company vessels, e.g. a non-Amerada Hess vessel on fire while moored at the facility.

RECOMMENDATION 22: That HOVIC's fire brigade receive shipboard fire fighting training and become familiar with the general arrangements of the vessels which call at their facility.

RECOMMENDATION 23: That a copy of this report be sent to the American Bureau of Shipping for their information and action as they deem appropriate.

ACTION: We concur with recommendations 14 through 23. A copy of this report will be sent to the American Bureau of Shipping, Amerada Hess, Atlantis Agency Corporation, and Hess Oil Virgin Island Company for their information and appropriate action.

RECOMMENDATION 24: That a copy of this report be widely disseminated to the marine industry to remind them of the dangers of working on pressurized flammable and combustible liquid systems, and to educate them on the lessons learned from this casualty and encourage the incorporation of them in their own safety programs/initiatives.

ACTION: We concur. Commandant (G-MOA) will disseminate the report to the marine industry and ensure that the lessons learned from this casualty and the hazards associated with working on pressurized combustible liquid systems are widely publicized.

W. D. RABE
By direction

Copy: CCGD7(m)
CCGD5(Am)
Republic of Liberia
MSO San Juan

FIRST ENDORSEMENT on SS SEAL ISLAND formal investigation 16732/MC94020954 of 22 Aug 95

From: Commander, Seventh Coast Guard District
To: Commandant (G-MAO)

Subj: SS SEAL ISLAND, LLOYDS NO. L7326130; ENGINEROOM FIRE AT THE HESS OIL REFINERY, ST. CROIX, U. S. VIRGIN ISLANDS, CARIBBEAN OCEAN ON 8 OCTOBER 1994 WITH LOSS OF THREE LIVES AND SIX INJURIES

1. This report was prepared at my direction as the result of a one man formal board of investigation conducted by Captain Anthony Regalbuto, U. S. Coast Guard. Captain Regalbuto's outstanding report accurately depicts the casualty and proposes a number of well conceived recommendations. The final report was adopted in its entirety by Mr. A. P. Ritola, Investigating Officer, for the Republic of Liberia. This report is forwarded approved.

2. Recommendations 1, 2, 3, 4, 5, 6, 7, 8, and 9 should be addressed to the International Maritime Organization (IMO) by Commandant (G-M) at the earliest opportunity due to their potential for saving lives and property at sea.

3. Recommendations 10, 11, 12, 14, 23, and 24 require further action by Commandant (G-M).

4. Coast Guard Marine Safety Office San Juan will take recommendation 13 for action, and will monitor the efforts of Hess Oil Virgin Island Company in complying with recommendations 15, 16, 21, and 22.

5. Recommendations 17, 18, 19, and 20 should be addressed by letter to the Atlantis Agency Corporation by Commandant (G-M).

6. Finally, I believe it is appropriate to take special note of Section n. of the Narrative, and Paragraph 29 of the Conclusions, which discuss the vessel operators safety management system and ISM/ISO 9002 certification. The findings note that even before their ISM/ISO certification, the operator had many oversight systems for discovering and reporting discrepancies. Despite the obligations of the vessel crew to report, and at least seven audit visits by company personnel and a consultant, no one took any action on the temporary repairs to the steam generator lube oil system, or the lack of maintenance on the diesel generator. This highlights the glaring problem that many safety plans are simply constructed to satisfy regulators and insurers, and have

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very little effect on the actual operations and practices on the vessels. Plans are no substitute for proper maintenance and are of no value if their lofty provisions are routinely ignored.

R.T. RUFE, JR.

Copy: CG MSO San Juan w/recommendations
CG MSO Jacksonville, Capt. A. Regalbuto

U.S. Department of Transportation
United States Coast Guard

Commanding Officer
U. S. Coast Guard
Marine Safety Office

7820 Arlington Expwy, Suite 400
Jacksonville, FL 32211-7445
Phone: (904)232-2640

16732/MC94020954
22 August 1995

From: U.S. Coast Guard Investigating Officer
To: Commandant (G-MMI)
Via: Commander Seventh Coast Guard District (m)

From: Republic of Liberia Investigating Officer
To: The Commissioner of Maritime Affairs, Republic of Liberia

Subj: SS SEAL ISLAND, LLOYDS NO. L7326130; ENGINEROOM FIRE AT THE HESS OIL REFINERY, ST. CROIX, U.S. VIRGIN ISLANDS, CARIBBEAN OCEAN ON 8 OCTOBER 1994 WITH LOSS OF THREE LIVES AND SIX INJURIES

FINDINGS OF FACT

SUMMARY

At about 0840 (local time) on 8 October 1994, the SS SEAL ISLAND sustained a major engineroom fire while the vessel was berthed at dock number 3, Hess Oil Refinery, St. Croix, U. S. Virgin Islands. A large fire originating near the lubricating (lube) oil duplex strainer for the steam turbine generator located on the forward starboard side of the boiler platform engulfed the engineroom killing three and injuring six crew members. The fire and resulting smoke continued to rage until 1340 on 9 October 1994 and spread to a provisions locker and the passageways and some of the staterooms on A and B decks. Damage to the ship was determined to be about $12 million. The vessel was towed to Cadiz, Spain and was later sold in its unrepaired/damaged condition.

VESSEL DATA

Name:	SEAL ISLAND
Flag:	Liberian
Lloyd's Number:	L7326130
Call Sign:	ELDM8
Service:	Tank Vessel
Gross Tons:	123,009
Net Tons:	104,967
Dead Weight Tons (DWT):	259,042
Length (overall):	340.52 meters
Breadth (molded):	51.82 meters
Depth (molded):	25.61 meters
Home Port:	Monrovia, Liberia

Date Built:	July 1973
Place Built:	Malmo, Sweden
Built by:	Kockums M/V
Owner:	Seal Island Shipping Corporation 1185 Avenue of the Americas New York, NY 10036
Operator:	Atlantis Agency Corporation 1185 Avenue of the Americas New York, NY 10036
Propulsion:	Steam Turbine
Horsepower:	32,000
Master:	Pasquale Buonarotti
Classification Society:	American Bureau of Shipping

RECORD OF DEAD

Name:	Antonino Marchese
Position on Vessel:	First Assistant Engineer
Age:	49
Home Address:	Via S. Donato 17-Monopoli Bari, Italy

Name:	Dante C. Dela Cruz
Position on Vessel:	Electrician
Age:	36
Home Address:	Lot 5 Block 7 Rukal Subdivision Pag Bilao Quezon, Philippines

Name:	Nomer V. Surmieda
Position on Vessel:	Fitter
Age:	25
Home Address:	9A Gabriel, Gabriel Subdivision Gabriel Halabon, Philippines

RECORD OF INJURED

Name:	Mario Pontarelli
Position on Vessel:	Chief Engineer
Age:	45
Injury:	severe smoke inhalation; second and third degree burns to hands, face, back, and buttocks - two months comatose and five months in hospital.

Name:	Ariel S. Padasas
Position on Vessel:	Fitter
Age:	26

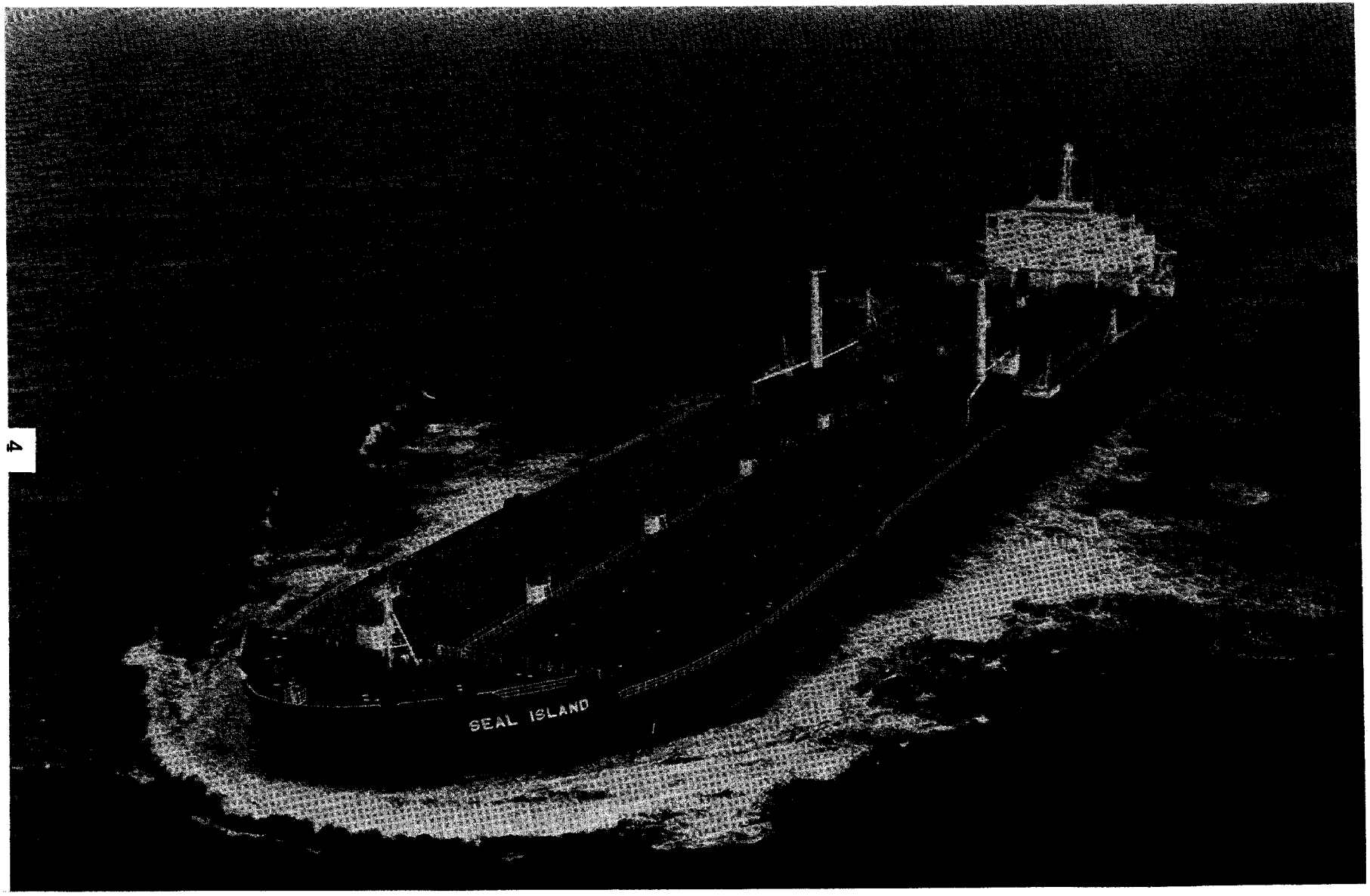


Figure 1 - Photograph of the SEAL ISLAND

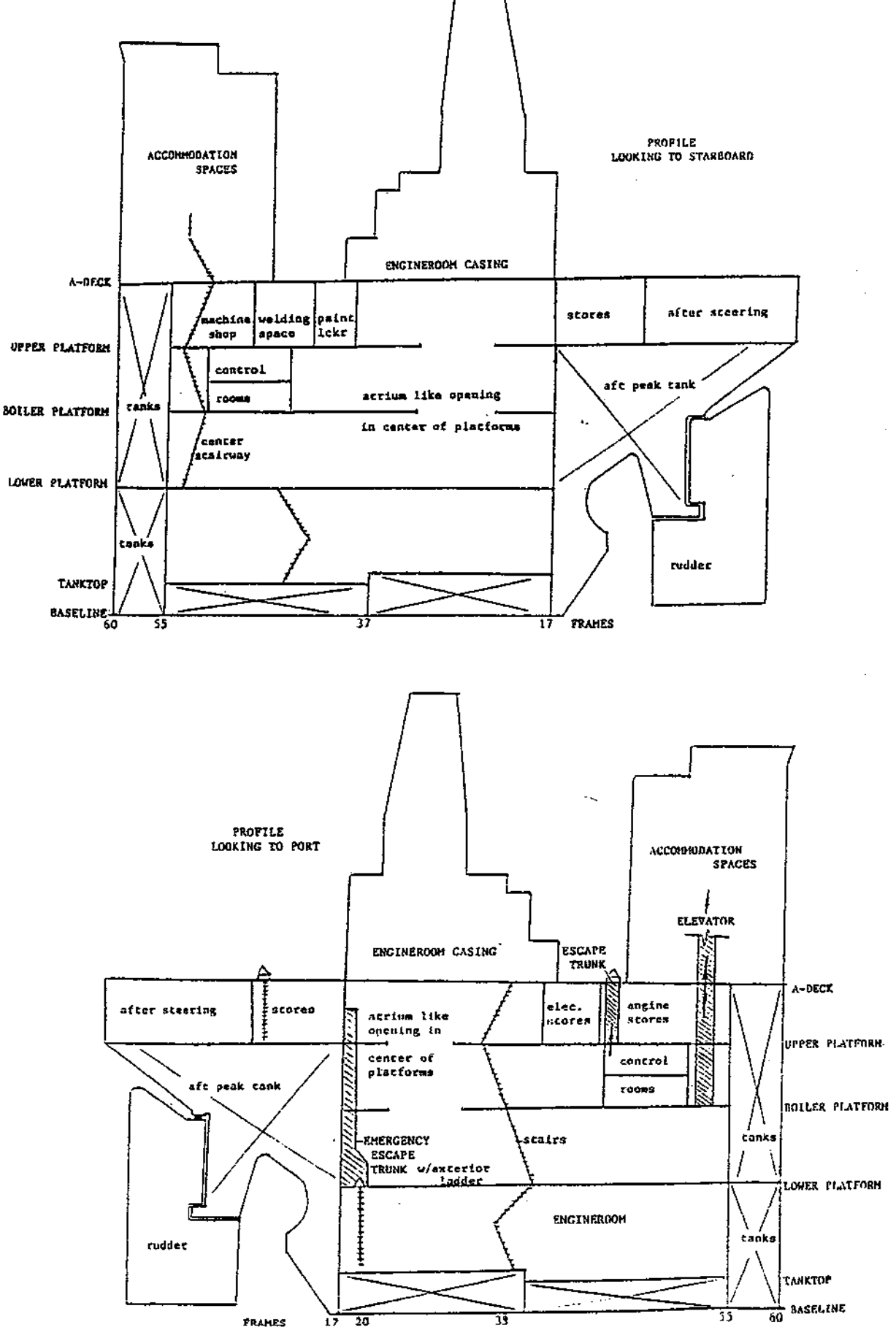


Figure 2 - Cross Section Drawing of the After Section of the Vessel Including the Engineroom

report and is located between frames 51 and 55. Decks are lettered A starting at the main deck and continuing up to F which is the bridge. Each accommodation house deck has a passageway that encircles the center stairs.

The tank top level contains the main condenser, reduction gear, high and low pressure turbines and the propulsion shafting. Near the forward bulkhead (frame 55) are two fire pumps with a capacity of 180 cubic meters per hour. The starboard fire pump can be started remotely from the bridge. On the after section of the tank top level near the bulkhead is a ladder which extends up to the lower platform level near frame No. 20 where the emergency escape trunk is located. Entrance into the escape trunk is achieved by opening a horizontal hatch.

The lower platform level is 9.66 meters (31.7 feet) above the keel. It contains the emergency operation station, maneuvering valves for the main turbine, low pressure steam generator, main feed water pumps, service and control air compressors and receivers, fuel oil service and transfer pumps, and the evaporators. On the after section of the lower platform level adjacent to the bulkhead at frame No. 17, the emergency escape trunk extends up to the upper platform level. There is no entry into the escape trunk at this level. On the exterior of the trunk is a ladder which extends upward to the levels above. On the forward bulkhead on the starboard side near the centerline is the center stairway.

The boiler platform level is 15.79 meters (51.8 feet) above the keel and is the principal engineering operating level. The two main boilers are located aft between frames 21 and 29 and a two level engine control room is located forward. Inside of the upper control room, there is an emergency escape trunk which extends up to the main deck to a hatch located on the starboard side just aft of the accommodation house and forward of the engineroom casing. The lower control room is located at the boiler platform level. Above the lower control room is the upper control room and there is a stairway connecting the two rooms. The control room is air conditioned and its source of air is from the engineroom. The main switchboard is located inside of the control room in a separate space. On the starboard side, outboard of the control room is a single steam turbine generator and on the port side, outboard of the control room is a single diesel generator. Forward of the control room just to the port side of centerline is an elevator which extends upward into the upper levels of the engine room and further up into the house. On the starboard side of the centerline in the same general area is the center stairway. On the port side, forward of the boiler, near frame 33 is a stairway which extends upward into the engineroom casing near the direct contact (DC) heater. On the port side of this platform, there are two 45 kilogram (two 99 pound) CO2 fixed fire extinguishers with a 20 meter hose. On the starboard side, there is a 136 kilogram (300 pound) semi-portable dry chemical fire extinguisher. It is located about 6.1 meters

(20 feet) aft of the steam turbine generator. There is no entrance into the emergency escape trunk which is located on the aft bulkhead at frame 17.

The upper platform level is 21.04 meters (69.02 feet) above the keel. On the starboard forward section is a machine shop and a welding space. Just aft of this space is a paint locker. On the port forward section is an engine storeroom with some combustible material stored in it and just aft of it, there is an electrical storeroom. Outboard of the machine shop and other storerooms are fuel oil tanks. On the after bulkhead at frame 17, near the centerline, the emergency escape trunk from below terminates at this level. Access from the trunk via a door to the starboard passageway near the steering gear room is available. In the passageway, there is another emergency trunk which extends up to the main deck to a hatch aft of the engineroom casing. On the starboard side of the after bulkhead, there is a door which leads from the engineroom into the starboard passageway.

Above the upper platform, the engineroom casing extends above the main deck and has several minor platforms at the upper levels. On the port side of the engineroom casing outboard of the DC heater, the stairway terminates from the platforms below near frame No. 33. Access to the main deck is available via two doors on the port side near the stairway at frame No. 33. The exterior door is on the forward side of the engineroom casing.

The engineroom is protected with a 10,251 kilogram (11.3 ton) fixed low pressure CO2 system. The CO2 room is located on the starboard side outboard of the engineroom casing. The CO2 can be released from outside of the space via remote controls on the forward bulkhead. In addition to the CO2 system, the engineroom is fitted with a multizone open head manual water spray system. The vessel also has a main foam tank of 9,000 liters capacity located in the accommodation house and an auxiliary foam tank of 5,000 liter capacity located in the forecastle.

A diesel driven emergency fire pump is located in the forward machinery space on the forecastle. This fire pump has a capacity of 360 cubic meters per hour.

It is customary for the engineers on this vessel to operate only the steam turbine generator while the vessel is at sea and to operate the turbine generator in parallel with the diesel generator when the vessel is maneuvering in pilot waters or while the vessel is at the loading/discharge berth. They also normally operated the generators in parallel when testing the fire pumps or operating other heavy electrical equipment such as the inert gas system fans. The normal electrical load while the vessel was at sea was between 700 to 850 KW. While the vessel was maneuvering or during cargo operations, the normal electrical load was between 1000 to 1100 KW. Either generator was designed to carry the normal ship's load at sea according to the engineers and shoreside personnel interviewed during the course of this

investigation. The design rated capacities of the turbine and diesel generators were respectively 1350 KW and 940 KW. Both generators had been tested at their design rated capacities by ABS surveyors during their periodic surveys and had been found to be satisfactory.

The turbine generator was manufactured by STAL-LAVAL, model no. TGB 5/1600. The duplex strainer for the turbine generator was manufactured by Boll & Kirch, type 107-50. The main lube oil pump was gear driven by the turbine. It also had an auxiliary electrical pump which would activate if the lube oil pressure from the gear driven pump was too low. The diesel generator was manufactured by Hedemora Diesel AB, V12A, serial no. 168. The last continuous ABS Survey on the turbine and diesel generators were conducted in Dubai, UAE on 19 January 1993.

c. Temporary Repairs to the Turbine Generator's Duplex Strainer

In the early part of June 1994, First Assistant Engineer Peligra observed lube oil leaking out of the bottom of the duplex strainer in way of the directional control spindle valve. This was on the lube oil system for the turbine generator. The first assistant engineer thought the leak was caused by a defective or broken "O" ring on the spindle valve. When the first assistant engineer first noticed the oil, it was leaking about 2 quarts (1.9 liters) per four hour watch period but it increased to about one gallon (3.8 liters) per watch period shortly before the vessel reached Lagos, Nigeria. The first assistant engineer informed Chief Engineer Broccias about the leak. Chief Engineer Broccias was seriously ill at this time and was due to be replaced in Nigeria. Chief Engineer Broccias instructed the first assistant engineer to wait until the new chief engineer came on board the vessel to effect repairs.

On 10 June 1994, Chief Engineer Pontarelli and Mr. Armuzza boarded the SEAL ISLAND in Lagos, Nigeria. Mr. Pontarelli was assigned as chief engineer and it was his job to train Mr. Armuzza as his replacement. Mr. Armuzza was not familiar with this vessel and Atlantis Agency Corporation wanted him to get some additional training. When they boarded the vessel in Lagos, they were informed by the first assistant engineer of the lube oil leak. Chief Engineer Pontarelli said they would wait until the following morning to effect repairs.

On 11 June 1994, Chief Engineer Pontarelli went to the engineroom at about 0530 and met with the first assistant engineer. They both agreed that it would be necessary to shift the load from the turbine generator to the diesel generator and the turbine secured so the repairs could be made. They had planned on removing the spindle valve from the duplex strainer and renewing the "O" rings. They began to transfer the load from the turbine to the diesel generator. With the generators in parallel, they loaded the diesel generator to 600 KW and the turbine generator to 200 KW and waited about a half hour. The cooling water temperature

for the diesel generator rose to 78 degrees C. Since the chief engineer thought the high cooling water temperature trip was set at 80 degrees C, he decided to transfer the load entirely to the turbine generator. The high cooling water alarm and trip were actually set at 85 degrees C and 90 degrees C, respectively. The chief engineer at this time decided to effect temporary repairs which would consist of placing a cup underneath the duplex strainer to stop the leakage. He made a drawing and showed it to the first assistant engineer and instructed him to make the cup to the specifications listed on the drawing.

Under the first assistant engineer's direction, three of the crewmembers fabricated a cup with a gasket for placement underneath the bottom of the duplex strainer, where the directional control spindle valve exited the casing, to stop the leak. The crew also fabricated a screw jack made from a small steel plate which they welded to one end of a threaded stud. The free end of the stud (with nut installed) was placed into a pipe flange which held it upright. The cup was fabricated from teflon stock and was machine grooved around the circumference to accommodate the installation of an "O" ring. The center of the stock was machined out to accommodate the installation of the lower end of the directional control valve as it exited and extended over one inch below the casing. When the cup was in position, the nut was turned which raised the threaded stud and the small steel support with the cup, attempting to squeeze the "O" ring between the bottom of the strainer casing and the cup. The cup would not seat properly since the lower securing pin for the spindle valve on the duplex strainer was extending out.

The first assistant engineer went to the control room and briefed Chief Engineer Pontarelli and Mr. Armuzza about the problem with the securing pin. Chief Engineer Pontarelli instructed the first assistant to remove the securing pin. Mr. Armuzza upon hearing this intervened and advised them that it would be dangerous to remove the pin since it prevented the directional control spindle valve from rising out of the casing when the strainer was in operation and pressurized. Chief Engineer Pontarelli thought about this and then instructed the crew to fabricate a strongback clamp to keep the spindle valve properly seated in the duplex strainer casing.

The strongback clamp was fabricated from a 40.6 cm long, 5.1 cm wide (sixteen inch long, two inch wide) angle iron with three holes on one side of the angle. One hole was in the center, and the other two were at each end of the strongback. The center hole was made to accommodate the passage of the top of the directional control spindle valve through the strongback. The holes at each end were for the installation of threaded studs and nuts. Each threaded stud was welded perpendicular to the center of a five inch length of angle iron. Each angle iron was cut to fit the rounded shape of the strainer casing. With the nuts installed on the studs at each end of the strongback, tightening of the nuts would pull the small angle iron up against the

underside of the duplex strainer covers and pull down on the angle iron strongback, thereby holding the directional control spindle valve down into place in the spindle seat.

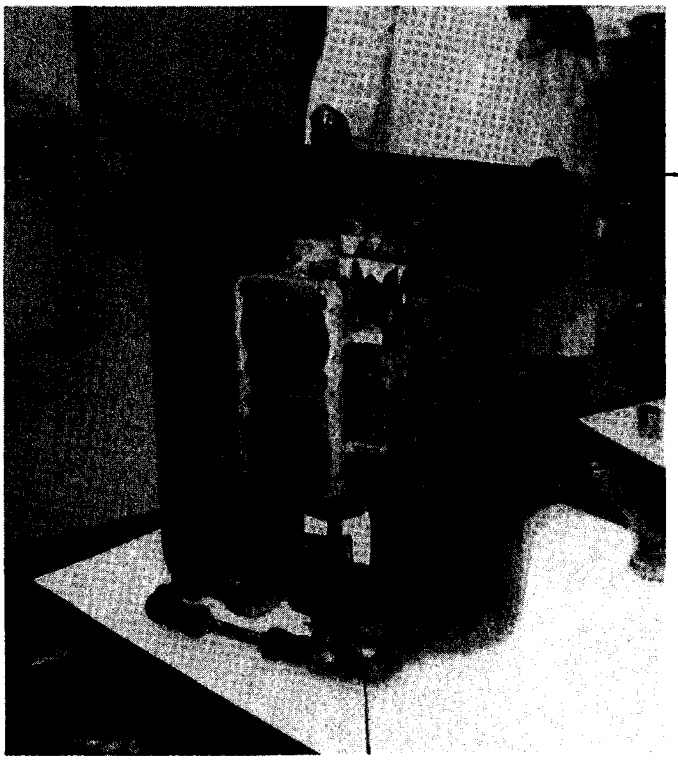
With the clamp in place, the crew, under the direction of the first assistant engineer and chief engineer, pushed the pin into the spindle valve thereby negating its ability to secure the valve in the duplex strainer casing. They placed the teflon cup on the jack and raised the cup until it made contact with the bottom of the casing. When they continued to tighten it, the cup became deformed and broke. The chief engineer upon seeing this instructed the crew to build another cup out of metal.

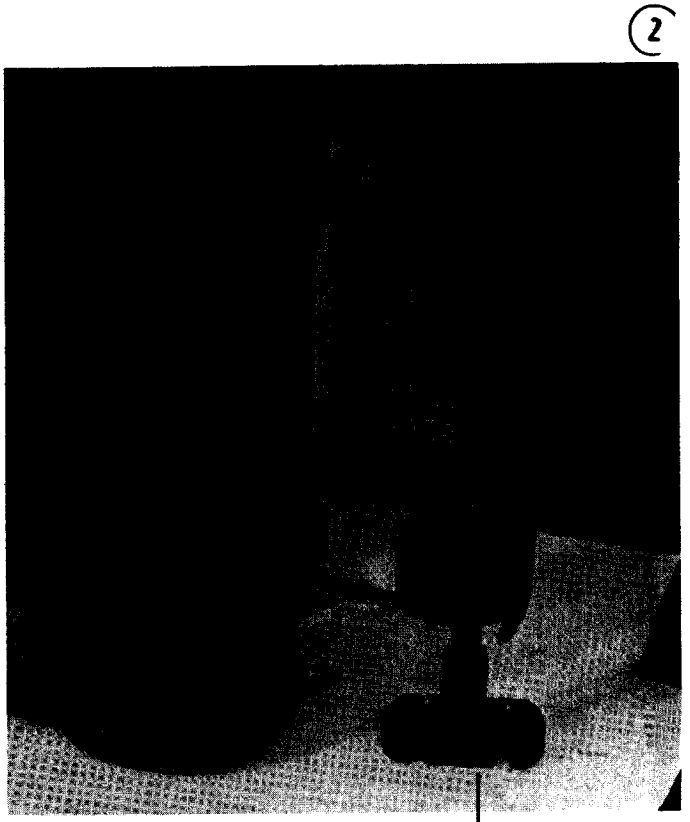
On 12 June 1994, the crew made another cup out of brass stock. They placed the cup on the jack and raised it up until it seated tightly against the duplex strainer casing which effectively stopped the lube oil leak. At this time, the strongback clamp was still in place from the day before. The chief engineer also instructed the crew to make a third cup with a hole drilled out of the bottom so that a relief valve could be fitted. The cup was fabricated by the crew and stored in the lower control room but it was never used. (See Figures no. 3 and 4 which are photographs of the duplex strainer, cup, screw jack, and strongback clamp.)

Chief Engineer Pontarelli remained on board until the end of June 1994 and was relieved by Chief Engineer Armuzza. Chief Engineer Armuzza was later relieved by Chief Engineer Pontarelli at the end of August. Chief Engineer Pontarelli stayed on board until 8 October (the day of the fire).

In mid September, Atlantis Agency Corporation ordered Chief Engineer Pontarelli to secure the starboard boiler for routine inspection and maintenance. The starboard boiler was secured for about two days from 15 September to 16 September while the vessel was at anchor at Hounds Point, Edinburgh, Scotland. According to Chief Engineer Pontarelli, it was possible, with a reduced electrical load and the starboard boiler secured, to shift the electrical load to the diesel generator so they could replace the "O" rings on the spindle valve for the duplex strainer. However, he felt that the crew was already busy making repairs to the starboard boiler. The chief engineer estimated it would have taken about 1 hour to complete the replacement of the "O" rings with the load on the diesel generator. With the starboard boiler repairs completed, the boiler was placed back in operation on 2130 on 16 September. On Saturday, 17 September, the vessel remained at anchor until 2130.

It was Chief Engineer Pontarelli's and Armuzza's intention to make permanent repairs to the duplex strainer as soon as possible and when time allowed. Since the temporary repairs had stopped the leak, both chief engineers felt it was a low priority to effect permanent repairs and that they had to tend to higher priority repairs and maintenance while they were aboard the vessel.





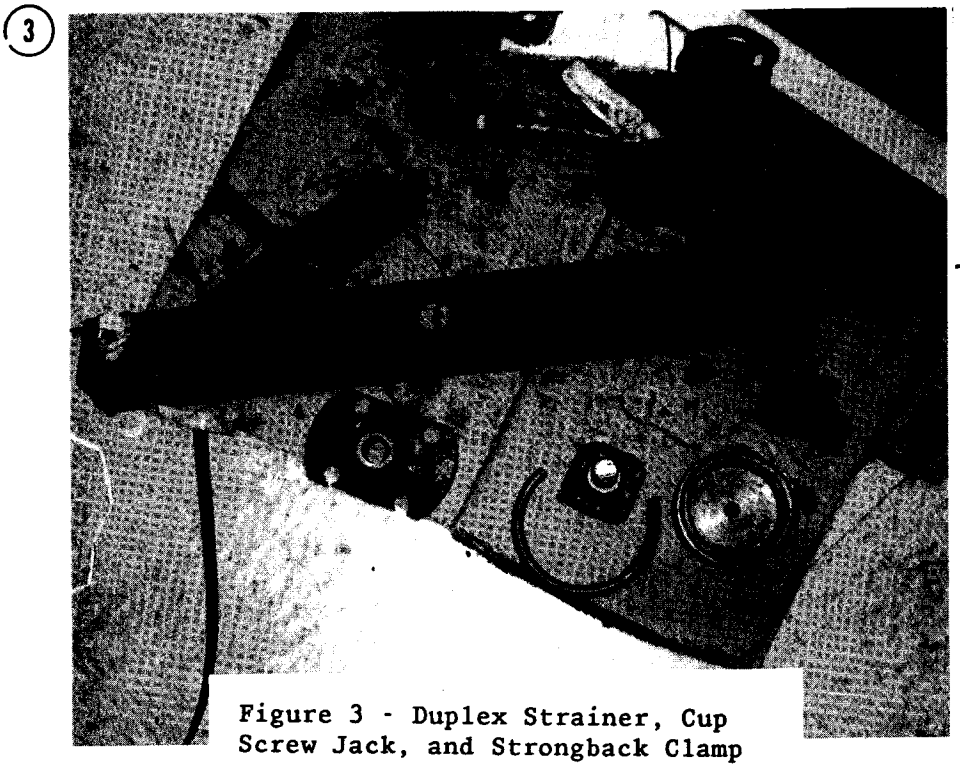


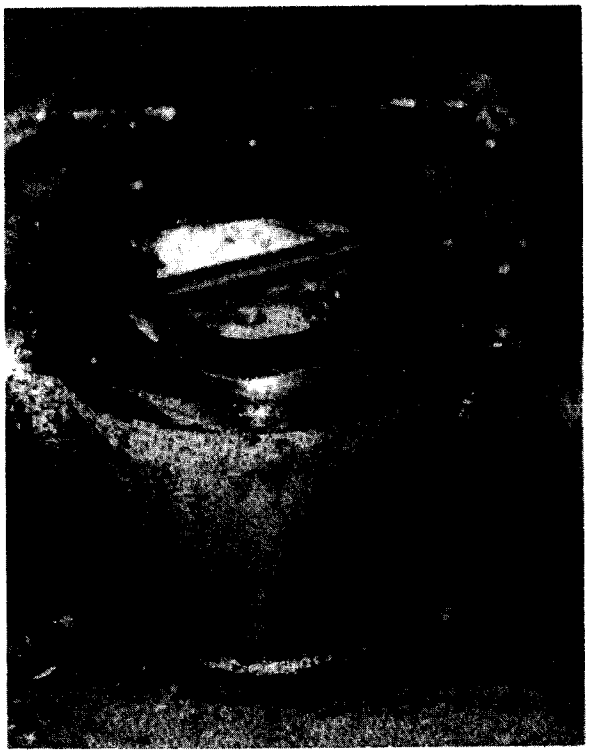
Figure 3 - Duplex Strainer, Cup Screw Jack, and Strongback Clamp

(10)

Spindle Valve

Duplex Strainer Casing

(11)

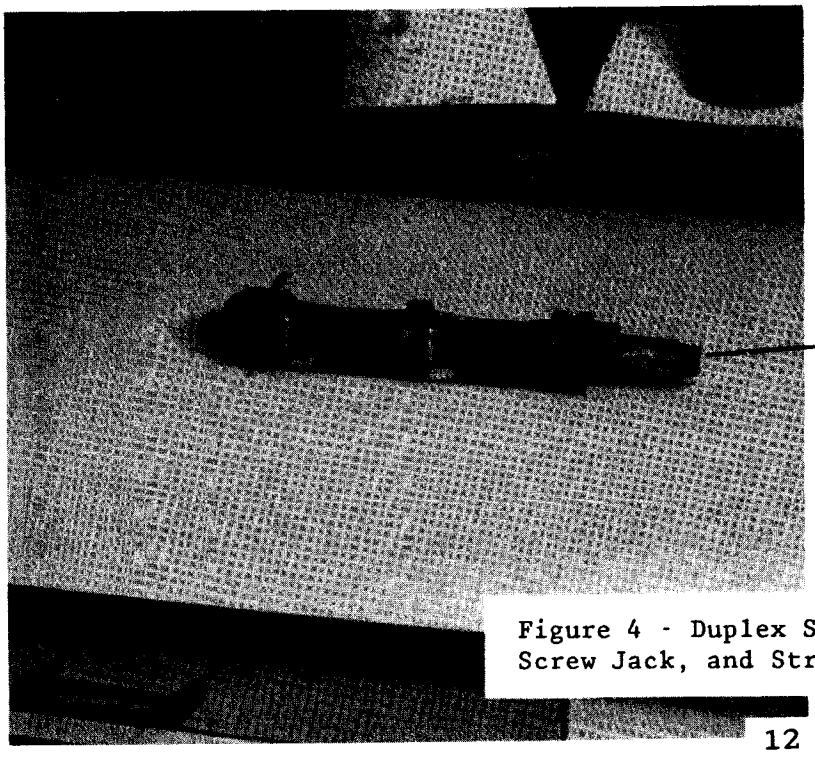


Bottom of Spindle Valve

* Note securing pin pushed in

** Duplex strainer casing upside down

(12)



Spindle Valve Removed From Casing

* Note '0' ring on bottom and missing '0' ring on top

Figure 4 - Duplex Strainer, Cup Screw Jack, and Strongback Clamp

d. Voyage No. 50/L for the SS SEAL ISLAND

With its Italian officers and Filipino crew, the SEAL ISLAND departed Hounds Point, Scotland at 1320 on 19 September 1994 bound for St. Lucia, West Indies with a load of crude oil. Its draft upon departure was 19.7 meters (64.75 feet) forward and 20.3 meters (66.58 feet) aft. It arrived in St. Lucia at 0800 on 3 October 1994 and discharged part of its cargo. Upon departure at about 2100 on 3 October, the SEAL ISLAND had a mean draft of 16.7 meters (54.83 feet) and was bound for St. Croix, U. S. Virgin Islands. The SEAL ISLAND arrived in St. Croix at about 1800 on 4 October and was moved to dock no. 3 at the Hess Oil Virgin Island Company (HOVIC) facility at 0836 on 5 October. Cargo operations began at about 1330 on 5 October and were completed without incident at about 2200 on 7 October.

Captain Pasquale Buonarotti boarded the SEAL ISLAND in St. Lucia on 1 October and rode the vessel to St. Croix with Captain Claudio Villa. During the relief process, Captain Buonarotti reviewed the vessel's documents and new procedures, and discussed the condition of the vessel with Captain Villa. There were no discrepancies reported to Captain Buonarotti. After the cargo operations were completed at 0001 hours on 8 October, Captain Villa was relieved by Captain Buonarotti as master of the vessel.

On the morning of 8 October at about 0800, the master contacted the terminal and informed them that he required a pilot for 0900. The master had only about one more hour to complete ballasting operations before he started the SEAL ISLAND's return trip to its loading port in Hounds Point, Scotland. The chief mate was in the cargo control room attending to the ballasting operations. The master also called the engineroom and advised them to be ready to sail at about 0900. The third assistant engineer on watch acknowledged this order. The master then ordered the third mate to test the navigational equipment in preparation for the vessel's departure as required by Title 33 Code of Federal Regulations, Part 164. From 0800 to about 0815, the third mate and third assistant engineer tested the steering gear from their watch locations. After issuing these orders, the master proceeded to his office to prepare messages to be sent to the company's New York office.

At 0800 on 8 October, the following ship's crew were in the engine room:

1.	Chief Engineer	Mario Pontarelli
2.	First Assistant Engineer	Antonio Marchese
3.	Third Assistant Engineer	Francesco Spada
4.	Chief Fireman	Roberto D. Alado
5.	Fireman	Primitivo Divinagracia

6.	Electrician	Dante C. Dela Cruz
7.	Fitter	Ariel S. Padasas
8.	Fitter	Nomer V. Surmieda
9.	Wiper	Darwin P. Pedrina

At the morning meeting held in the engine control room, the first assistant engineer instructed the chief fireman and the wiper to build a wooden box for some emergency equipment. The chief fireman and the wiper proceeded to the open space outside of the welding space and machine shop which is located on the forward starboard side of the engineroom on the upper platform which is one platform up from the control room. Upon arriving at this location, they began to build the wooden box.

The third assistant engineer who was the engineer on watch (0800 to 1200) was making rounds between the control room and the turbine generator periodically, warming up the main steam turbine.

At about 0815, the first assistant engineer instructed both fitters to make a hook for a placard which had the boiler operating specifications on it. The hook was going to be used to hang the placard on the boiler. Both fitters went to the machine shop and began to fabricate the hook.

At about this time, the fireman, who was on watch, checked the lube oil temperature and pressure of the turbine generator during his normal "rounds" of the engineroom. He said the temperature and pressure were within normal limits which were between 47 to 57 degrees C and about 8.9 bar (129 psig), respectively.

During this time period, the chief engineer was sitting in the control room chatting about non-work related topics with the third assistant engineer. A few minutes later, the chief engineer advised the third assistant engineer, "I think today we'll change the strainers". They had been operating on the forward strainer basket for the duplex strainer for the turbine generator for several months. Even though there was no excessive pressure differential before and after the strainer which indicated the strainer was relatively clean, the chief engineer felt it was necessary as part of routine maintenance. They proceeded to the turbine generator to perform the switch. When the first assistant engineer switched over to the after strainer basket using the directional control spindle valve, the pressure differential before and after this strainer was about 1 bar which indicated to the engineers that the strainer was dirty. The first assistant engineer then switched back to the forward strainer basket. The chief engineer at this time decided to change the strainer in the after basket of the duplex strainer.

Shortly thereafter, the first assistant engineer instructed the fireman to get Fitter Padasas to assist in the change out of the

strainer. The fireman went up to the machine shop and advised Fitter Padasas that the first assistant engineer wanted to speak to him. Fitter Padasas went down into the control room and was handed a spanner wrench by the first assistant engineer and was instructed to follow him to the turbine generator.

Upon arriving on the outboard side of the turbine generator, the fitter handed the open spanner to the first assistant engineer who was standing on a small ladder to reach the duplex strainer for the lube oil system. The first assistant engineer took the spanner and unbolted the strongback clamp which was attached to both sides of the top of the duplex strainer. Upon removing the clamp, the first assistant engineer handed it to the fitter who placed it down on the deck. At this time, the chief engineer was standing to the right of the first assistant engineer; the fitter was standing behind the two engineering officers and the fireman was standing to the left of the fitter.

The first assistant engineer removed the four bolts on the cover of the after duplex strainer and handed the cover and bolts to the fitter who placed it down on the deck. The first assistant engineer removed the strainer element, checked it and handed the strainer to the fireman. While this work was taking place, the third assistant engineer went to the upper control room to get a clean strainer. When he got there, he noticed the strainer was dusty so he took it to the machine shop and used compressed air to clean it. The third assistant engineer then carried the strainer with him and met the chief engineer on the stairs between the upper platform and the boiler platform level. The chief engineer took the strainer and carried it back to the turbine generator. The first assistant engineer took the new strainer, and placed it in the after port of the duplex strainer. The fitter handed the first assistant engineer the cover and bolts, and the first assistant engineer put the cover back on the duplex strainer and tightened all four bolts. The fitter picked up the strongback clamp and was preparing to hand it to the first assistant engineer.

A small amount of oil began spraying out of the top of the duplex strainer. The first assistant engineer and the chief engineer attempted to cover the spraying oil with their bare hands but had to remove them due to the hot oil (about 120 degrees F). The oil began to spray about one meter above the duplex strainer onto the first assistant engineer, the chief engineer and the fitter. Seconds later a fire erupted and the chief engineer's uniform caught fire. He attempted to trip the turbine generator but thought it had already tripped due to low lube oil pressure. The chief engineer rolled on the deck to put out the fire on the back of his uniform. The first assistant engineer yelled to the fireman to get a fire extinguisher as the oil sprayed higher hitting the underside of the next platform above the turbine generator which was the upper platform. The fireman ran to the inboard side of the turbine generator and got the portable fire extinguisher. When he looked back toward the turbine generator,

he noticed a fire near the forward outboard side of the turbine generator near the turbine end.

The third assistant engineer was at the forward end of the turbine generator walking back toward the control room when he heard someone yelling "Oh, Oh, Oh". He turned back and saw a fire by the turbine generator. He ran into the control room and got a portable extinguisher. Before he could leave the control room, the chief engineer opened the forward starboard door of the control room and appeared dazed. The third assistant engineer could see the fire through the opened door and he described it like being in "hell". The chief engineer's white coveralls were blackened and he appeared to be wet and covered with oil. The chief engineer activated the fire alarm, the general call and the engineering call alarms and ordered the third assistant engineer to start the electric fire pump. He also disconnected the preferential trips on the main switchboard which secured the air conditioning and ventilation fans for the engineroom and deck house. The chief engineer then went back out into the engineroom. The third assistant engineer noticed the lights in the control room were dimming and the turbine generator was losing power as it began to slow down. The third assistant engineer attempted to start the emergency fire pump located on the bow of the vessel. He did not attempt to start the two fire pumps in the engineroom because he could see and hear the turbine generator slowing down and it was customary for both generators to be running in parallel when the engineers ran the fire pumps. He also testified that the diesel generator was not running at 100 percent efficiency because the engineers had not performed any routine maintenance on it during the three months he was on board. Routine maintenance on the diesel generator should have included cleaning of the fuel pumps, air inlet strainer for the turbo charger, and fuel oil injectors. He was concerned that the diesel generator in this condition could not carry the load with the fire pump in operation. Shortly thereafter, the lights went out. A few seconds later, the emergency lights came on.

e. Evacuation of Engineroom

While the chief fireman and the wiper were in the process of constructing the wooden box, the wiper noticed heavy black smoke coming up from the stair well forward from the platform below. He informed the chief fireman who saw flames shooting up and the two of them immediately began to depart the upper platform via the stairway on the port side aft near frame 33. While they were climbing up the stairway, the general alarm bells began to ring and the engineroom lights went out. In the dark and thick smoke, they began to feel there way up to the area near the DC heater and out the door on the port forward side of the after casing onto the main deck between the forward house and after casing. They estimate that it took them less than a minute to reach the main deck from their work area.

Upon seeing the oil spraying up from the duplex strainer and the chief engineer running forward to the control room, the fitter,

Mr. Padasas, followed the chief engineer. When the fitter got near the control room, the lights went out. He continued to run past the control room to the port side into the diesel generator space. He continued aft and when he got to the open hatch area behind the control room, he passed the first assistant engineer, who was holding a flash light, running forward on the port side. The fitter ran to the stairway near frame 33 and went down one level to the lower platform. He continued aft in total darkness and found the emergency escape trunk located on bulkhead no. 17. He realized there was no opening for the escape trunk at this level. He found a vertical ladder on the outside of the trunk, and climbed to the upper platform, and felt his way to the door on the starboard side of bulkhead no. 17. He opened the door and walked into the passageway near the steering gear room and climbed up the ladder to the main deck. As he got on the main deck, he collapsed. He estimated that it took him about ten minutes to reach the main deck from when the fire started.

The chief engineer who had gone back into the engineroom and was attempting to go near the turbine generator could not see it due to the heavy smoke and darkness. He found his way back into the control room and met the electrician and the third assistant engineer. They proceeded to the upper platform and opened the lower hatch on the emergency escape trunk. The electrician climbed up the ladder a short way. It is the chief engineer opinion that the electrician attempted to open up the hatch at the top of the trunk and was unsuccessful. The third assistant engineer's opinion was that the electrician did not get to the top of the trunk because he did not have time to complete the ascent and descent in the short period of time on the ladder which he estimated at about one second.

The chief engineer then proceeded to the forward starboard door in the upper control room but was unable to open it due to the door being distorted by the heat of the fire. He then went down to the lower control room and exited via the aft starboard door. With zero visibility, he made his way over to the stairway on the port side aft near frame 33. When the chief engineer got near the stairway, he lost consciousness and collapsed on the deck due to the smoke. He regained consciousness shortly thereafter and began to climb up the stairway. He made his way to the platform near the DC heater and out the door on the port forward side of the after casing onto the main deck, and collapsed again. He estimated from the time of the fire to the time that he made it up on the main deck took about ten minutes.

The fireman seeing the fire on the forward outboard side of the turbine generator departed the boiler platform via the stairway on the port side aft near frame 33. He made his way up to the platform where the DC heater was located but was driven back down the stairway because of the flames and heat in the area. He then tried to go forward to the center stairway located near the forward bulkhead of the engineroom but was again driven back by the flames. He could only see about one meter in front of him

due to the thick smoke. He then went aft by the boilers and made his way to a door located on the starboard side of the bulkhead at frame 17. He opened the door into the passageway near the steering gear room and climbed up the vertical ladder to the main deck behind the after machinery casing. He walked forward on the main deck and when he got between the forward house and the machinery casing, he saw the chief engineer laying on the deck. The chief engineer was near the door leading to the DC heater on the forward part of the machinery casing.

When the chief engineer ran out of the control room, the third assistant engineer thought his chances of survival where better in the control room so he stayed there with the electrician. The control room had filled with black smoke and visibility was reduced to several feet. The third assistant engineer and the electrician, in the darkened, smoke-filled room, went to the upper control room and grabbed a self contained breathing apparatus (SCBA) and dragged it to the stairway leading to the lower control room. As the electrician attempted to descend the stairs, he slipped and fell to the deck below. The third assistant engineer dragged the SCBA down the stairs to the lower control room since there was less smoke at this level. They connected the hose with the mask to the bottle and took turns breathing in the mask. They continued to do this for about three minutes when the electrician became agitated. The electrician yelled "Oh Jesus" or words to that effect, grabbed the SCBA and ran out the after door of the lower control room into the engineroom. The third assistant engineer yelled to the electrician, "no, no", but the electrician continued on his attempt to escape.

The third assistant engineer found a portable radio in the control room and repeatedly called on the radio, "help me; please open the doors; I am in the control room." He did not hear any response to his calls since he had kept the transmitting button depressed. The third assistant engineer was having difficulty breathing when he remembered there was an emergency escape breathing apparatus also in the upper control room. He tried two times to get to the upper level but was forced back down to the deck because of the lack of oxygen. With his shirt over his face and struggling to breathe, he opened the refrigerator and took several deep breathes from inside the refrigerator in an effort to get oxygen. Shortly, thereafter the second mate opened the upper hatch on the main deck and created a draft which blew out much of the smoke in the control room. The third assistant engineer could see daylight and with his last ounce of strength, climbed the emergency escape trunk ladder to the main deck. He estimated from the start of the fire to his getting on the main deck took about fifteen minutes.

f. Testimony of Chief Engineer Pontarelli

The testimony of Chief Engineer Pontarelli differs in many substantive areas from the testimony of the other material

witnesses and the examination of physical evidence. The following is a listing of the facts as testified to by Chief Engineer Pontarelli:

- Chief Engineer Pontarelli stated that the cooling water high temperature alarm for the diesel generator sounded on 11 June 1994 as he was attempting to shift the load from the steam turbine generator to the diesel generator so he could effect repairs to the duplex strainer. According to him, the alarm sounded at about 79 degrees C (174.2 degrees F) and the cooling water high temperature trip was set at about 80 degrees C (176 degrees F). None of the other witnesses heard the alarm.

- Chief Engineer Pontarelli did not know the bottom securing pin for the spindle valve had been pushed into the valve by the crew thereby negating its ability to hold the valve in its proper position. He also testified that the strongback clamp did not serve any real purpose except for added safety in case the securing pin inadvertently moved by the placement of the cup or during operations.

- On 11 June, Chief Engineer Pontarelli called Captain Buonarotti from the engineroom and informed him that they had a small oil leak and the repair would take about a half hour to complete. He also informed the captain the repair was not a safety problem. Captain Buonarotti has no recollection of this conversation and denies any knowledge of the leak or temporary repairs.

- Chief Engineer Pontarelli stated that Captain Villa brought up in conversation with him the temporary repairs to the duplex strainer. The chief engineer described to the captain the temporary repairs and informed him that the first chance they got they would make permanent repairs. Captain Villa has no recollection of this conversation and denies any knowledge of the leak or temporary repairs.

- Chief Engineer Pontarelli testified that Mr. Cundari, Senior Ship Superintendent for Atlantis Agency, stated to him - "what are we supposed to do with the strainer?" - just prior to Mr. Cundari leaving the vessel on 7 October 1994. Chief Engineer Pontarelli believes he was referring to the duplex strainer. Chief Engineer Pontarelli testified that he replied to Mr. Cundari that he would take it apart and make a permanent repair to it as soon as he had the opportunity to do so. Mr. Cundari has no recollection of this conversation and denies any knowledge of the temporary repairs to the duplex strainer.

- According to Chief Engineer Pontarelli, it was the first assistant engineer's idea to switch from the forward operating basket to the after basket for the duplex strainer on the turbine generator on the morning of 8 October.

- Chief Engineer Pontarelli saw the first assistant engineer prepare his tools to open the after cover for the duplex

strainer on 8 October. About the same time, the chief engineer sent the third assistant engineer to get a new strainer from the upper control room. When he did not return in due time, the chief engineer went to assist him. The chief engineer met the third assistant engineer who had found the strainer, and they both returned to the area of the turbine generator. When he approached the crew working on the duplex strainer, the chief engineer saw oil spraying out of the after cover. He saw the first assistant engineer put his hands on top of the cover trying to hold it down. The chief engineer also tried to hold the cover down with his hands but was only able to do so for a few seconds because of the pain he experienced from the hot oil. At the time of the fire, the third assistant engineer was still holding the new strainer in his hands. After reviewing the testimony of the other witnesses, Chief Engineer Pontarelli testified he did not know if the spraying oil came from a loose after cover on the duplex strainer or from the spindle valve raising up above the duplex strainer casing.

- According to Chief Engineer Pontarelli, the vessel was scheduled to sail at 1200 on 8 October and that the fire started between 1115 and 1130.

- When the chief engineer, third assistant engineer and electrician opened the lower hatch for the emergency escape trunk ladder in the upper control room, there was no smoke in the control room and the chief engineer could see clearly from bulkhead to bulkhead.

g. SEAL ISLAND Crews' Fire Fighting and Rescue Efforts

At about 0840, the master heard the ship's fire alarm sound while he was working in his office. He immediately went to the bridge which was one level up from his office. The alarm was ringing continuously. The third mate who was on watch on the bridge glanced at the fire/smoke detection panel which indicated a fire in the engineroom. Shortly thereafter, the master received a radio call from the terminal port captain asking if the vessel was experiencing a problem because smoke was bellowing out from the ship's funnel. The master went to the starboard bridge wing and verified smoke coming from the funnel. Concluding from the large quantity of smoke that he had a major fire, he radioed the terminal port captain and asked for shoreside assistance.

The master then attempted to start the emergency fire pump remotely from the bridge. The emergency fire pump is located in a machinery space in the forecastle. He did not attempt to start the starboard fire pump in the engineroom remotely from the bridge. The master proceeded to the main deck and then aft on the starboard side. Using his portable radio which was on channel 67, the working frequency for his vessel, he attempted to call the engineroom about six times repeating "engineroom, engineroom do you read me, over". He never received any response. When the master arrived between the forward house and

engineroom casing, he noticed that the hatch cover to the emergency escape trunk from the engineroom control room was already open.

Upon hearing the fire alarm, many crew members mustered at the fire station on the port side aft of the accommodation house. Several crew members, upon seeing flames about one foot high coming out of the engineroom skylight, grabbed portable fire extinguishers and discharged them into the opening.

Mr. Brian Swensen, a senior ship superintendent for Sheridan Transportation Corporation which is a subsidiary of Amerada Hess, observed smoke on board the SEAL ISLAND while working on another vessel at the terminal. In the past, Mr. Swensen was a ship superintendent for the company's VLCCs. When the fire erupted on the SEAL ISLAND, Mr. Swensen responded because he was the senior Amerada Hess on scene representative who was familiar with the layout and operation of the vessel. Mr. Swensen called Mr. Joseph Gehegan, President of Atlantis Agency, in New Jersey to advise him of the situation. Mr. Swensen boarded the vessel and noted a white haze of inert gas coming out of the vents for the cargo tanks. He was relieved since it indicated to him the cargo tanks were still under a positive pressure of inert gas.

The chief mate and second mate donned self contained breathing apparatus and fire suits and attempted to enter the engine room via the steering gear flat. They were able to proceed forward about two meters into the engine room from the starboard door on bulkhead 17 when they decided to return to the main deck due to dense black smoke and intense heat. They then tried to enter the engineroom through the center stairs on A deck but the engineroom door was hot and deformed. Due to the deformity, it could not be opened.

The second assistant engineer, who had been asleep in his stateroom on D deck when he was awakened by the fire alarm, tried to gain access to the engineroom via the A deck door. He was driven back by the smoke. He then tried to enter the engineroom from the machinery casing door near the DC heater. As he started to go into the door, he was met by the chief engineer coming out. The second assistant engineer helped the chief engineer, who was burned, to an open area on the main deck between the casings. The third mate administered oxygen to the chief engineer. Other crew members, who had mustered on the stern of the vessel, placed the chief engineer on a stretcher and carried him ashore. The crew also assisted the five other injured engineers, who had escaped from the engineroom, ashore.

The master noticed several ship's hoses had been led out on deck by the crew but the hoses were not charged. He instructed the second assistant engineer to go forward to the emergency fire pump to check if it was running and if it was not, to start it locally. About this time, shoreside firemen from HOVIC were arriving on board the vessel. When the second assistant engineer

and two other crew members got to the emergency fire pump, they found the prime mover (diesel engine) was not operating. A red indicator light on the control panel was on which indicated an engine problem. They checked the engine oil and the water which was within normal limits and then tried to start the engine. The engine turned over but would not start. After repeated attempts to start the engine, the batteries were depleted of their electrical charge and the engine would no longer crank over. They then tried to start the engine using the hydraulic accumulator, but were again unsuccessful.

At about 0930, the second assistant engineer walked back to the manifold area and reported to the master and the predesignated incident commander, who was the refinery manager, that the emergency fire pump was inoperative. The master informed the incident commander the vessel had no water for fire fighting. The master further advised the incident commander they had to connect the shoreside fire hoses into the ship's fire main system with international shore connections. The master instructed the chief mate to prepare the connection. At about 0945, the chief mate got the shore connection from the pumpman's storeroom and the crew hooked up the ship's connection in the fire station box located on the starboard side just forward of the cargo manifold.

At about 0950, an eruption occurred on board the vessel. Mr. Swensen heard a tremendous roar and a slight vibration of the deck. More smoke poured out of the open hatches from the engineroom. The fire chief ordered his firemen to abandon the vessel. All of the firemen and most of the ship's crew abandoned the vessel, while Mr. Swensen, the master, chief mate, second mate, second assistant engineer and several crew members remained on board.

At about 1000, the master, after consultation with Mr. Swensen, prepared to release the low pressure CO2 system. The remote control is located on the forward starboard bulkhead of the machinery casing on the main deck. The master had his hands on the levers to release the CO2 when he hesitated. The master looked at Mr. Swensen and said, "but the men, the men". Mr. Swensen responded, "the men are (already) dead". The master pulled the levers and the CO2 would not release from the remote location. The second mate entered the CO2 room and used a pipe wrench to manually open the two pistons on the low pressure tank which released the CO2. The master saw the pressure gauge rise indicating the CO2 was releasing. Mr. Swensen heard the flow of gas through the pipes and walked aft to look at the smoke coming out from the stack. He noticed the smoke change from a dark black to a brown haze. The incident commander, who was ashore at this time, noticed the smoke coming out of the engineroom had lessened considerably. The master then instructed the chief mate to close all vents, dampers and other openings to the engineroom. The chief mate and several of his crew assisted in closing many of the openings in the accommodation house and the engineroom including the exterior engineroom door near the DC heater. They

also hit the stop switches for the engineroom's ventilation system.

Mr. Swensen closed the exterior doors on A deck on the after part of the accommodation house for the starboard passageway, the deck storeroom, the provisions storeroom, and the refrigeration machinery/foam fire fighting room. He also closed the skylight hatch which is located on a larger hatch for the engineroom on the port side of the centerline on the main deck, aft of the accommodation house, and the emergency escape hatch cover for the engineroom control room. All of these doors and hatches were closed in about five minutes after releasing the CO2. Mr. Swensen then instructed the chief mate and the second mate to manually close all of the valves on the main deck to isolate the IGS system on deck. The mates then proceeded to close the valves. Mr. Swensen then went aft and on top of the machinery casing in way of the fidley and closed seven fire dampers. Some of these dampers were for the engineroom.

At about 1100, Mr. Swensen was asked to come down to the dock to meet with the fire chief and the incident commander. When he went down to the dock, he took with him the vessel's fire control plan which had been given to him by the chief mate. The plan had been stowed in a red tube located at the starboard cargo manifold. During this meeting, Mr. Swensen made it clear that no one should go back on board the ship until 1200 since he did not want anyone opening up the hatches, dampers, and other openings on the vessel.

h. HOVIC's/Shoreside Fire Fighting and Rescue Efforts

Captain Richard Michael, operator of the tug MANCHENIL BAY, was in the port captain's office at the HOVIC refinery on the morning of 8 October looking out toward the water. He observed the integrated tug and barge NEW YORK proceed outbound from Dock No. 1 with a two tug escort. At about 0842 as the NEW YORK cleared Dock No. 3, he observed a large discharge of black smoke from the engineroom vents on the SEAL ISLAND. The port captain called the fire department and Captain Michael went to the tug dock to get the MANCHENIL BAY underway. At 0848, the tug left the dock and headed for Dock No. 3 with its fire pump engaged.

At about 0850, Mr. Scott Stebbins, refinery manager for HOVIC, received a phone call from Mr. Dennis Malt, terminal manager, and reported there may be a fire in the engineroom of the SEAL ISLAND. Mr. Stebbins advised Mr. Malt to call the refinery's fire department and have them respond with a pumper. He further advised Mr. Malt to sound the refinery's fire alarm if he confirmed there was a problem.

The tug MANCHENIL BAY arrived on scene at the port quarter of the SEAL ISLAND at 0854. At about the same time, the tug CANEGARDEN BAY also arrived on scene after being released from the escort of the NEW YORK. Both vessels, began to cool the hull of the Seal Island using their fire monitors.

At about 0855, the fire alarm sounded and Mr. Stebbins got into his car and drove down to dock no. 3. Even though Mr. Stebbins had a fire bunker suit and helmet which clearly designated him as the incident commander, he did not don it. At about 0857, Fire Chief Edgeley arrived on scene, and about the same time, three pumpers and the ambulance also arrived at the dock. At about 0902, the chief engineer and the fitter, who were more seriously burned than the other crew members, were transported to the local hospital by HOVIC's ambulance. Shortly thereafter, additional refinery fire fighting and rescue equipment arrived on scene. The following personnel and equipment were eventually used in the fire fighting and rescue effort:

- 130 fire fighters within ten minutes of response and 160 fire fighters during the height of efforts.
- Five pumpers provided foam/water mix.
- Three foam tankers provided foam concentrate to resupply the pumpers.
- Two ambulances from HOVIC and two from the local fire department.
- One rescue unit.
- Two decontamination units.
- 50 SCBA's with 100 spare bottles and about 225 charged bottles were used.
- Two nitrogen trailers, each of 50,000 cubic feet, for maintaining the inert gas in the cargo tanks.
- 1524 meters (5000 feet) of 6.35 cm (2-1/2 inch) hose and 914.4 meters (3000 feet) of 3.81 cm (1-1/2 inch) hose was laid down the deck by the shoreside firemen.

By 0925, one fire hose was placed on the stern of the vessel from ashore and another was being rigged parallel to the first one by the firemen. The incident commander boarded the vessel near the gangway to get a status report from the fire chief. When he got on board, he heard the fire chief was involved in a rescue attempt. He was concerned since he did not know if the vessel's cargo tanks were inerted and it appeared to him it would still be some time to get water to the engine room since the firemen were having difficulty hooking into the vessel's fire main system. HOVIC did not have an international shore connection to mate up with their fire hose provided from shore so there was a further delay in providing water for fighting the fire.

When the fire chief proceeded aft on the vessel, he was informed there were two people trapped in the engine room control room.

He was directed to the emergency access hatch for the control room and yelled into the hatch, but got no response. He then donned an SCBA and went about half way down the ladder. He felt no heat nor saw any smoke. He then came back out on deck and directed two of his rescue team to enter. With their fire suits and SCBAs, the two rescue team members climbed down the ladder and entered the upper control room. There was lights on in the upper and lower levels of the control room and the team conducted a search of the room, but did not find any of the ship's crew.

They then walked about five steps out of the forward starboard door of the control room and saw a raging fire about 20 feet away on an outboard bulkhead which was near the turbine generator. Not seeing any crew members and feeling the tremendous heat in the area, they went back into the lower control room, and opened the door on the after bulkhead. They saw daylight through the open skylight on the main deck. One of the rescuers walked partially around the opening in the platform which was surrounded by a railing and again did not locate any of the crew members. Below the opening was the vessel's steam turbines. They then requested on their portable radio additional firemen to man the fire hose which had been lowered down to them from the main deck. The additional firemen started down the ladder.

At about 0930, the tug LIMETREE BAY arrived on scene of the SEAL ISLAND and assisted the other two tugs in cooling the hull with its fire monitors. Also about this time, an ambulance from the local fire department on St. Croix was dispatched to the local hospital with the chief fireman, the fireman and the wiper. Shortly thereafter, another ambulance from the local fire department transported the third assistant engineer to the hospital.

Between 0930 and 0940, hundreds of spare SCBA bottles were placed on the vessel by firemen using the refinery's crane.

At about 0935, the firemen were able to directly hook up their shore hose into the vessel's fire main using an international shore connection from another ship at the refinery and the SEAL ISLAND's fire main was charged.

At about 0940, the fire chief, who was on the main deck between the forward house and the machinery casing, saw a door on the after starboard side of the forward house blow open and felt what he described as several "whumps" from the engineroom below. He immediately radioed the rescuers and ordered them to get out of the control room and return to the main deck. The rescuers had been below decks for about 22 minutes when one of the rescuer's bell on his SCBA started to ring which meant he only had about 34.5 bar (500 psi) of air left in his bottle. All of the men, evacuated the space via the emergency trunk. Several of them burned their bare hands on the hot ladder rungs as they were climbing up to the main deck.

At about 0945 when the rescuers returned to the main deck, the fire chief gave the order to his personnel to abandon the vessel. He did not order the ship's crew to go ashore. He informed the master that his shoreside firemen were leaving. The master asked him "what about the CO2 system?" The fire chief responded, "its your ship, Captain".

Prior to leaving the ship, the shoreside firemen tied two 2-1/2 inch fire hoses into the top of the engine room skylight. The firemen started to pump foam from the pumpers ashore through the fire hoses into the skylight hatch for the engineroom at about 1010. The firemen also placed two 2-1/2 inch fire hoses on deck and discharged water against two doors on the after side of the superstructure since fire had been observed in these two spaces. A watch was posted at the gangway at about 1030 so no one could get back on board without authorization. At about this time, the incident commander noticed, while in his car ashore, foam coming off the bow of the vessel near the anchor. Also at about this time, they were able to get a good head count and the exact number of crew at the hospital. From this information, they were able to determine three engineers were still missing. There was still some doubt since they did not know the names of the crew members who had been transported to the hospital. The incident commander tasked someone to go to the hospital to get the names of the injured people so the head count and names of the missing crew members could be confirmed.

At about 1105, the incident commander held a meeting of all of the key players to assess the situation and to make plans for future actions. At about this time, an officer from the local Coast Guard office arrived on scene to monitor the situation and to be available for any assistance. The incident commander asked him to look at towing needs if it became necessary. The terminal manager had three small assist tugs standing by the vessel and he was not sure if they would be able to get the vessel off the dock if the fire could not be controlled. The incident commander knew the two big tugs of 7200 horsepower were in St. Lucia and if the three smaller assist tugs could not move the SEAL ISLAND deadship, other tugs would have to come from Puerto Rico. Mr. Swensen, using the fire safety plan, briefed the firemen on the various means of entry into the engineroom.

Mr. Swensen then went back on board the vessel to assess the situation. He noticed there was less heat and smoke from the engineroom at this time. He then directed the placement of cooling water being sprayed onto the vessel by the shoreside firemen and by the three small tugs which were alongside on the outboard side of the vessel. Mr. Swensen noticed smoke coming from a fuel oil vent on the starboard side forward of the accommodation house. He radioed the fire chief and requested more hoses be directed onto the deck in the area of the fuel tank to keep the vessel cool. As Mr. Swensen got nearer to the entrance to the pumproom, he felt a tremendous amount of heat coming from the pumproom. He then placed a charged fire hose

into the pumproom in an attempt to cool the space. He also wanted a foam blanket placed into the fuel tank and the engineroom and advised the fire chief.

At 1136, the port captain instructed the captains of the three tugs, who had been spraying water on the hull of the SEAL ISLAND, to spray water on the deck of the tanker in way of its engineroom. The tugs used their second deck and mast fire monitors in their attempts to cool the deck. The tugs continued to pump cooling water onto the deck until 1300 when they were instructed to secure their operations.

At about 1200, Mr. Swensen walked back down onto the dock for a second meeting with the shoreside firemen and ship's crew. Mr. Swensen advised the incident commander, fire chief, and master that he did not want anyone on board the vessel until 1800. At about this time, he noticed the firemen were pumping foam through the ship's fire main. It was reported to him the foam was spilling on deck because valves had been left open on the vessel. He told the fire chief to secure the foam operation since it was not going into the engineroom and he did not want to waste it. Mr. Swensen then went back on board the vessel to secure the valves and to isolate the forward fire main system so the foam could be directed to the engineroom and other adjacent spaces. Foam continued to be pumped into the engineroom and pumproom until about 1400. About 4,180 gallons of AFF-ATC synthetic foam concentrate was pumped onto the vessel. HOVIC had 28,000 gallons of foam on hand at the start of the fire.

At about 1210, the supervisor of the Coast Guard Resident Inspection Office in St. Croix requested Mr. Stebbins provide a portable oxygen meter so the chief mate could check the oxygen levels in the cargo tanks. The cargo tanks were checked by the chief mate and he determined the oxygen levels were below eight percent and the tanks still had positive pressure. The chief mate continued to check the tanks during the day. Coast Guard personnel continued to the monitor the situation and provided input to the personnel on scene during the fire fighting efforts.

At 1346, the rescue team mustered on the after poop deck since they wanted to determine if there were any of the missing engineers trapped in the steering flat or other adjoining spaces to the engineroom. After testing the atmosphere in the store room and escape hatch on the stern of the vessel, Mr. Swensen entered the hatch with a safety harness and lifeline. When he entered the steering gear flat, he found it was not effected by the fire and smoke. He went forward, opened the door, entered the engineroom and conducted a limited search but was not able to locate any of the missing crew. He limited his search due to the intense heat, and smoke and came back on deck.

At 1415, the firemen set additional hoses on deck to cool all surrounding bulkheads and the deck in way of the accommodation house. The starboard accommodation house and the deck in way of

the engineroom appeared to have the highest presence of heat at this time. The heat also seemed to be spreading to the after port corner of the accommodation house. At 1545, Mr. Swensen reboarded the vessel and noticed an increase in heat on the port side of the vessel and he repositioned a tug which directed more water in this area. He also noticed a minimal amount of smoke coming from the fuel tank vent on the starboard side compared to what he had observed earlier. The firemen from ashore and a tug continued to spray water onto both sides of the accommodation house.

At about 1615, Mr. Joseph Gehegan, arrived on scene from New Jersey, and was briefed by Mr. Stebbins. Mr. Gehegan consulted with the local pilots about the ability of the small local tugs to move the SEAL ISLAND away from the dock to sea if it became necessary. The pilots were uncomfortable with it so Mr. Gehegan ordered two 10,000 horsepower tugs from Puerto Rico. He was told it would take about twelve to eighteen hours to arrive on scene in St. Croix.

At 1648, the Coast Guard personnel were informed by HOVIC's senior agent that the fitter and the chief engineer were flown to Centro Hospital in Puerto Rico; the chief fireman, the fireman, and the wiper were flown to St. Barnabas Hospital in Livingston, NJ; and the third assistant engineer was in the local hospital.

At 1730, the rescuers reported back on board the vessel. Fourteen people were assembled on the stern of the vessel. The people were divided into two teams; one lead by Mr. Gehegan. The other team was led by Mr. Al Colletti, Manager, Marine Department for Atlantis Agency Corporation, who had arrived with Mr. Gehegan from New Jersey. At about 1900, the teams entered the store room via a hatch on the stern of the vessel. They then went through the doorway which led them into a passageway near the steering gear room and went forward until they got to another door which led them into the engineroom between the boilers. Fire hoses were strung down with them so each team could have a fire hose with them as they entered the engineroom. With their SCBAs on, the rescue teams opened the doorway and entered the engineroom. One team went around the port boiler and forward while the other team went around the starboard boiler. One of the team members on the starboard side went into the machine shop and paint locker which is located near the forward bulkhead and did not locate any of the missing engineers. The smoke was thick with about three feet of visibility and it was very hot. When Mr. Gehegan heard a bell ring on one of the SCBAs worn by one of the firemen, he yelled to Mr. Colletti and to his team to get out. The teams then exited the machinery space. The door to the engineroom was closed and the rescue effort was abandoned. Mr. Gehegan decided to wait until the following morning, to continue the rescue effort. It was generally believed by the personnel on scene that the fire in the engineroom was out at this time but there were secondary fires in the accommodation spaces where the ships stores were located.

The senior Coast Guard official on scene requested provisions be made to keep the cargo tanks inerted. The incident commander advised him that a nitrogen trailer would be placed at Dock no. 3 in the event any additional inerting of the tanks was required. When it was later determined that the oxygen levels were getting too high in some of the tanks, the refinery brought in two of their nitrogen trailers and pumped the nitrogen in the tanks to maintain the inert blanket. The refinery produces nitrogen and therefore had sufficient quantities of nitrogen on hand throughout the event.

During the last couple of hours, the heat had moved up to A deck in the forward house and a decision was made to reboard the vessel. Mr. Gehegan and several others went up via the exterior ladders to E deck which is just below the bridge and dragged up two ship's fire hoses with them. They then proceeded to flood the elevator shaft from the top on E deck. They found the door leading up from E deck to the bridge was open and they closed it. Then working down each deck, they closed fire doors for staterooms at each level and opened fire station valves on D, and E decks to cool the area. There was no water available on C deck from the fire stations. On B deck, the deck was very hot and blistering and again they opened fire station valves to cool the area. When they got to the starboard side door on B deck which goes down to A deck, it was extremely hot, and, therefore, decided not to enter. On each of the decks, they searched the staterooms and other spaces for any missing crew members; none were found. They also observed smoke coming out of many cableways where it penetrated the decks at various levels. They then went down the exterior ladders to the main deck and proceeded aft in between the forward house and machinery casing. They entered the door for the storeroom on the after side of the forward house and encountered a large fire in the space. Most of the ship's stores were on fire so they placed a fire hose in the space. Due to the extreme heat, they abandoned the effort. At about 2015, most of the firemen and other personnel left the vessel to get some needed rest. Fire boundaries were set and a live fire watch was established prior to departing the vessel.

At 0800 on Sunday, 9 October, the firemen reboarded the vessel and brought aboard additional fire hoses and SCBA bottles which had been recharged. The firemen entered the bridge, and inspected D, C, and B decks and found them to be free of any fires. The bolted manhole covers on the void space between the superstructure and the deck on the port and starboard sides were removed and flooded with water to allow cooling of this area which had a substantial heat build up. This was a major concern of the Atlantis Agency and Coast Guard personnel since the bunker tanks were below the void spaces. At about 1130, the shoreside firemen entered the A deck storeroom with firemen manning three fire hoses, and extinguished the fire in this space. They then continued to cool the forward house.

At about 1340, the fire was officially declared out by the fire chief since no more smoke was coming from the ship. The firemen

began to open hatches, including the engineroom skylight and the escape hatch to the control room. At this time, it was collectively decided to try to search for the missing crew members. The rescue team proceeded into the A deck storeroom and down the central stairway into the engineroom. When they got down into the engineroom by the control room, they began to search the area. They found one victim on the boiler platform on the port side aft of the control room near the stairway by frame 33. The victim was later identified as the electrician. Near his body, they found an SCBA lying on the deck. Another victim was found on the port side of the boiler platform near the diesel generator. He was later identified as the first assistant engineer. At this point, the teams were running low on air, and they exited the engineroom. Since it was getting late in the day, it was decided to wait until the next morning to continue in their efforts to recover the victims.

On Monday morning on 10 October at about 0700, the rescue team came back on board the vessel. During their search of the engineroom, the third victim was found one level up from the boiler platform on the port side by frame 33. The deceased was identified as the fitter. The fitter had been found with a fire blanket wrapped around his head, which apparently he had taken with him from a designated locker in the machine shop. The three deceased engineers were photographed and their bodies were removed from the engineroom using a tackle system rigged from the main deck. The deceased were released into the custody of the St. Croix Coroner.

Detailed autopsies were conducted on all of the deceased. The autopsy report for the fitter, Nomer V. Surmieda, indicated the cause of death as smoke inhalation and intense heat exposure. He had first and second degree burns to his face, neck, trunk, upper extremities and anterior thighs. His exposed skin on the face, head, neck, and hands were covered with a black sooty, oily film. The autopsy report for the electrician, Dante C. Dela Cruz, indicated the cause of death as smoke inhalation and intense heat exposure. He had first and second degree burns to his face, neck and upper extremities. His exposed skin on the face, head, neck, hands, and lower forearms were covered with a black sooty, oily film. The autopsy report for the first assistant engineer, Antonino Marchese, indicated the cause of death as smoke inhalation and heat exposure (asphyxia), first and second degree burns, extensive. His exposed skin and clothing were covered with a black sooty, oily film.

i. Miscellaneous Information

Shipboard records and statements of the engineers revealed the lube oil pressure and temperature at the duplex strainer under normal operating conditions was about 9.5 bar (137.8 psi) before the strainer and 9.3 bar (134.9 psi) after the strainer, and 57 degrees C before the cooler and 42 degrees C after the cooler. The lube oil for the turbine generator was manufactured by Exxon

Company International and its product name is TRO-MAT T. According to its material safety data sheet, TRO-MAT T has a flash point of 224 degrees C (435 degrees F), and an autoignition temperature greater than 260 degrees C (500 degrees F). The superheated steam that powered the turbine had a temperature of about 510 degrees C (950 degrees F) at the superheater outlet on the boiler. Steam piping temperatures in way of the generator would be slightly less but well above the lube oil's autoignition temperature.

It was reported by the Atlantis Agency Corporation that the normal quantity of lube oil for the turbine generator was 910 cubic decimeters (240.5 gallons). Lube oil soundings taken after the casualty revealed that the sump was dry. Soundings taken of the fuel oil and other lube oil tanks and sumps after the fire indicated no change in the volumes when compared with the levels prior to the fire.

An informal workbook maintained by the first assistant engineers on board the SEAL ISLAND indicated the strainers for the turbine generator were changed on 25 February 1994. The workbook's last entry was dated 30 June 1994. According to the engineers interviewed during the course of this investigation, the strainers were only changed when the pressure differential before and after the strainers became too great. They could not remember any specific dates when they had last changed the strainers and they did not routinely change the strainers on a set schedule. The manufacturer of the turbine generator recommends the switching over to the standby clean strainer when the differential pressure across the duplex strainer is higher than normal. The manufacturer recommends a maximum differential pressure rating of between .8 bar and 1.2 bar since the strainer is no longer functioning as designed because it is too dirty. The lube oil system on the SEAL ISLAND had no differential alarm system.

Under the latest SOLAS rules, tank vessels are required to have on board 4 self contained breathing apparatus (SCBA) with sufficient spare cylinders and 4 fireman's outfits. Under the latest Coast Guard regulations, tanker vessels are required to have on board 2 SCBAs with 2 spare cylinders and 2 fireman's outfits. There is no requirement under SOLAS rules or Coast Guard regulations for emergency escape breathing apparatus (EEBA) to be placed on board tank vessels.

Prior to the casualty, the SEAL ISLAND had a total of 9 SCBAs and 13 additional cylinders on board. They were located in the following areas: a total of 7 SCBAs and 10 spare cylinders in three above deck emergency gear lockers; and 2 SCBAs and 3 spare cylinders in the engineroom. It also had a total of 11 ten minute EEBAs on board; with 4 EEBAs in the engine control room; 3 in the gear lockers; 1 in the cargo control room; and 3 in the pump room. They also had 8 fireman's outfits aboard.

After the casualty, Atlantis Agency reassessed its emergency equipment needs and added additional equipment to its two remaining VLCCs. They created a new emergency gear locker in the engineroom on the boiler platform level forward of the elevator and added emergency equipment. They now have on board a total of 14 SCBAs with 28 spare cylinders. They are located in the following areas: a total of 12 SCBAs and 24 spare cylinders in the four gear lockers; and 2 SCBA and 4 spare cylinders in the engineroom. They also now have 23 EEBAs in the following locations: a total of 8 EEBAs in the four gear lockers; 4 in the engine control room; 4 on the boiler platform level; 2 in the lower engineroom near the emergency escape trunk; 2 in the lower pumproom; 2 in the mid-level pumproom; and 1 in the cargo control room. They also now have 14 fireman's outfits aboard.

Fire drills and the testing of the emergency equipment including the emergency fire pump were conducted on a weekly basis and recorded in the deck and engineering logbooks. In reviewing the logbooks and discussing the fire drills conducted on board the SEAL ISLAND with the crew, it was determined only one fire drill in the last year was conducted with a simulated fire in the engineroom.

According to the port captain, it is company procedure to test the emergency fire pump with its electric and hydraulic starting system. However, the port captain testified he was on board the vessel during three Coast Guard examinations and each time the emergency fire pump was only started using the electric system. The third assistant engineer testified he only started the emergency fire pump with the electric system during the three months he was on board prior to the casualty. A review of the Coast Guard regulations and policies and SOLAS rules revealed that there are no requirements for the crew, Coast Guard inspectors, or class society surveyors to test emergency equipment using all available starting systems.

During this investigation, it was determined that the Coast Guard Marine Safety Office, San Juan, Puerto Rico and its Resident Inspection Office, St. Croix, U.S. Virgin Islands did not have a firefighting contingency plan for St. Croix as required by the Marine Safety Manual, Volume VI, Chapter 8.

There were no oil deflectors installed adjacent to the duplex strainer on the SEAL ISLAND and its sister vessels. Current Coast Guard marine safety regulations require suitable oil deflectors in way of flanged and mechanical pipe joints. There are no requirements for deflectors if all of the pipe joints are welded to the duplex strainer. There are also no requirements for deflectors around the duplex strainer even though they are subject to pressure if inadvertently opened up by the vessel's crew during replacement of the strainers. There are no similar requirements under SOLAS rules. According to Mr. Colletti, spray shields were installed on the two sister vessels after the casualty.

A review of the SEAL ISLAND's safety plan, indicated that the emergency escape trunk from the engine control room and its associated hatch on the main deck were not depicted on the plan. The EEBAs and SCBAs that were reported on board the vessel were also not accurately depicted on the plan. The plan was also missing the semi-portable dry chemical extinguisher which was located on the boiler platform level.

j. Post Casualty Inspection of Duplex Strainer Assembly

During the course of this investigation, the Coast Guard investigator and Mr. Gehegan boarded the SEAL ISLAND in St. Croix several times from 11 to 13 October. When they went to look at the duplex strainer for the first time, Mr. Gehegan put a wrench on the bolts for the forward and after covers for the duplex strainer. They found that both covers were on tight. They also observed that the directional control spindle valve had moved upward from the casing. The upper "O" ring groove on the spindle valve was visibly extending above the casing. The cup and jack assembly were obscured and not observed in place on the bottom side of the duplex strainer. The existence of the strongback clamp and the function of the cup and screw jack were not known by the personnel on scene at this time. The chief engineer informed Mr. Gehegan of the existence of the cup, screw jack, and strongback clamp while he was in the hospital in Puerto Rico. The cup, and screw jack were later found in place under the duplex strainer by a shoreside engineer for Atlantis Agency. The strongback clamp was also found by a shoreside engineer in the presence of Coast Guard inspectors in the vicinity of the turbine generator buried in the debris and ash in the area.

On 11 January 1995, the duplex strainer was examined at the NTSB Materials Laboratory in Washington, D.C. The strongback clamp, screw jack and cup with its "O" ring were also examined.

During on board operation, the cup and "O" ring were positioned below the bottom center of the strainer casing to fit around the outside diameter of the strainer casing, where the directional control spindle valve exits the casing. During the examination, it appeared that the lower securing pin in the bottom of the spindle, when in its designed position (extending .25 inches from the valve body onto the casing), interfered with the leak stopping ability of the cup and "O" ring. This pin, in its designed position, prevents the directional control spindle valve from rising upward out of the casing when pressurized lube oil is flowing through the strainer. To properly position the cup and "O" ring to stop the leak, the pin which held the spindle valve down into its proper position in the valve seat had to be moved back within the circumference of the directional control spindle valve or sheared off. The securing pin was examined microscopically and revealed no indications of shearing effects. The securing pin was found in such a position to allow the directional control spindle valve to move upward in the strainer casing. With the bottom securing pin in this position, a NTSB

investigator was able to manually lift the valve upward about 4 inches with little effort. The cup's "O" ring was also examined microscopically and appeared in good material condition.

The directional control spindle valve was removed from the strainer casing and examined. The upper "O" ring was missing. The lower "O" ring appeared in relatively good material condition.

During the course of the examination, the forward and after covers were unbolted and the strainers in each basket were examined. The strainers from the after basket were visibly cleaner than the strainers from the forward basket which supports the fact that the new replacement strainer had been installed by the first assistant engineer in the after section of the duplex strainer prior to the start of the fire.

Calculations were submitted by one of the parties in interest to show the net upward force acting upon the spindle valve with the cup and jack in place under the duplex strainer casing on the day of the casualty. The net force was about 252 KG (556 pounds) pushing upward against the spindle valve.

The lube oil strainers on board the two sister vessels, SAINT LUCIA and MT CABRITE, were examined by Coast Guard inspectors in St. Croix and Long Beach, CA. The lower securing pins were found in the proper position, extending out .25 inches from the valve body. No temporary repairs were found to the lube oil system.

k. Post Casualty Inspection and Reports on Fire Fighting Equipment

The instructions for operating the low pressure CO2 system were posted on the cover for the remote control box located on the forward starboard bulkhead of the machinery casing on the main deck. The cover is hinged on the bottom which places the instructions face down to the deck when it is opened. In this position, the instructions are not visible to the operator. The instructions are very explicit. When the cover is opened, the CO2 alarm in the engineroom starts to ring and the ventilation fans are stopped automatically. It then indicates to pull handle No. 1 which opens a valve in front of the CO2 tank and puts the valves in the control box under pressure. When the pressure on the gauge has passed 10 kp per square cm, pull handle No. 2 which opens the outer main valve for the engineroom. Pulling handle No. 3 opens the inner main valve and floods the engineroom with CO2.

On 9 December 1994, the low pressure CO2 system was inspected by a ship service company in Cadiz, Spain. This was done at the request of this investigating officer. The CO2 tank was found empty. The pilot valve was found to be in proper working condition and the main discharge valve for the tank was opened.

Subsequent to the fire, the emergency fire pump and its associated diesel engine were inspected by Atlantis Agency Corporation's Manager of the Marine Engineering Department because of the failure of the diesel engine to start during the emergency. The diesel engine is equipped with two means for starting - a 24 volt electrical system and a self contained hydraulic start system. The fire destroyed the electrical cable to the charging system in the engineroom. The batteries for the electrical start system were replaced and a new power supply cable was jumpered into the existing cable to operate the charger. Further investigation into the operation of the electric start system revealed that the starter motor had shorted out. It is not known whether the consecutive tries at starting the diesel engine by the vessel's crew worsened or created this problem. The hydraulic start motor was found to be slightly misaligned. This misalignment resulted in the engine not getting sufficient starting torque. Both the electrical and hydraulic starters were repaired and the emergency fire pump was tested and run. This testing was witnessed by Coast Guard personnel in St. Croix and by a salvage association representative.

Mine Safety Appliance Company (MSA) examined the Ultralite II SCBA which had been used by the electrician and third assistant engineer during the fire. The unit was extremely dirty from soot. All of the face-piece tests failed due to the extremely dirty surfaces. The bypass and audio-alarm tests were run and the bypass test result was acceptable. The audio-alarm failed the alarm accuracy test on the high side which meant the alarm rang earlier than it should. The face-piece was cleaned and retested. It passed the mask leakage test and the exhalation valve performance test. The cylinder gauge read zero and the cylinder valve was found in the closed position. Upon opening the valve, there was a small undetectable amount of air remaining in the cylinder. MSA believed there was less than 6.9 bar (100 psi) in the cylinder. The cylinder burst disc was intact.

1. Fire Damage in Machinery Space and Superstructure

Mr. Matthew T. Gustafson, a fire protection engineer, from Commandant G-MTH, examined the vessel several weeks after the casualty. He reported the machinery space revealed a large, intense fire occurred in the area of the steam turbine generator. The heat and fire rose to the deck above and then upward to the top of the machinery space. The hot upper layers of the fire appeared to have spread out across the entire overhead of the machinery space. Smoke followed a similar path and was generated in tremendous quantities based upon the blackened surfaces and the amount of soot deposits. Soot was heavily deposited on all surfaces above the boiler platform level where the steam turbine generator was located. Very dark soot in the upper part of the machinery space indicated very high temperatures in the hot upper layer. The weather bulkheads at the base of the main superstructure suffered blistered paint and cracked welds that indicated exposure to high temperatures.

Below the level of the boiler platform, there was very little soot on interior surfaces. However, soot was deposited on the sideshell of the vessel all the way down to the lowest level. Smoke in the lower portions of the space apparently did not deposit on most surfaces but clearly did coat the sideshell of the vessel. The relatively cool sideshell below the waterline may have caused soot to condense on the steel plating. Plastics and class A combustibles below the boiler platform level showed no signs of melting or heat damage.

The fire progressed through the main deck into the main superstructure. The center stairway had heavy heat and smoke damage from bottom to top. It appeared that the door between the main machinery space and the center stairs was closed during the fire. However, it is likely that the door allowed significant leakage given the extreme heat conditions on the machinery space side and the warping of the main deck near the door. A door on one of the decks was apparently left open between the center stairs and the deck corridor. This corridor suffered heavy smoke damage. The bridge also suffered heavy smoke damage.

Bulkheads and doors separating the center stairs from the corridors on each deck, where closed, were effective against both smoke and heat dispersion in the superstructure. There was, however, some smoke damage on every deck. B class bulkheads and doors separating corridors from cabins and wardrooms were highly effective against smoke and heat spread. Ventilation louvers in lower portions of doors opening into the corridors remained free of soot deposits, indicating that they did not substantially contribute to smoke spread.

Cable trays in the A deck storerooms, stairs, and corridor overhead were destroyed. It appeared that the fire was able to spread from the overhead above the A deck storeroom, through the stairs and then out into the A deck corridor along the overhead cable trays. The performance of cable penetration fire stops in this area is in doubt. In the vicinity of the center stair bulkhead cable penetrations did not have fire stopping sealants in place. It was not evident that they had been in place prior to firefighting operations.

Cables were heavily involved in fire both in the machinery space and in the superstructure. Cable insulation had oozed out of the metal armor and were heavily charred. The cables added to the fire intensity and smoke production. The sealant in the main deck cable transit penetrations between the machinery space and the superstructure appeared intact but charred. The copper conductors of the cables may have conducted considerable heat through the cable transit systems.

m. Drug and Alcohol Post Casualty Testing

Body fluid and tissue specimens were saved on the three deceased crew members and sent to the Center for Human Toxicology in Salt

Lake City, Utah. The purpose of the examination was to determine if there was any evidence of alcohol or drug use and to determine the carbon monoxide levels.

The fitter's blood alcohol concentration was negative and no drugs were detected in the blood or urine sample; blood carbon monoxide - 14% carboxyhemoglobin saturation; blood cyanide - not detected.

The electrician's blood alcohol concentration was negative; drugs detected in the blood sample - Acetaminophen: 63 ug/mL, Dextromethorphan: 732 ng/mL; drugs detected in the urine sample - Acetaminophen: > 150 ug/mL, Dextromethorphan: 1460 ng/mL; drugs in the liver sample - Dextromethorphan: 9300 ng/Gram; drugs in the brain sample - Dextromethorphan: 1317 ng/Gram; blood carbon monoxide - 16% carboxyhemoglobin saturation; blood cyanide: not detected.

The first assistant engineer's vitreous alcohol concentration was negative; blood alcohol concentration - negative; no drugs in the blood sample; blood carbon monoxide - 19% carboxyhemoglobin saturation.

Drug and alcohol testing was requested by Atlantis Agency personnel for the six injured crew members. Due to their life threatening injuries which required evacuation off the island of St. Croix to Puerto Rico, and Livingston, NJ to receive proper medical treatment, Atlantis Agency personnel had difficulty coordinating the tests. As a result, no testing was conducted on these injured crew members. There is no evidence of drug and alcohol impairment concerning these crew members.

n. ISM/ISO 9002 Certification of Atlantis Agency Corporation

Prior to the fire on 8 October 1994, Atlantis Agency Corporation was pursuing an ISM/ISO 9002 Certification. In August from the 5th to 8th and from the 28th to the 30th, Mr. Colletti along with his consultant boarded the SEAL ISLAND and instructed the master and chief engineer in the implementation of the ISO 9002 and ISM codes. In November 1994, Atlantis Agency's shorebased management team passed their final audits and received their certification for ISO 9002. One of the company's VLCCs, SAINT LUCIA, received its ISO 9002 and ISM certifications in December 1994, and the other VLCC, MT CABRITE received its certifications in January 1995.

Even prior to their ISO/ISM certification, the company had in place many oversight systems for discovering and reporting discrepancies found on board their vessels. Each of their vessels were routinely boarded by their shoreside personnel in the loading and discharge ports except for the loading port in Nigeria. Due to the instability of the government in Nigeria and civil unrest, the U. S. Department of State advised American citizens and companies not to visit this country. Atlantis

Agency Corporation abided by this warning. Their deck department personnel usually boarded the vessels in the loading ports and the engineering department personnel boarded the vessels in the discharge ports. During their visits to the vessels, they met with the masters and the chief engineers to discuss any problems they were having on board or any other issues. The shoreside personnel also conducted a cursory inspection of the vessels including the engineroom to check on the general condition and to assess if their were any problems. To aid in their inspections, they also used a check sheet to document their inspections and to comment on any discrepancies found. If a discrepancy was found, it would be reported to their New York Office by facsimile or e-mail. If it was engine related, it was reported to the marine manager, manager of engineering and senior ship superintendent and if it was deck related, it was reported to the marine manager and port captain. The shoreside personnel also discussed the discrepancy with the master and the chief engineer if appropriate.

During the seven shoreside visits by management in the loading and discharge ports since June 1994, no one in management noticed the temporary repairs to the duplex strainer which were completed on 11 and 12 June 1994. During this investigation, most of the shoreside personnel reported walking on the inboard side of the steam turbine generator and looked for evidence of leaks from the lube oil system in the pan underneath the equipment. Since there was no indication of any leakage, no further inspection of the equipment was conducted. None of them reported walking on the outboard side of this generator where the duplex strainer was located. The chief engineer also never reported to the master or shoreside personnel in writing or in person the problem with the duplex strainer leaking lube oil nor the temporary repairs he authorized to the equipment - strongback clamp and cup with a screw jack. These temporary repairs were not recorded in the deck or engineering logbooks or other reports which were sent monthly to New York for management review.

Between 23 and 26 June 1994, the vessel was boarded by a private consultant hired by Atlantis Agency Corporation personnel for the purposing of conducting a safety audit. Chief Engineer Pontarelli testified that the private consultant as part of his out brief told the chief engineer that he found the temporary repairs to the duplex strainer during his inspections. The chief engineer explained to the consultant what they had done to stop the oil leak and that they would make a permanent repair at the first opportunity. The chief engineer also testified that the consultant stated he was going to include it in his written report. The consultant when shown a picture of the temporary repairs testified that he was absolutely certain that he had not seen it during his inspection and there was no mention of it in his written report. In reviewing the consultant's hand written notes which he used to prepare his final report, a note was found indicating "lube oil strainer caps on turbine generator". The consultant after reviewing his notes concluded that most likely

he saw the strongback clamp on top of the duplex strainer but he does not remember seeing the cup and jack below it. Apparently, he forget to mention it in his final report to Atlantis Agency Corporation.

After the casualty, a personal workbook maintained by the first assistant engineer and written in Italian was found on board the vessel. This workbook documented the temporary repairs to the duplex strainer. According to this workbook and testimony received during the investigation, the "O" rings for the duplex strainer were last replaced while the vessel was in a shipyard in Cadiz, Spain in February 1994. The "O" rings were made from a kit on board the vessel.

The company had a computer system in place for documenting maintenance items. This system was used to document items that had been repaired and also remained outstanding. This system was also used for their planned maintenance and for their ABS Continuous Machinery Survey Program. A review of the maintenance system printout revealed that the chief engineer did not document his repairs to the duplex strainer. Requests for spare parts or repair requisitions were sent to the marine manager in New York. These requests were entered into the company's automatic requisitioning computer system which had equipment numbers for every piece of equipment. A review of a printout for the steam turbine generator revealed, the chief engineer never requested a spare duplex strainer housing be sent to the vessel even though the company had one in their warehouse in New York.

Atlantis Agency had various instructions and policies provided to the crew of the SEAL ISLAND prior to the casualty which required the chief engineer to report, to the master and shoreside management, the temporary repairs made to the duplex strainer. One instruction stated - "Each member of the Engine Department should be instructed to notify his immediate superior of any condition, equipment, machinery, or practice which, in his opinion, is unsafe and consequently harmful to the vessel and personnel. It also stated - "Before removing any fittings or part subject to pressure, be sure that all pressure is removed and parts properly isolated and drained. Valves should be locked, closed and tagged." Another instruction stated - "You must ensure that the proper spares are on board your vessel at all times." In a Corporate Procedure for Requests for Repairs, it stated - "The Chief Engineer shall immediately inform the master of the severity of an equipment or system failure as required by Casualty Response and Reporting S70.020, Hull and Machinery Casualties." In a Corporate Procedure for Maintenance, it stated that a monthly maintenance report shall be compiled and sent to Atlantis Agency. It indicated the report shall consist of a summary of the First Assistant Engineer's daily maintenance log.

o. Incident Command System

According to Mr. Stebbins, the refinery manager, he is the predesignated incident commander for fires at the refinery. Mr. Stebbins acted in this capacity the moment he arrived on scene on the morning of 8 October. The fire chief had a very active role in fighting the fire, and rescue attempts. The fire chief reported his actions to the refinery manager.

During discussions of HOVIC's command system during the course of this investigation, it was universally agreed that the master had ultimate responsibility for the vessel. He called for shoreside assistance as soon as he determined there was a major fire on board his vessel. He took some initial actions but soon after the HOVIC firemen arrived on scene, he took on a lesser role and acted as a consultant to Mr. Stebbins, and the fire chief.

When Mr. Swensen arrived on board the vessel, it was his understanding he was in charge on scene since there were no other owner's representatives in St. Croix. In this capacity, he advised the master to take several critical actions including the discharge of the CO2 system and the closing of many of the opening into the engineroom and other spaces.

When Mr. Gehegan arrived on scene later in the day on Saturday, 8 October, Mr. Stebbins and Mr. Gehegan both felt that the incident commander was now a shared responsibility, even though there were no discussions on this issue. It was their understanding Mr. Gehegan was responsible for the ship's crew and Mr. Stebbins was responsible for his personnel at HOVIC. When they were questioned during the investigation concerning a hypothetical situation, i.e., if there was a difference of opinion between the two of them on a course of action, they agreed that a consensus would be reached between the two of them since they both worked for the same parent company, Amerada Hess.

During the course of this investigation, HOVIC's Fire Brigade and Incident Command Organization, Fire Brigade Training Manual, training scenarios, and Emergency Response Reference Guide were reviewed. The organization and responsibilities in HOVIC's manual did not parallel the command system used during the incident. According to the Emergency Response Reference Guide, the refinery manager is not identified as the incident commander. It describes his responsibilities as follows:

- Reviewing the situation with the Fire Chief, Shift Superintendent, and Operating Department Manager responsible for the unit after arrival at the scene of the emergency.

- Releasing any statement to the news media.

- Permitting persons other than HOVIC employees to enter the Refinery.

- Maintaining contact with the Fire Chief and Shift Superintendent to provide any information or logistics as required.

- Requesting necessary supplies and equipment from mutual aid sources if necessary.

According to HOVIC's organizational manual, the refinery manager's duties include the following:

- Obtain briefing of incident from incident commander.

- Approve and authorize implementation of "incident action plan".

- Monitor incident command operations to identify potential inter-organizational problems.

- Approve requests for additional resources, equipment and supplies.

- Conduct critique of the incident and approve final report of the incident.

The refinery's shift superintendent had several responsibilities, according to the training manual, including supervision and direction of emergency personnel and equipment until the arrival of the fire chief, assistant fire chief, or fire fighter on duty.

The fire chief also had several defined responsibilities according to the training manual, including supervision of the fire brigade and maintaining communication with the command post and shift superintendent with up-to-date information on the emergency.

According to the organization manual, the fire chief was identified as the incident commander. The following is his delineated duties:

- Activate fire and/or evacuation alarms.

- Establish and announce location of command post.

- Obtain size up from operations chief and assess incident situation.

- Develop incident action plan.

- Insure agency call outs initiated.

- Brief Command Staff and operations chief.

- Coordinate Staff Activities.

- Manage incident termination.

- Insure incident report is completed and forwarded to refinery manager.

There appears to be discrepancies between HOVICs emergency response guide and organization manual. The former guide describes an organization with delegated responsibilities to several key people but with no one clearly defined as the person overall in charge or incident commander and no clear chain of command. The organization manual identifies the fire chief as the incident commander.

It also appears HOVIC's planning was exclusively geared to shoreside fires. No mention was made to ship board fires in any of the references provided. Also, it did not address the role of the vessel's master and his crew in the response organization.

In reviewing the training scenarios, it again appears the training was mainly focused on shoreside emergencies. In the fire brigade and rescue team critique of this fire, they noted that none of the fire brigade had ever received any type of marine fire fighting training. They recommended the following:

- Send at least the leader of the brigade to a marine fire fighting school;

- Build a training prop on the fire field that can be used to train the remainder of the brigade and marine department personnel in ship fires; and

- The rescue team and fire brigade should hold drills aboard vessels and make periodical walk-throughs for familiarization of different ships.

CONCLUSIONS

1. The proximate cause of this casualty was the failure of the chief engineer to make proper permanent repairs to the lube oil system's duplex strainer for the steam turbine generator in June 1994. Based upon the observations of the crew that oil was leaking from the bottom of the duplex strainer, the chief engineer should have replaced the lower "O" ring on the directional control spindle valve using the material in the "O" ring kit on board the vessel. If this did not stop the leak, the chief engineer should have ordered a spare duplex strainer assembly from Atlantis Agency Corporation. The company could have air delivered the assembly to the next port and the chief engineer could have made the replacement.

2. When the chief engineer experienced high water temperature on the cooling system for the diesel generator on 11 June, he should have reduced the electrical load by securing the air conditioning and ventilation systems and if necessary secured one of the boilers, before transferring the load to the diesel generator. The chief engineer also had ample opportunity to make permanent repairs to the duplex strainer when the vessel was at anchor in Hounds Point, Edinburgh, Scotland in September 1994. At this time, the vessel was operating in much colder sea water. When the starboard boiler was secured due to routine inspection and maintenance, the electrical load could have been reduced and the load transferred to the diesel generator. Once accomplished, the repairs could have been performed safely. Based upon the chief engineer's own testimony, he considered it a low priority to effect permanent repairs to the duplex strainer since the temporary repairs had taken care of the immediate problem of stopping the leak.

3. A contributing cause of this casualty was the failure of Chief Engineer Armuzza to effect permanent repairs to the duplex strainer when he relieved Chief Engineer Pontarelli at the end of June 1994. Chief Engineer Armuzza also considered the permanent repair a low priority since the temporary repairs had taken care of the immediate problem of stopping the leak.

4. It can not be positively determined why the diesel generator experienced high water temperatures in the cooling system on 11 June. Most likely the cooling water jacket was dirty/plugged and/or the injectors or air strainer were dirty. The diesel generator was also not operating at 100 percent efficiency because it, most likely, had not been properly maintained by the engineers for several months.

5. Once the strongback clamp was removed by the first assistant engineer on the morning of 8 October 1994, the directional

control spindle valve was free to move upward since its bottom securing pin had been pushed in for the placement of the cup with the "O" ring. Shortly thereafter, the lube oil under pressure (about 9.5 bar or 140 psi) caused the directional control spindle valve to lift above the casing and exposed the upper "O" ring. With the valve in this position, the lube oil began to spray upward in a cone shape hitting the steel platform above and showering down onto the hot turbine casing.

6. The lube oil was ignited by the hot surfaces (about 510 degrees C or 950 degrees F) of the steam turbine generator or associated steam piping.

7. The electrician and the fitter died as a result of smoke inhalation and intense heat exposure. The first assistant engineer died as a result of smoke inhalation, heat exposure (asphyxia), and extensive first and second degree burns.

8. There were no reports of oil leaking out of the top of the duplex strainer casing prior to the fire. The upper "O" ring on the directional control spindle valve was in place and operating properly prior to the fire. This "O" ring was most likely consumed in the fire or was blown off the upper section of the spindle valve where it was positioned in the machined groove by the pressurized lube oil. This most likely occurred when the "O" ring became exposed above the duplex strainer casing.

9. This casualty could also have been prevented if the chief engineer had taken the proper actions to replace the strainer baskets on the duplex strainer on the morning of 8 October 1994.

a. While the vessel was in the port of St. Croix, the turbine and diesel generators were operating in parallel in accordance with the engineer's standard operating procedures. The chief engineer should have secured the steam turbine generator, reduced the electrical load and switched the entire load to the diesel generator. When accomplished, the lube oil system would have been depressurized allowing the engineers to safely remove the strongback clamp and make the necessary replacement to the strainer baskets.

b. The chief engineer could also have removed the cup from the bottom of the duplex strainer, and knocked the securing pin out so it was in contact with the casing. Once this was accomplished, the strongback clamp on top of the strainer could have been safely removed and the strainers replaced without incident.

10. The testimony from Chief Engineer Pontarelli noted in the Findings of Fact, paragraph f. is not supported by the testimony of the other material witnesses or by the examination of the physical evidence. His testimony, as documented in this paragraph, was found to be self serving and/or his facts, most likely, distorted from posttraumatic stress. His memory may have

also been effected by his long convalescence following his life threatening injuries which included being comatose for two months.

11. Due to the conflict in testimony between the chief engineer and the third assistant engineer, it could not be positively determined if the electrician climbed to the top of the emergency escape trunk from the upper control room and failed to open the upper hatch in his attempt to get to the main deck. Most likely, the electrician became panic stricken, while climbing the ladder in the narrow constraints of the trunk which was dark and smoke filled, and aborted his attempt. This is supported by the fact that he grabbed the SCBA from the third assistant engineer shortly thereafter and ran out into the engineroom in a very agitated state leaving the third assistant engineer behind.

12. The steam turbine generator tripped off the line probably due to low lube oil pressure and the diesel generator tripped off line shortly thereafter, probably due to insufficient oxygen which was rapidly being consumed by the massive fire. As the steam turbine continued to turn due to its momentum, the lube oil continued to spray out of the duplex strainer since the lube oil pump was gear driven by the turbine. The small quantity of lube oil (910 cubic decimeters or 240.5 gallons) in the sump ran dry probably in several minutes. Once the lube oil was consumed, the major fuel for the fire was depleted. Combustible materials, such as engineering stores and insulation on electric cables continued to burn.

13. It could not be positively determined how and when the fire in the engineroom was extinguished. The CO2 system was released by the master at 1000. The failure of the crew, and shoreside personnel to ensure that all of the openings were secured prior to the release of the CO2 system may have delayed the extinguishment of the fire in upper levels of the engineroom. At 1545 on 8 October, fire fighters noticed an increase in heat on the port side of the vessel in way of the engineroom. This transfer of heat from the starboard side to the port side was probably due to Class A fires which spread to the engineroom stores area in the upper platform level and Class C fires which spread along the electrical wire runs above the turbine generator to the port side of the engineroom.

14. It can not be positively determined why the CO2 system failed to discharge when the master pulled the levers in the remote control box. Most likely, in his anxiety and concern for the personnel trapped in the engineroom, the master did not follow the explicit instructions posted on the cover of the remote control box and opened the levers in a different sequence. The failure of the instructions to be posted so they were visible with the cover open probably contributed to the momentary delay in discharging the CO2 system. This delay had no bearing on the fire fighting effort.

15. If this fire had happened at sea, the vessel would have most likely sustained much more damage and possibly more injuries and deaths since the master and his crew were limited in their ability to mount an effective fire fighting effort other than releasing the CO2 system. The master's response was severely hampered since all of the licensed engineers who were knowledgeable about the fire fighting systems had been injured or died in the fire, except the second assistant engineer. The following other factors would have contributed to greater damage and possible injuries/deaths: limited crew to engage in a fire fighting effort; failure of the crew to remotely start the fire pump in the engineroom; inoperative emergency fire pump; inability to re-inert cargo tanks once the oxygen levels rose in the tanks; lack of sufficient quantities of SCBAs; and unavailability of other vessels to assist in fire fighting efforts in a timely manner.

16. The failure of the master to remotely start from the bridge the starboard fire pump in the engineroom delayed for over one hour the ability to provide water on deck for fire fighting and cooling of the vessel. The vessel's fire pumps, foam and manual water spray fire fighting systems were never used during the incident.

17. The fire developed very rapidly and filled the upper levels of the large engineroom with smoke within seconds, thereby allowing the engineers little opportunity to escape uninjured or fight the fire. Had the vessel been equipped with an automatic water mist fire suppression system, it would have probably extinguished the fire, helped maintain a tenable atmosphere for the engineers to escape and probably prevented most, if not all, of the deaths and major injuries.

18. The air conditioning system for the control room took its air supply directly from the engineroom. As the engineroom filled up with smoke, the open ducting to the control room allowed the smoke to enter this space. The control room quickly filled up with smoke and did not provide a safe haven for the engineers.

19. Visibility in the engineroom became severely limited within seconds of the fire due to the rapid generation of smoke. The emergency generator and emergency lighting came on very shortly after the steam turbine generator tripped off the line, however, the density of smoke obscured most of the lighting. Most of the engineers reported their visibility was limited to only two or three feet at all levels in the engineroom.

20. Had the vessel been designed with escape trunks with self closing doors, emergency lighting and an outside supply of air, at every major level in the engineroom, it is probable some of the deaths and injuries would have been prevented.

21. Based on the large quantity of SCBAs and spare cylinders used by the fire brigade and other personnel in response to this

fire, there were insufficient quantities of SCBAs on board the vessel for the crew to have mounted a credible effort to fight the fire and attempt rescue efforts.

22. Atlantis Agency Corporation had placed numerous emergency escape breathing apparatus on board their vessels as part of its own safety initiative. If the emergency escape breathing apparatus in the engineroom had been located in more accessible areas in way of escape routes, it is possible some of the deaths or injuries may have been prevented, and/or some of the injuries may have been less severe. Present SOLAS rules and Coast Guard regulations do not require this equipment.

23. Had the master and chief engineer simulated more fire drills in the engineroom and had the engineers practiced using the emergency escape trunks on a frequent training schedule, it is possible some of the deaths or injuries could have been prevented, and/or some of the injuries could have been less severe.

24. Had the crew been trained in escaping from the engineroom in low level lighting conditions, it is possible some of the deaths and injuries could have been prevented and/or some of the injuries could have been less severe.

25. Had the emergency fire pump been started with its hydraulic accumulator, in addition to its electric starting system at the weekly fire drills, it is probable the crew would have found the misaligned hydraulic starter motor prior to the fire. If it had been started hydraulically during class society surveys and Coast Guard inspections, the misaligned motor (if this condition existed at the time of the survey or inspection) may have been found prior to the fire.

26. The failure of HOVIC to have an international shore connection immediately available to mate up with the vessel's shore connection delayed for about one hour the ability to provide water on deck for fire fighting and cooling of the vessel.

27. Had it become necessary to move the SEAL ISLAND away from the dock within the first 36 hours, there may have been inadequate tugs of sufficient horsepower to safely conduct this operation. Presently, there are no marine regulations which require the availability of tugs with adequate horsepower in a port area to safely move dead ships in an emergency.

28. All of the engineers in the engineroom, in their anxiety to evacuate the space went directly up using the normal means of egress (unprotected stairways/ladders) instead of the emergency escape trunks. Their actions placed them in direct contact with the flames, and the hottest areas in the upper levels of the engineroom where the smoke was the most concentrated. If the engineers had been trained to use the emergency escape trunks

during their fire drills, it is possible some of the deaths and injuries could have been prevented.

29. Atlantis Agency had a safety management system in place including the establishment of standard operating procedures, management oversights and audits which could have discovered the temporary repairs made to the duplex strainer. The chief engineer should have reported the temporary repairs to management in accordance with the standard operating procedures. He also never reported it to management personnel who visited the ship in the four months prior to the accident. The port captains and ship superintendents did not detect the temporary repairs during their cursory examinations of the engineroom. The safety consultant probably saw the strongback clamp on top of the duplex strainer but he never included it in his written report to the company. Also, Atlantis Agency reviewed the deck and engine logbooks and other reports compiled by the vessels' crews. The work logbook, however, maintained by the first assistant engineer was the only written record of the temporary repairs and had not been reviewed by management. Also, Atlantis Agency did not detect the lack of maintenance to the diesel generator by the shipboard engineers during their management oversights and audits.

30. Had their been an oil deflector between the lube oil strainer and the heated surfaces of the turbine piping and generator or if the oil strainer was installed a safe distance away from heated surfaces, this casualty may have been averted.

31. The command system employed during the response consisted of two parallel organizations (HOVIC and Atlantis Agency) headed by two incident commanders. This was not the system envisioned in HOVIC's contingency plan. For the most part, this evolved organization worked effectively coordinating the response actions. The command system they used did not reflect an incident command system with one incident commander and clear lines of authority and an effective chain of command. Without a true incident commander system for fires at the refinery, they (HOVIC and Atlantis Agency) could have reached an impasse on critical issues if a consensus could not have been reached. For example, it could have been total chaos if one commander wanted the vessel moved for the safety of the facility and the other wanted to keep the vessel at the dock to save the vessel and no agreement reached between the two commanders. Someone has to have the ultimate decision making authority so that the actions of all of the parties can be coordinated and conducted safely. This situation could have been further complicated if the vessel involved in the fire was owned by an independent company instead of Amerada Hess.

32. HOVIC's fire brigade had not received any shipboard fire fighting training or vessel familiarization prior to the casualty.

33. SEAL ISLAND's safety plan was not up to date in that it did not depict the emergency escape trunk from the engine control room and its associated hatch on the main deck; the proper number and locations of the EEBAs and SCBAs; and the 300 pound semi-portable dry chemical extinguisher which was located on the boiler platform level.

34. There was not a significant spread of fire in the accommodation house beyond the dry stores areas because it was constructed with noncombustible materials.

35. Coast Guard Marine Safety Office, San Juan, Puerto Rico did not have a firefighting contingency plan for the island of St. Croix as required by the Marine Safety Manual. If they had a plan, it may have assisted the local Coast Guard personnel in their monitoring efforts.

36. Except as noted above, there is no evidence of actionable misconduct, inattention to duty, negligence or willful violation of law or regulation on the part of licensed or documented persons, nor evidence that the use of drugs or alcohol, nor evidence that failure of inspected material or equipment, nor evidence that any personnel of the Coast Guard, or any other government agency or any other person, contributed to the casualty.

RECOMMENDATIONS

1. That the U.S. Coast Guard and Republic of Liberia review the need to amend the marine safety regulations and SOLAS rules to require an automatic water mist fire suppression system in enginerooms of oceangoing vessels.

2. That the U.S. Coast Guard and Republic of Liberia review the need to amend the marine safety regulations and SOLAS rules to require the construction of engine control rooms on vessels which provide a safe haven for the engineers with a supply of air for the ventilation/air conditioning systems from atmosphere vice directly from the engineroom, a control room of air tight construction, and/or a space under positive pressure, with fans operating off the emergency bus, that would prevent the introduction of smoke from fires in the engineroom.

3. That the U.S. Coast Guard and Republic of Liberia review the need to amend marine safety regulations and SOLAS rules to require a high intensity emergency lighting system located at deck level in enginerooms to mark the means of egress. Photoluminescent and electroluminescent systems should also be tested in smoke conditions to determine if they provide adequate lighting to mark the means of egress.

4. That the U.S. Coast Guard and Republic of Liberia review the need to amend the marine safety regulations and SOLAS rules to require escape trunks with self closing doors, emergency lighting and an external supply of air at every major level in the enginerooms of oceangoing vessels.

5. That the U.S. Coast Guard and Republic of Liberia initiate rulemaking to amend the marine safety regulations to increase the number of self contained breathing apparatus and spare cylinders required for oceangoing vessels. The U.S. Coast Guard and Republic of Liberia should propose to the International Maritime Organization (IMO) a similar amendment to the SOLAS rules.

6. That the U.S. Coast Guard and Republic of Liberia initiate rulemaking to amend the marine safety regulations to require emergency escape breathing apparatus be provided in enginerooms, pumprooms or other vessel spaces where personnel normally would be working and could be exposed to smoke or noxious fumes and located in way of escape routes. The U.S. Coast Guard and Republic of Liberia should propose to IMO a similar amendment to the SOLAS rules.

7. That the U.S. Coast Guard and Republic of Liberia initiate rulemaking to amend the marine safety regulations to require, at a minimum, monthly fire drills where the fire is simulated in the

engineroom and the crew is required to use the emergency escape trunks provided in reduced lighting conditions. The U.S. Coast Guard and Republic of Liberia should propose to IMO a similar amendment to the SOLAS rules.

8. That the U.S. Coast Guard and Republic of Liberia initiate rulemaking to amend the marine safety regulations to require the testing of emergency machinery during the weekly/monthly drills using all the starting systems available. The U.S. Coast Guard and Republic of Liberia should propose to IMO a similar amendment to the SOLAS rules.

9. That the U.S. Coast Guard and Republic of Liberia initiate rulemaking to amend marine safety regulations to require an oil deflector between the lube oil strainer and the heated surfaces of piping and equipment or require the oil strainers be installed a safe distance away from sources of ignition and heated surfaces. The U.S. Coast Guard and Republic of Liberia should propose to IMO a similar amendment to the SOLAS rules.

10. That the U.S. Coast Guard and Republic of Liberia initiate rulemaking to amend marine safety regulations to require international shore connections at marine transportation related, and designated waterfront facilities which are compatible with their fire hoses and hydrants ashore.

11. That the U.S. Coast Guard and Republic of Liberia review the need to initiate rulemaking to require marine transportation related and designated waterfront facilities to ensure tugs of adequate horsepower be provided at all times, within a minimum response time, to tow any dead ship away from a facility.

12. That guidance be provided to U.S. Coast Guard marine inspectors to test emergency machinery using all the starting systems available during their boarding examinations and inspections.

13. That Coast Guard Marine Safety Office, San Juan, Puerto Rico develop a firefighting contingency plan for St. Croix.

14. That American Bureau of Shipping review guidance to their surveyors to ensure they are instructed to test emergency machinery using all the starting systems available during their surveys.

15. That Amerada Hess survey all of its waterfront facilities and refineries and insure the availability of international shore connections so fire fighting water can be supplied from shore.

16. That Atlantis Agency Corporation and HOVIC determine tug requirements (number of tugs and horsepower) to safely move dead ships from their waterfront facilities and to insure their availability at all times.

17. That Atlantis Agency Corporation include in their fire safety training the science of fire including the concentrations of heat and noxious smoke at the upper levels of a space, and the concentration of oxygen at the lower levels of the space so their crews can make more informed decisions on how to safely escape from a burning space. Included in this training should be familiarization with normal and emergency means of egress.

18. That Atlantis Agency Corporation should consider the periodic review of the first assistant engineer's work book by management in an effort to correct its nonconformity with its ISO 9002/ISM program to detect unauthorized/improper repairs in the engineroom. Atlantis Agency Corporation should also review its management oversight so it can properly monitor if the shipboard engineers are conducting routine maintenance on its critical equipment and machinery including the diesel generator.

19. That Atlantis Agency Corporation review how the instructions are posted for the low pressure CO2 system on its two remaining VLCCs. If the instructions are on the cover, they should be relocated to the bulkhead adjacent to the remote control box so they will be visible during operation of the system.

20. That Atlantis Agency Corporation review the fire safety plans for the SAINT LUCIA, and MT. CABRITE, and update them, if necessary, to accurately reflect the safety equipment and emergency escape trunks on board these vessels.

21. That HOVIC review its fire contingency plans, resolve any discrepancies and develop an incident command system for all fire scenarios at its refinery and marine terminal. The command system should also include the integration of shoreside and vessel personnel from company owned and independent company vessels, e.g. a non-Amerada Hess vessel on fire while moored at the facility.

22. That HOVIC's fire brigade receive shipboard fire fighting training and become familiar with the general arrangements of the vessels which call at their facility.

23. That a copy of this report be sent to the American Bureau of Shipping for their information and action as they deem appropriate.

24. That a copy of this report be widely disseminated to the marine industry to remind them of the dangers of working on pressurized flammable and combustible liquid systems, and to educate them on the lessons learned from this casualty and encourage the incorporation of them in their own safety programs/initiatives.

A. REGALBUTO, Captain, U.S. Coast Guard

A. P. RITOLA, Republic of Liberia
Investigating Officer

Encl: (1) Original CG Form 2692's
(2) Autopsy and Toxicology Reports
(3) Depositions of Roberto Alado, Darwin Pedrina, Primitivo Divinagracia, and Francesco Spada dated October 17, 1994
(4) Deposition of Ariel Padasas dated October 25, 1994
(5) Depositions of Paul Louis Pedretti, Raymond Marquardt, Carmelo Spadaro, and Carmelo Cundari dated December 13, 1994
(6) Depositions of Alan E. Colletti and Joseph P. Gehegan, Jr. dated December 14, 1994
(7) Deposition of Mario Pontarelli dated March 16, 1995
(8) Continuing deposition of Mario Pontarelli and George Ireland dated March 17, 1995
(9) Depositions of Pasquale Buonarotti and Claudio Villa dated April 17, 1995
(10) Depositions of Salvino Armuzza and Natale Peligra
(11) Continued Deposition of Francesco Spada
(12) Depositions of Sune Andersson and Alan Colletti dated May 15, 1995
(13) Continuing deposition of Mario Pontarelli dated June 23, 1995
(14) Emergency Headquarters and Supplementary Gear Locker Equipment
(15) Records of Interviews
(16) Deck Log - February thru April
(16-A) Deck Log - May thru July
(16-B) Deck Log - August thru October
(17) Engine Room Logs - January thru March
(17-A) Engine Room Logs - April thru June
(17-B) Engine Room Logs - July and August
(18) Instruction Book - STAL-LAVAL (Ship Service Turbine Generator)
(19) Station Bill
(20) Exhibits Number 1 to Number 77
(21) HOVIC's Emergency Plan Summary
(22) HOVIC's Inventory of Emergency Equipment/Materials
(23) HOVIC's Fire Brigade and Incident Command Organization
(24) HOVIC's Fire Brigade Training Manual
(25) HOVIC's 1994 Fire Training Schedule
(26) HOVIC's Field Exercises
(27) ABS Surveys
(28) Reports of Shoreside Visits to S/S SEAL ISLAND
(29) ABS Certificate of Fitness to Proceed Under Tow
(30) Crew Training
(31) Crew List - October 7, 1994
(32) Copies of License of Competence to Merchant Marine Officer and Progress Reports for Tranquilli, Anzalone, Giannone, Pontarelli, Marchese, Braga, Spada and Buonarotti
(33) SEAL ISLAND Safety Training Manual
(34) Drug and Alcohol Policy

(35) Fire Fighting Procedures
(36) Soundings of Fuel and Lube Oil Tanks Before and After Accident
(37) Overtime Reports and Records
(38) Certificate of Inspection from Carib Supply
(39) Copies of First Assistant Engineer's Log Book from SEAL ISLAND Jan 17, 1994 to June 13, 1994 with English translation
(40) Supervisor, RIO St Croix' Letter dated October 31, 1994
(41) Safety Plan
(42) Statement of Times/Facts from Steve Williams
(43) SITREP One and SITREP Two regarding SEAL ISLAND
(44) Weather Observations
(45) Exxon Company International Product Health and Safety Data
(46) Various Photographs of SEAL ISLAND