UNITED STATES COAST GUARD

REPORT OF THE INVESTIGATION INTO THE CIRCUMSTANCES SURROUNDING THE ENGINE ROOM FIRE ON BOARD THE

M/V SSG EDWARD A. CARTER, JR.

WHILE MOORED AT MILITARY OCEAN TERMINAL SUNNY POINT, N.C., ON JULY 14, 2001 WITH THE LOSS OF TWO LIVES

U.S. Department of Transportation
United States Coast Guard

Commandant
United States Coast Guard

2100 Second Street, S.W.
Washington, DC 20593-0001
Staff Symbol: G-MOA
Phone: (202) 267-1430
FAX: (202) 267-1416
SSIC: 16732

SEP 30 2002

INVESTIGATION INTO THE CIRCUMSTANCES SURROUNDING THE ENGINE ROOM FIRE ON BOARD THE M/V SSG EDWARD A. CARTER, JR., OFFICIAL NUMBER 665785, WHILE MOORED AT THE MILITARY OCEAN TERMINAL, SUNNY POINT, N.C., ON JULY 14, 2001, WITH THE LOSS OF TWO LIVES.

ACTION BY THE COMMANDANT

The record and the report of the investigation of the subject casualty have been reviewed. The record and the report, including the findings of fact, conclusions, and recommendations are approved subject to the following comments.

CAUSE OF THE CASUALTY

We concur that the cause of this casualty was human error on the part of the Second Assistant Engineer in that he failed to monitor the transfer of heavy fuel oil from the port and starboard overflow tanks to the heavy fuel oil settling tank. The resulting spill of a fuel oil mixture was ignited by an undetermined source.

COMMENTS ON FINDINGS OF FACT

Finding of Fact 57: The ship's engineering and cargo hold spaces are protected by a 22,000-pound low-pressure carbon dioxide (CO_2) system manufactured by Ginge Brand & Elektronik A/S of Denmark. The Ginge Brand system was installed on board the SSG CARTER and the 11 other ECON-class vessels built for U.S. Lines in Korea during the mid-1980s. In order not to delay delivery of the vessels and cause economic hardship to U.S. Lines, U.S. Coast Guard Headquarters (G-MVI-3, Systems Survival Branch, Merchant Vessel Inspection and Documentation Division) allowed Ginge Brand more time to complete the system component testing which already was in progress by Underwriters Laboratory (UL). The Coast Guard agreed to accept the CO_2 system before all of the approval requirements were met contingent upon Ginge Brand replacing any components that failed UL testing or that were not found satisfactory by the Coast Guard. Neither Ginge Brand, nor its successor Ginge-Kerr, received UL approval for all of the system components. Therefore, the Ginge-Kerr system installed on the SSG CARTER, and its 11 sister vessels, never received system and component approval as required by 46 CFR 95.15-1(b).

Comment: We do not concur with this finding of fact. The original involvement of Commandant (G-MVI-3) was limited to review and processing of the manufacturer's request for type approval. UL listing of the Ginge Brand CO_2 system was required to form the basis of Coast Guard type approval. Commandant (G-MTH-4) and Commander, Third Coast Guard District (mmt) also were involved in the review of the CO_2 system for specific vessels. Commandant (G-MTH-4) indicated that components of the Ginge Brand CO_2 system could be installed provided that UL listing was obtained as soon as possible and that any components failing UL approval be immediately replaced with approved components. The initial acceptance of the systems installed on the various U.S. Lines vessels was completed under the authority of the cognizant Officer in Charge, Marine Inspection (OCMI). Neither the record of this investigation nor the currently remaining but incomplete type approval file at Coast Guard Headquarters provide specific details regarding initial OCMI acceptance of the Ginge Brand CO_2 system. The record includes a copy of a letter dated September 27, 1989 from Commandant (G-MVI-3) stating that the remaining outstanding component approval issues were resolved and that the Ginge-Kerr CO_2 system components were acceptable. Therefore, although the Ginge-Kerr system did not receive Coast Guard type approval, it did receive system and component approval per 46 CFR 95.15-1(b).

Finding of Fact 58: In their review of the Design, Installation, and Maintenance Manual submitted by Ginge Brand, G-MVI-3 cited several discrepancies that had to be corrected prior to final approval. One of the items listed in a March 22, 1985 letter from G-MVI-3 to Ginge Brand was to provide "simple instructions on how to discharge the CO_2 system manually in case of power failure." G-MVI-3 was concerned that during a power failure the electric solenoid valve would be inoperative, which in turn would prevent the opening of the main block valve. The UL component test files maintained by G-MVI-3 listed the results of under-voltage tests completed on this electric solenoid valve. There was no further discussion in the G-MVI-3 files regarding the installation of this electric solenoid valve in the system.

Comment: We partially concur with this finding of fact. Neither the record of this investigation nor the currently remaining but incomplete type approval file at Coast Guard Headquarters document a G-MVI-3 concern that the main block valve would be prevented from opening during a power failure. The UL under-voltage tests on the electric solenoid valve were completed satisfactorily.

Finding of Fact 59: The Coast Guard and SOLAS regulations for carbon dioxide fixed firefighting systems do not specifically prohibit the use of electric power to control the opening and closing of control and discharge valves. However, according to [a staff member in] (G-MSE-4, Lifesaving and Fire Safety Division), Coast Guard Headquarters has been applying a standard practice to prohibit the use of electric-controlled valves in their review of carbon dioxide fixed firefighting systems. [The staff member] reported that this practice was in place during the review of the Ginge-Brand system in 1985. G-MVI-3 did not direct the removal of the electric solenoid valve during their review.

Comment: We partially concur with this finding of fact. Neither the record of this investigation nor the currently remaining but incomplete type approval file at Coast Guard Headquarters document a Coast Guard Headquarters practice to prohibit the use of electric power to control the opening and closing of control and discharge valves. The currently remaining but incomplete type approval file confirms the policy in effect in the 1980's and in effect today to consider new technologies that show an equivalent level of safety.

Finding of Fact 60: The general layout plan for the CO_2 System (Ginge Drawing #12-131-A38F) reviewed by G-MVI-3 listed a 1.5" ball valve in-line with the siren to the main engine room. This ball valve is prohibited because if it were to be closed, the siren would not automatically sound when the carbon dioxide is released into the engine room in accordance with 46 CFR 95.15-30. G-MVI-3 did not direct either Ginge Brand or Sea-Land to remove this ball valve from the siren line when they completed their review of the system.

Comment: We partially concur with this finding of fact. The requirements of 46 CFR 95.15 apply to high pressure CO_2 systems. Nevertheless, 46 CFR 95.15-30 does not prohibit a stop valve in the line to the siren. This valve is a necessary safety feature that prevents CO_2 from bleeding from the CO_2 tank, through the line, and into the engine or auxiliary engine room when maintenance is performed on the siren actuation valves.

Finding of Fact 62: The low-pressure CO_2 fixed fire-fighting system can be activated locally from the CO_2 room or remotely from two control stations. One of the remote control stations is located in the Fire Control Room along the port pipe tunnel on the second deck. The second remote control station is located in the passageway of the starboard pipe tunnel. To activate the system from the Fire Control Room or starboard pipe tunnel, one of the two pony bottle cylinder valves needs to be opened before pulling the two levers on the manifold between the pony bottles. This three-step operation is above the two-step limit as defined in 46 CFR 95.15-10. No comments were made in any correspondence by G-MVI-3 to address or correct this design.

Comment: We partially concur with this finding of fact. The requirements of 46 CFR 95.15 apply to high pressure CO_2 systems, which involve a different system design than low pressure systems such as the Ginge Brand. While a two-step actuation method is simpler than a three-step process and would be preferable, there is no evidence in the record that the three-step method represents a design weakness or contributed to the casualty. There is no compelling reason to require that the systems be modified to reduce the number of steps required to release the CO_2 from the remote control stations.

COMMENTS ON CONCLUSIONS

Conclusion 15: U.S. Coast Guard Headquarters (G-MVI-3) failed to enforce their standing policy to prohibit the use of electrical power to control the operation of CO_2 discharge valves during their review of the low-pressure CO_2 system. G-MVI-3 did not order the in-line ball valve to the engine room CO_2 siren to be "locked open" or removed so as to allow automatic operation as required by the regulations. G-MVI-3 did not order any design changes to the three-step procedure to activate the CO_2 system from the remote control stations. The "acceptance" letter for the Ginge-Kerr system was issued by G-MVI-3 despite knowing about the system's dependence on electricity for normal operation, the presence of the in-line ball valve, and the three-step process to activate. At least 11 other sister vessels to the SSG CARTER may have the same type of Ginge-Kerr system as the SSG CARTER with erroneous acceptance letters issued by G-MVI-3.

Comment: We do not concur with this conclusion. See our comments on findings of fact 57, 59, 60, and 62.

COMMENTS ON RECOMMENDATIONS

Recommendation 1: That the American Bureau of Shipping review guidance and training programs provided to their surveyors to ensure they are instructed on and familiar with how to complete operational tests for fixed firefighting systems, especially the low pressure types.

Action: We concur with this recommendation. Guidance and training programs provided to surveyors for completing operational tests of fixed firefighting systems, especially low-pressure systems, will be included on the agenda for the next Alternative Compliance Program (ACP) oversight meeting.

Recommendation 2: That the U.S. Coast Guard initiate a rulemaking to the marine safety regulations which would require the ability to remotely close sideport doors which form part of the hull from a position outside the protected space during an emergency. The U.S. Coast Guard should propose a similar amendment to the SOLAS rules.

Action: We concur with the intent of this recommendation. Sideport doors and other openings that may admit air or allow extinguishing gas to escape should be capable of being closed from outside the protected space. However, 46 CFR 95.15-35, 46 CFR 97.15-17, and the International Convention for the Safety of Life at Sea (SOLAS), 1974, regulations II-2/5 and II-2/11, adequately address this issue.

Recommendation 3: Should the efforts to pursue regulations fail, Maersk Line Limited and other vessel operators with similar sideport door arrangements, should include a policy in their respective Safety Management Plans to keep the doors closed when the engineers are not receiving machinery supplies or equipment. The policy should specifically prohibit allowing these doors to remain open for ventilation purposes only.

Action: We concur with the intent of this recommendation. As indicated in the action on recommendation 2 above, adequate regulations already exist. Commandant (G-MOA) will develop and distribute a safety alert on this issue.

Recommendation 4: That the U.S. Coast Guard initiate a 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 simulate activating the fixed firefighting system. The U.S. Coast Guard should propose a similar amendment to the SOLAS rules.

Action: We concur with the intent of this recommendation. Existing requirements are sufficient to address this issue. 46 CFR 199.180(f) requires fire drills to be held monthly and that they be planned with consideration of the various emergencies that may occur for the type of vessel and its cargo. 46 CFR 199.180(g) requires the crew to be instructed in the use of the vessel's fire-extinguishing appliances. In addition to similar requirements under SOLAS regulation III/19, the 2000 amendments to SOLAS add a requirement under regulation II-2/15 for the vessel's training manual to include an explanation of the operation and use of firefighting systems and appliances. To facilitate compliance with these requirements, we will coordinate with Training Center Yorktown to have the CG-840 inspection books updated to assist inspectors in checking these items.

Recommendation 5: That the U.S. Coast Guard initiate a rulemaking to the marine safety regulations that would require a position indicating device to readily determine if the main stop valve on a low-pressure CO_2 tank is open or closed. The U.S. Coast Guard should propose a similar amendment to the SOLAS rules.

Action: We concur with the intent of this recommendation. While we agree that additional guidance on the design and installation of low pressure CO_2 fire-extinguishing systems is needed, we do not believe that a regulatory change is the best approach. The current Coast Guard regulations for CO_2 extinguishing systems are based on a high pressure system. Additional guidance is provided in Navigation and Vessel Inspection Circular (NVIC) 6-72, which is currently under review. Guidance on low pressure CO_2 systems, including the tank shut-off valves, will be included as part of the next revision to NVIC 6-72.

Recommendation 10: That Commandant (G-MOC-2 and G-MSE-4) work together to determine which ships still have the Ginge-Kerr low-pressure CO_2 system and notify the owners of the potential problems associated with the failure of the main block valve to open in case of power failure. G-MSE-4 should review and approve all design and operation plan modifications to include removal of the electric solenoid valve. Additionally, G-MSE-4 should review and approve modifications to reduce the number of steps (from three to two) needed to release CO_2 from the remote control stations. During the interim, G-MOC-2 should inform the owners, as well as ABS surveyors and USCG marine inspectors, on the importance of ensuring the crews on ships fitted with a Ginge-Kerr system know how to operate the bypass valve in case of power failure.

Action: We partially concur with this recommendation. A safety alert was published in March 2002 alerting owners and operators of vessels with the Ginge-Kerr type and other similar fire extinquishing systems of the potential problems associated with the loss of electrical power. This safety alert also has been placed in the Marine Information for Safety and Law Enforcement (MISLE) system for easy access by Coast Guard personnel. Additionally, a search was completed to identify other ships that might have such a system installed. As a result, Maersk Lines and U.S. Ship Management Co., owners of vessels known to have Ginge-Kerr low pressure CO_2 systems, have been notified to replace the electric controls with controls not requiring electric power, and have agreed to do so. With respect to the review and approval of any modifications to systems installed on vessels, the safety alert provided guidance to the owners and operators to contact system technical representatives to determine the types of modifications necessary to ensure that normal CO_2 release procedures can be accomplished without electrical power and to initiate Flag State and classification society approval for any modifications to be made. There is no compelling reason to require that the systems be modified to reduce the number of steps required to release the CO_2 from the remote control stations. For U.S. vessels, system modifications are normally reviewed and approved by the Marine Safety Center, or in special cases by Commandant (G-MSE-4). In two recent cases involving modifications of the Ginge-Kerr low pressure CO_2 systems on two vessels, the review and approval was completed by Commandant (G-MSE-4). The safety alert has informed the owners, as well as ABS surveyors and USCG marine inspectors, on the importance of ensuring the crews on ships fitted with a Ginge-Kerr system know how to operate the bypass valve in case of power failure.

Recommendation 11: That Maersk Line Limited amend their shipboard familiarization program to be consistent with the guidance set forth by STCW 95, Section A-VI/1.

Action: We concur with this recommendation. A copy of this report will be forwarded to Maersk Line Limited for appropriate action.

Recommendation 12: That a copy of this investigative report be provided to the following organizations: Military Sealift Command, Military Ocean Terminal Sunny Point, Maersk Line Limited, American Bureau of Shipping, International Maritime Organization, U.S. Coast Guard Marine Safety Office Wilmington, NC, and the estates of Mr. Paul Powell and Mr. Horace Beasley.

Action: We concur with this recommendation. Copies of this report will be provided as recommended.

Recommendation 13: That this investigation be closed.

Action: We concur with this recommendation. This investigation is closed.

W. D. Rabe

W. D. RABE
By direction

16732
MAY 7 2002

SECOND ENDORSEMENT on Investigating Officer's ltr 16732 of 08 April 2002

From: L. J. BOWLING
CGD FIVE (m)
To: COMDT (G-MOA)

Subj: FORMAL INVESTIGATION INTO THE CIRCUMSTANCES SURROUNDING THE ENGINE ROOM FIRE ON BOARD THE M/V SSG EDWARD A. CARTER, JR., O.N. D665785, WHILE MOORED AT THE MILITARY OCEAN TERMINAL, SUNNY POINT (MOTSU), N.C., ON JULY 14, 2001, WITH THE LOSS OF TWO LIVES.

1. Approved, subject to the following comments.

2. I concur with recommendations 1 and 2.

3. I partially concur with recommendation 3. I believe it is impractical to not allow the opening of the sideport doors solely for ventilation purposes. The engine room can be a very "inhospitable" work environment at times and opening the doors to allow fresh air in can help alleviate the situation – and it can be done safely. Instead, I recommend both the Safety Management Plan and the Station Bill be amended to assign a member of the engineering department the responsibility of ensuring the doors are closed during emergency response situations. In addition, I also recommend the Oil Transfer Procedures be amended to require the doors be closed during fuel oil transfer operations in order to strengthen fire boundaries around the engine room in the event of a fire.

4. I concur with recommendation 4. The crew's inability to effectively respond to the fire was due mainly to a lack of familiarization with the ship and its firefighting system/equipment. At a minimum, Commandant should amend NVIC 6-91 to require monthly engine room fire drills <u>and</u> simulated activation of the fixed firefighting system. Special emphasis should be placed on proficiency in operation/activation of Low Pressure CO2 systems.

5. I concur with recommendation 5.

6. I concur with recommendations 6 and 7. I note that MOTSU has already taken action on both of these recommendations.

7. I concur with recommendations 8 and 9. MSO Wilmington shall initiate an investigation to determine if suspension and revocation proceedings and/or civil penalty action is appropriate. I have also considered other possible enforcement options under Title 18, but have determined they would not be appropriate in this case.

8. I concur with recommendation 10. It is paramount that Commandant identifies U.S. vessels that have the same Ginge-Kerr system and initiate corrective action. Commandant (G-MSE) has

already been in communication with Maersk Lines regarding several affected vessels in their fleet. In addition, Commandant should notify the foreign owners/operators of any former U.S. flag vessels that have the same system onboard. Also, in light of the importance of the firefighting system and the potential adverse results that could arise if the system fails, Commandant should establish and enforce a formal written policy on the use of electrical solenoid valves.

9. I concur with recommendation 11.

10. I concur with recommendation 12. I further recommend that release of the investigative report be coordinated to allow both the Parties in Interest and the next of kin for Paul C. Powell and Horace C. Beasley sufficient time to review the report before making it available to the general public.

11. I recommend this investigation be closed.

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16732/MC01009305
April 10, 2002

FIRST ENDORSEMENT on Formal Investigation 16732/MC01009305 dtd 08 APR 2002

From: CAPT W. C. Bennett
Commanding Officer, Marine Safety Office Wilmington, NC
To: Commandant (G-MOA)
Thru: Commander, Fifth Coast Guard District

Subj: M/V SSG EDWARD A. CARTER, JR., O.N. D665785, ENGINE ROOM FIRE WHILE MOORED AT THE MILITARY OCEAN TERMINAL, SUNNY POINT (MOTSU), N.C., ON JULY 14, 2001, WITH THE LOSS OF TWO LIVES

1. This investigation is forwarded recommending approval.

2. Recommendation 1 requires action by the American Bureau of Shipping under the direction of Commandant (G-MOC) who oversees the Alternate Compliance Program.

3. Recommendation 2 requires action by Commandant. Although the low-pressure CO_2 system failed to activate during this casualty, the Investigating Officer has clearly shown that if it had been activated its effectiveness would have been diminished due to the large sideport openings in the hull. The intent of this recommendation is in keeping with existing U.S. and international regulations which require certain watertight doors to be closed from remote locations outside the protected space.

4. Maersk Line Limited has already taken action on Recommendation 3 as observed during the return visit of the SSG CARTER to MOTSU on 15 February 2002.

5. Recommendations 4 and 5 require action by Commandant.

6. Action on Recommendation 6 was completed when the fire department at MOTSU obtained a thermal imaging camera late last year.

7. Action on Recommendation 7 was initiated by my letter dated February 26, 2002, to MOTSU's Commander informing him of the need to improve the response time of the fire tug. MOTSU has enhanced their crew recall procedures so that a fire tug will available to respond to a vessel fire within one hour of notification from the fire department. The Southern Coastal North Carolina Marine Firefighting Contingency Plan will be updated to include this change in response time.

8. I concur with Recommendations 8 and 9. I am prepared to initiate Suspension & Revocation and civil penalty actions as suggested.

9. Action on Recommendation 10 has been partially fulfilled by the Safety Alert which was provided to the marine industry by Commandant (G-MOA) last month. The Safety Alert described the potential problems associated with the electric operation of the main block valve and discussed alternatives in case of power failure. To date, Commandant (G-MSE) has only approved design modifications to the Ginge-Kerr system made onboard the SSG

CARTER. No action has been taken by Commandant to determine which other U.S. vessels have the same type of Ginge-Kerr system and initiate the necessary design modifications as suggested. Also, no action has been taken by Commandant (G-MOC) to post a special notice in the MISLE database files for those vessels fitted with the Ginge-Kerr system.

10. Recommendation 11 is a change that Maersk Line Limited will have to complete to improve their shipboard familiarization program.

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INVESTIGATION INTO THE CIRCUMSTANCES SURROUNDING THE ENGINE ROOM FIRE ON BOARD THE

M/V SSG EDWARD A. CARTER, JR.

ON JULY 14, 2001 WHILE MOORED AT THE MILITARY OCEAN TERMINAL, SUNNY POINT WITH MULTIPLE LOSS OF LIFE

EXECUTIVE SUMMARY

At approximately 1602 on 14 July 2001, a fire started on board the container ship SSG EDWARD A. CARTER, JR. (ex-SEALAND OREGON) while the vessel was moored starboard side at the south wharf of the Military Ocean Terminal, Sunny Point in Southport, NC. At the time of the fire, the SSG EDWARD A. CARTER, JR. was loaded with approximately 5 million pounds of Class 1 explosive cargoes in support of Military Sealift Command operations. Since the fire occurred on a Saturday afternoon, the explosive cargo was not being handled. Eighteen of the vessel's crew were on board when the fire started.

At approximately 1530 on 14 July, the Second Assistant Engineer started a transfer of heavy fuel oil (HFO) from tanks within the engine room. The HFO transfer was left unsupervised and eventually overfilled the HFO settling tank before filling up the HFO vent piping. The HFO proceeded along the common vent piping and entered the main engine mixing tank which contained diesel oil. The HFO mixed with the diesel fuel oil and the mixture was forced up through two disconnected vent lines on the 01 level of the machinery casing (fidley). The diesel oil and HFO mixture spilled onto the 01 level and covered the solid deck plating. Eventually the diesel fuel oil cascaded over the 01 level deck coaming and made contact with the hot auxiliary boiler exhaust stack located several feet away. The exact ignition source was not conclusively determined but the auxiliary boiler exhaust stack was considered the most likely source to flash the diesel oil mixture into a fire.

The fire developed quickly and spread intense flame, heat, and smoke throughout the aft levels of the engine room and inside the fidley as the diesel and heavy fuel oil mixture cascaded down from the 01 level and second deck. One of the engine crew members made an initial attempt to fight the fire in the vicinity of the auxiliary boiler, on the third platform level, with a portable extinguisher but was unable to extinguish all the flames due to the amount of burning fuel "raining" down from above. The ship's crew was unsuccessful in controlling the fire and failed in their two attempts to activate the low-pressure carbon dioxide system protecting the engine room space.

The Third Assistant Engineer and Wiper died as a result of the fire. The Third Assistant Engineer's body was found on the 03 level inside the fidley approximately twelve feet from the fire door that leads to the galley spaces. He died from smoke inhalation while attempting to escape from inside the fidley. The Wiper drowned in the Cape Fear River after jumping overboard from the opened port sideport door on the third platform level within the engine room. One crew member made an attempt to rescue the Wiper by tossing two life rings overboard but the Wiper's inability to swim or tread water prevented him from reaching either life ring.

At approximately 1610, firefighters from the Military Ocean Terminal, Sunny Point (MOTSU) fire department arrived at the wharf to assist with the fire response. Approximately 150 firefighters from 30 surrounding county and city fire departments responded to provide personnel support and equipment to fight the fire. Their combined efforts successfully contained the fire to the aft sections of the engine room which prevented the heat and fire from spreading forward and affecting the explosive cargo located forward of the engine room. The fire was brought under control within six hours after it had started and was completely extinguished after nine and a half hours.

Total damage to the ship was estimated to be $15 million. After the explosive cargo was offloaded, the ship was dead-ship towed to Norshipco Shipyard in Norfolk, VA to make the repairs. Besides the two deaths reported above, there were no other injuries or pollution as a result of this casualty.

On 31 July 2001, a Formal Investigation was convened by order of the Commander, Fifth Coast Guard District. Formal proceedings were held in Wilmington, NC over the course of ten days at the direction of the Investigating Officer. Testimony was received from twenty-six witnesses to include the following:

- A Port Engineer and previously assigned Chief Engineer with Maersk Line Limited;
- Two ABS surveyors who completed Alternate Compliance Program exam in June, 2001;
- The USCG marine inspector who completed last Certificate of Inspection in June, 2001;
- Eight crew members on board at the time of fire;
- The USCG Investigating Officer and Alcohol, Tobacco, & Firearms agent assigned to complete the preliminary investigation;
- A mechanical engineer from the USCG Marine Safety Center;
- A chemist from USCG Marine Safety Lab;
- The previous Chief Engineer who served on board when vessel owned by Sea-Land Inc.;
- Three service company representatives who serviced low-pressure CO_2 system;
- A representative from electronic control system company;
- A commercial marine firefighting school instructor;
- The first MOTSU firefighter to respond to scene;
- Two coroners who completed autopsies on the deceased crewmen.

The proceedings included testimony from these witnesses along with the entry of 80 exhibits into evidence. Seven "Parties in Interest" were designated by the Investigating Officer as follows: Maersk Line Limited (owner/operator); Master; Chief Engineer; First Assistant Engineer; Second Assistant Engineer; widow of Third Assistant Engineer; and father of Third Assistant Engineer. The two parties representing the Third Assistant Engineer were present because his estate was not settled at the time the proceedings commenced.

U.S. Department of Transportation
United States Coast Guard

Commanding Officer
United States Coast Guard
Marine Safety Office Wilmington

1502 N. 23rd Street
Wilmington, NC 28405
Phone: (910) 772-2230
Fax: (910) 772-2238

16732/MC01009350
08 April 2002

From: U.S. Coast Guard Investigating Officer
To: Commandant (G-MOA)
Via: (1) Commanding Officer, MSO Wilmington, NC
(2) Commander, Fifth Coast Guard District

Subj: M/V SSG EDWARD A. CARTER, JR., O.N. D665785, ENGINE ROOM FIRE WHILE MOORED AT THE MILITARY OCEAN TERMINAL, SUNNY POINT, N.C., ON JULY 14, 2001 WITH THE LOSS OF TWO LIVES

FINDINGS OF FACT

VESSEL DATA

Name:	SSG EDWARD A. CARTER, JR.
Official Number:	D665785
Service:	Freight (Container) Ship
Gross Tons:	42,719
Net Tons	32,284
Deadweight Tons (DWT):	58,943
Length (Overall):	939.45 feet
Breadth (molded):	105.9 feet
Depth (molded):	51.9 feet
Homeport:	Norfolk, VA
Date Built:	1985
Place Built:	Korea
Built By:	Daewoo Shipyard (Hull 4007)
Owner:	Maersk Line Limited Suite 400 120 Corporate Blvd Norfolk, VA 23502-4952
Operator:	Maersk Line Limited
Propulsion:	Diesel Direct
Horsepower:	28,000
Master:	Robert A. Vranish
Classification Society:	American Bureau of Shipping (ABS)
Certificate of Inspection:	Issued 12 June 2001 by MSO Hampton Roads
Last Drydock:	25 June 2001 (Norshipco Shipyard)

16732/MC01009350
08 April 2002

RECORD OF DECEASED

Name:	Paul C. Powell
License/MMD:	Third Assistant Engineer of Any Horsepower Serial # 825705; MMD # 166-62-4703
Age:	35
Home Address:	
Position on Vessel:	Third Assistant Engineer

****

Name:	Horace C. Beasley
MMD:	Ordinary Seaman/Wiper MMD # 156-48-6617
Age:	44
Home Address:	
Position on Vessel:	Wiper

Narrative Description

1. The SSG EDWARD A. CARTER, JR. (hereafter referred to as the SSG CARTER) is one of five containerships chartered by the Military Sealift Command to transport explosive cargo as part of their Prepositioning Program for the U.S. Army. The vessel changed ownership from U.S. Ship Management to Maersk Line Limited (hereafter referred to as Maersk) on February 28, 2001. During the most recent drydock in June, 2001, the ship was converted to carry containerized ammunitions. Additionally, four new electro-hydraulic pedestal cranes were installed along with large cocoons to cover four container holds to control the atmosphere (dehumidified air). The ship is designed to carry 2,129 40-foot containers on deck and within 17 cargo holds. The ship was one of twelve ECON-class ships originally built for U.S Lines to run the Pacific Ocean trade during the mid to late 1980s. The ship was subsequently sold to Sea-Land, Inc and U.S. Ship Management to operate container traffic around the world.

2. At the time of the fire, the ship was loaded with 1,212 containers holding a total net explosive weight (NEW) of 5 million pounds. The vessel was to complete loading Class 1 explosives before departing the south wharf of the Military Ocean Terminal, Sunny Point (MOTSU) at the end of July. The vessel's intended destination was the island of Diego Garcia in the Indian Ocean to fulfill a multi-year contract. The cargo stowed on board was located in cargo holds #1 through #16. Cargo hold #17, which is located immediately forward of the engine room, was empty. Cargo hold #19 is located aft of the engine room and was used to store paint (for delivery to another ship in the prepositioning fleet) and miscellaneous supplies. Cargo hold #19 is protected by the vessel's low-pressure CO_2 fixed firefighting system.

Weather Conditions

3. The weather on 14 July was clear with an air temperature of 75 degrees Fahrenheit and winds

from the southwest at 5 knots. The Cape Fear River current was slack and the tidal height was 3.8 feet in the vicinity of MOTSU at 1600. The water temperature was 72 degrees Fahrenheit.

Vessel Layout

4. The ship has two decks that extend the entire length of the ship; the main deck and the second deck. Above the main deck are seven levels that extend up through the main engine casing (fidley) and accommodations (house) structure. Below the second deck in the engine room space are five levels that extend down to the baseline. Figure 1 is a profile of the various decks and levels between frames 0-58. The schematic also shows the location of the sideport doors and the HFO service, settling and overflow tanks. Each frame is separated by 4.5 feet.

5. The accommodations area and navigation bridge are located aft of amidships immediately above the engine room space. Primary access to the engine room is via doors and ladders on the port and starboard sides of the main deck and second deck. A separate door and ladder leading to the aft section of the main engine room is located on the second deck. Secondary access (inport only) was through one of two large sideport doors located on the port and starboard sides of the hull at frame 47 on the third platform level. The height of these sideport doors above the design waterline is 13.5 feet. A small elevator provides access from all the accommodations levels to the port side entrance to the main engine room.

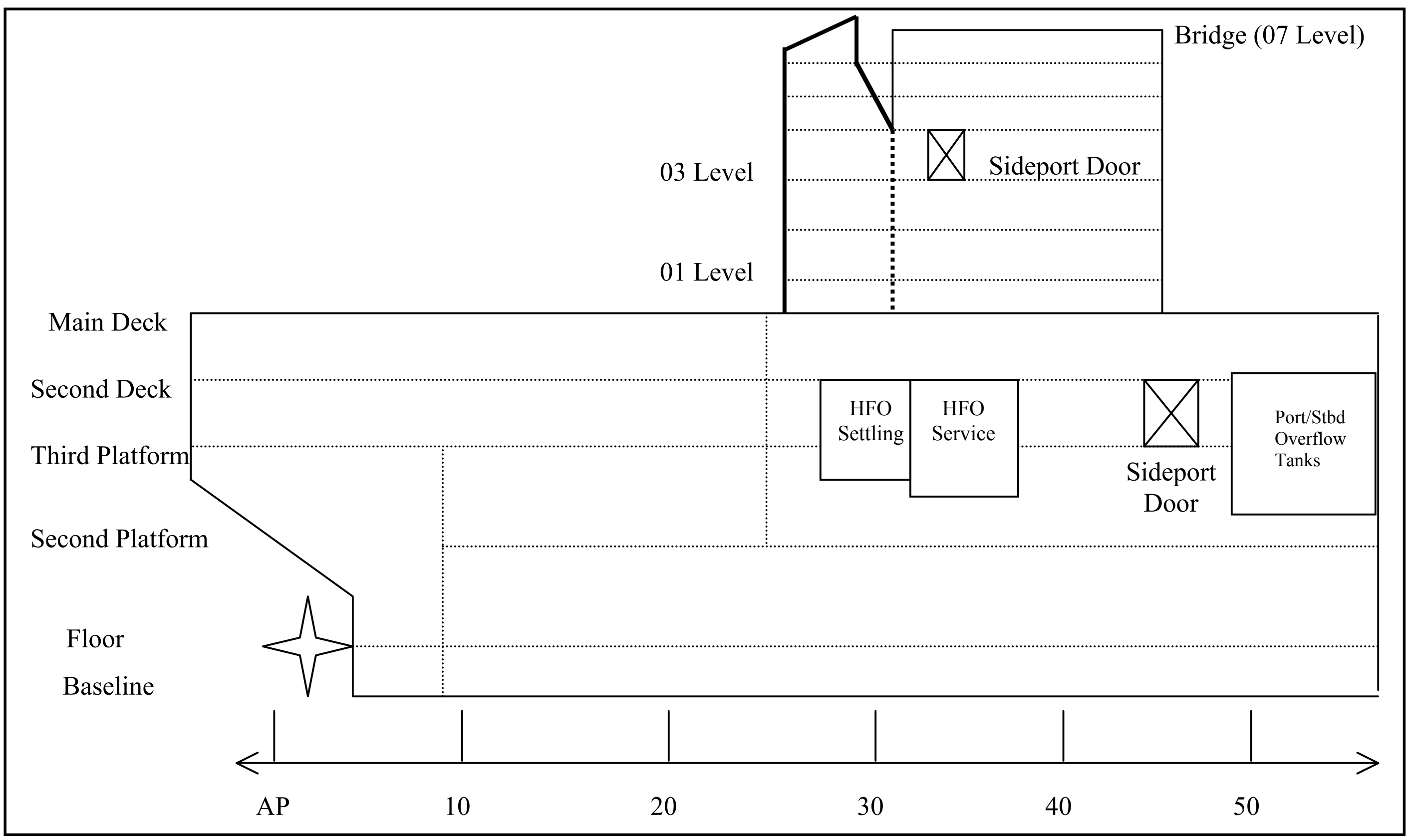


Figure 1: Profile View of the After End of the Vessel (Frames 0-58)

6. The center of the engine room is open between the third platform level and the main deck. The open area allows for the hoisting of machinery or other parts of the engine room equipment from various levels. In the forward section of the engine room is a grated elevated walkway that extends from the port and starboard pipe tunnels on the second deck. The port and starboard pipe tunnels extend for 720 feet (frames 25-185) to provide access to various piping and electrical equipment. The only entrances to the port and starboard pipe tunnels are through watertight doors located at frame 25 on the second deck. Along the aft section of the main engine room is the fidley that extends from the main deck up to the funnel top located above the bridge (07 level).

Human Factors

7. The vessel's Certificate of Inspection requires the SSG CARTER to have at least 20 crew members on board. The engine room is considered minimally attended because the vessel is fitted with automated control and monitoring of the machinery systems as described in 46 CFR Part 62.50-20. Six of the vessel's crew reported on board the vessel on or after 15 June while the vessel was moored at MOTSU. Four of these six were licensed officers, including the Chief Mate, the Chief Engineer, the First Assistant Engineer, and the Third Assistant Engineer. All the crewmembers held the proper Coast Guard and International credentials to fulfill their assignments.

8. The deceased Wiper, Horace Beasley, completed basic safety training as required by the International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers, 1978, as amended in 1995 (STCW 95), on 08 October 1999 at the Maritime Institute of Technology & Graduate Studies (MITAGS). As part of the basic safety training, the Wiper had to demonstrate the ability to safely jump from a height of at least one meter into the water while wearing a lifejacket and keep afloat for one minute without wearing a lifejacket.

9. The Master, Robert Vranish, assumed his duties on 10 June 2001 just prior to the ship's departure from Norfolk Shipyard (Norshipco). He has held a Coast Guard license to serve as a Master since 1990 and has sailed with Maersk for 17 years. He has spent time sailing as the Master on board a variety of ships, including sister vessels to the SSG CARTER within Maersk's Military Prepositioning Program.

10. None of the licensed engineers had ever served on an ECON-class vessel like the SSG CARTER prior to this casualty.

11. The Chief Engineer, Louis Champa, Sr. has worked for Maersk during the past two years serving on board a gas-turbine ship. The majority of his 20-year career has been served on board machinery plants powered by heavy fuel oil.

12. The First Assistant Engineer, George Howard, has served with Louis Champa previously on two vessels. Although he holds a license to sail as Chief Engineer, he has only done it twice since 1987.

13. Of all the licensed engineering officers, the Second Assistant Engineer, Peter Donat, had the most experience with the plant on the SSG CARTER since he had served on board continuously since late February, 2001.

14. The deceased Third Assistant Engineer, Paul Powell, was previously assigned to a gas-turbine ship while working for Maersk. He received the initial issue of his Coast Guard license in June, 1999.

15. The Wiper, Horace Beasley reported on board the SSG CARTER on 16 May, 2001.

16. During the watch that ended with this casualty, the vessel was manned with the following engineering personnel assigned to the duties listed:

    Chief Engineer – Louis Champa, Sr.; non-watchstander
    First Assistant Engineer – George Howard; watchstander
    Second Assistant Engineer – Peter Donat; dayworker
    Third Assistant Engineer - Paul Powell; dayworker
    Electrician – Donald Hastings; dayworker
    QMED – not filled
    Wiper – Horace Beasley; dayworker

17. Nine days prior to the casualty, the QMED, Bobby Taylor, was discharged from the vessel due to a sprained ankle. His replacement had yet to report on board. According to the SSG CARTER's Station Bill, the QMED is assigned the duty to set fire boundaries.

Safety Management Plan Requirements

18. Maersk has an established fleet-wide shipboard familiarization training program for all crew members assigned to their ships to fulfill the requirements of the STCW Code, Section A-VI/1. According to the company's Safety Management Plan, the Master is responsible for ensuring that newly assigned crew members, or those serving in assigned positions for the first time, receive this on board familiarization training. The training is divided into two categories: 1) those that need to be completed before the ship sails and, 2) other miscellaneous checks. The mandatory pre-sail items include review of abandon ship station and duties, location of personal floatation devices, and location of fire station and duties. The Master testified that it should take no longer than two hours to complete the pre-sail items. In addition to these required pre-sail items, the familiarization form for the licensed engineers includes a line item to review lock out and tag out procedures for the machinery equipment. The Maersk form does not include a requirement to complete familiarization training for identifying emergency escape routes as required by STCW Code, Section A-VI/1-2.

19. The vessel's Safety Management Plan states that the Chief Mate is responsible for ensuring that all of the vessel's firefighting and damage control equipment is maintained and that the crew is properly trained in its use. In addition, the Plan requires the Chief Engineer to inform the Master when any of the vessel's equipment is not maintained in good working order. The Chief Engineer is responsible for ensuring that all of the engine department personnel are

familiar with lockout/tagout procedures and they are aware of escape routes from shipboard spaces where engine personnel may be assigned to work.

20. Once a crew member completes all the required items, the Chief Mate makes a report to the Master. The Master then signs a letter documenting the dates that the familiarization items were completed. A review of the signed letters for the crew on the SSG CARTER revealed the following:

    a. All the pre-sail items for the deck department were completed on 13 June and all other miscellaneous items were signed on 21 June;
    b. All pre-sail items for the stewards department were completed on 13 June and all other miscellaneous items were completed on 19 June;
    c. All pre-sail items for the engineering department were completed on 9 June and all other miscellaneous items completed on 10 July, with exception of the First Assistant Engineer Howard;
    d. Both pre-sail and all other line items for First Assistant Engineer Howard were completed on 10 July;
    e. The completion dates for the pre-sail items for the Chief Engineer and Third Assistant Engineer preceded their reporting dates by six and nine days respectively; and
    f. There was no indoctrination letter on file for the Chief Mate who arrived on board on 2 July.

21. The Master testified that the indoctrination completion dates for the First Assistant Engineer were the same because his original letter was lost. The amount of days it took to complete the pre-sail items ranged in time from 15 days for the deck crew, 20 days for the steward department staff, and over three months for the Second Assistant Engineer and Electrician. The Master claims that all the forms for the engineers were lost and had to be redone after the ship sailed from Norfolk based on his recollection of what the previous Chief Mate told him. The Master testified that it should take about two weeks to complete all the familiarization items.

22. The Third Mate testified that the crew received training on the location of all the Emergency Escape Breathing Apparatus (EEBA) as part of the lifesaving equipment familiarization.

23. During the morning fire drill held on 14 July, everyone mustered (with exception of the Master who remained on the bridge) at repair locker #1 located inside the port pipe tunnel. The Station Bill required everyone to muster, including the Wiper, at repair locker #1 during a fire. A review of the Station Bill determined that it was consistent with the guidance set forth in Navigation and Vessel Inspection Circular 7-82 and SOLAS 74 (1983 Amendments), Chapter III, Part C, Regulation 53. Two fire hoses were charged using the emergency fire pump. The Chief Mate had everyone move to repair locker #2 located on the 03 level passageway to hold a training session. Several lectures were given on various topics to include use of portable extinguishers, confined space entry, hypothermia, and a review of the repair locker locations. No training was provided on how to activate the fixed CO_2 system or instructions on how to complete a muster. The Chief Mate testified that he informed all hands, after consulting with the Master, that they were to muster at repair locker #2 for future fire and abandon ship emergencies before they secured from the drill. The Master informed the Chief Mate to make the appropriate changes to the Station Bill. The change was not made

on the Station Bill before the fire.

Post-Casualty Drug Testing

24. Post-casualty drug testing was completed for the Master, Chief Engineer, First Assistant Engineer, Second Assistant Engineer, and Electrician at Dosher Memorial Hospital in Southport, NC. All tests were negative. It was not possible to take blood or urine samples from the deceased due to the extent of burns on the Third Assistant Engineer and the advanced state of decomposition for the Wiper. Alcohol testing was not completed on the crew due to their prolonged involvement in the firefighting efforts. Preliminary interviews conducted on all crew members during the latter stages of the firefighting effort revealed that no individuals were or had been consuming alcohol on the day of the fire.

Norshipco Shipyard Period – Surveys and Exams

25. Maersk purchased the SSG CARTER in late February, 2001 from Sea-Land, Inc. The ship was subsequently brought to Norfolk Shipyard Company (Norshipco) facility in Norfolk, VA to complete a drydock, renew its hull and machinery classification certificates and Certificate of Inspection, and upgrade its cargo handling equipment. The upgrades included installation of four new self-unloading container cranes and large neoprene cocoons on the main deck to maintain a dehumidified atmosphere in four cargo holds (numbers 10, 11, 14, 15).

26. A team of American Bureau of Shipping (ABS) surveyors worked from 12 March to 13 June to complete the following surveys: drydocking, tail shaft, annual hull, annual machinery, annual automation, Alternate Compliance Program, Safety Equipment, Safety Construction, International Oil Pollution Prevention, Load Line, and a special 5-year hull survey. The ship has been enrolled in the Coast Guard's Alternate Compliance Program (ACP) since 1995. Maersk had a Safety Management Plan (revision 19, dated 26 January 2001) in place for the SSG CARTER but had yet to complete any audits for issuance of a Safety Management Certificate (SMC) as part of the International Safety Management (ISM) program. The deadline for the SSG CARTER to receive its SMC is 01 July, 2002. The two ABS surveyors who completed the majority of the exams were Charlie Hughes and Mark Patricola, both from the Norshipco field office. No outstanding conditions of class were issued as a result of their surveys. The ship was issued all the proper international certificates and classification society documents for carriage of cargoes on an international route.

27. As part of the process to renew the Safety Equipment Certificate, the fire protection systems were tested and operated satisfactory. The systems tested included the newly installed smoke detection system in the cargo holds, the smoke detection system in the engine room, the fixed low-pressure CO_2 system, and the main/emergency fire pumps. The fire control plan was verified through independent confirmation of the various fire and life saving equipment throughout the vessel.

28. Surveyor Mark Patricola completed tests of the remote shutdown for the engine room ventilation fans, and tested the general alarm and the public address systems. Random tests were completed on the machinery control systems to include checks of various indicators and alarms. Based on their testimonies, neither Mark Patricola nor Charlie Hughes tested the control actuators

connected to the fuel oil quick-closing valves in the engine room. The ABS checklist for renewal of the Safety Equipment Certificate includes a line item on page 5 to test remote controls for shutting off machinery fuel supplies. This item was checked "yes" and signed by Charlie Hughes in ABS report #NN11731-A dated 25 June 2001. The ABS surveyors were not aware that the crew had repaired O-rings on the fuel quick-closing valves due to air leaks in early March.

29. As part of the ACP examination, Chief Warrant Officer (CWO) Ken Edmundson (assigned to MSO Hampton Roads) visited the vessel on 04 and 08 June. On 04 June, CWO Edmundson held a 16-minute long simulated fire drill in the ship's galley to evaluate the crew's response readiness and effectiveness. The general alarm was tested along with the emergency fire pump, which provided an effective supply of water from two separate hose stations. The emergency fire pump is rated to provide 440 gallons per minute at a pressure of 145 psi. The main fire pump is rated to provide 1,200 gallons per minute at a pressure of 145 psi. The crew mustered at repair locker #2 located on the 03 level while responding to the simulated galley fire. CWO Edmundson reported that crew was knowledgeable on how to use the fire equipment, dress out a four-person fire team and secure the ventilation and electrical power to the galley.

30. The ship's crew prepared for the drill by holding various training sessions during the week prior to the fire drill. The crew held a simulated fire drill in the crew's lounge on the 04 level. The crew mustered at the repair locker on the 03 level and led uncharged fire hoses to put out the fire. Following the fire drill, the crew received training on self-contained breathing apparatus use and confined space entry. Total time spent on the practice drill and lectures was 70 minutes.

31. A total of eight worklist items were issued by CWO Edmundson following his inspection on 04 June. Three of the worklist items were related to fire protection standards for the vessel, to include the following:

    a. no approved fire/safety plan (plan under review for approval by ABS);
    b. accommodations stairwell self-closing fire doors were not closing completely; and
    c. manual holdbacks were installed on fire doors within the accommodations spaces.

32. CWO Edmundson returned to the vessel on 08 June to clear all eight worklist items. He confirmed that Mark Patricola completed his review of the fire/safety plan and observed that the fire doors closed properly and all the manual holdbacks in the accommodations spaces were removed. The other remaining five worklist items were also cleared on 08 June. He issued a Temporary Certificate of Inspection on 12 June with no CG-835 deficiencies.

33. The ship departed Norshipco in the early morning hours of 13 June and arrived at MOTSU the following day.

Existing Problems with the Fuel Venting System

34. To prepare the ship for the drydock, all the diesel oil and heavy fuel oil (HFO) had to be removed from all of the storage and service tanks. While transferring the HFO from the service tank to a barge alongside, the barge tankerman informed the Chief Engineer at that time, Larry Gustafson, that the flow rate was below normal. Chief Gustafson confirmed the slow rate by

looking at the tank level indicator panel in the engine room control station. When Chief Gustafson opened the service tank's sounding tube (1-1/2" diameter) to gauge the fuel level, he confirmed that the service tank was under a vacuum by hearing air flow into the tube. He left the sounding tube open to complete the transfer. In addition, Chief Gustafson ordered the First Assistant Engineer at that time, Joe Serva, to clean the flame screen attached to the HFO service tank vent. Eventually, the transfer rate improved to complete the transfer. Chief Gustafson wasn't sure if the normal flow was attained as a result of keeping the sounding tube open or cleaning the flame screen. Chief Gustafson did not investigate if any other part of the HFO service tank vent arrangement was the source of the transfer problems. The crew did not inform the ABS surveyors of the problems with the fuel tank vents during any of their surveys completed between March and June, 2001.

35. The Second Assistant Engineer, Peter Donat, testified that the diesel oil service tank became overpressurized when the ship was receiving diesel oil following the drydock. The Second Assistant Engineer knew that this condition was not due to clogged flame screens because they had been either cleaned or replaced previously by the crew. In order to clear the diesel oil service tank vent line, the Second Assistant Engineer worked together with the Electrician, Donald Hastings, and the QMED, Bobby Taylor, to disassemble the intermediate fuel oil (IFO) and diesel oil (DO) vent collection chamber located on the 01 level. The IFO/DO vent collection chamber was disconnected and lowered to the deck in order to clean the rust particles that were mixed with accumulated diesel oil residue. In order to remove the rust from the diesel oil service tank vent line, the vent line was disconnected at the flange located just above the tank top. Compressed air was used to clear the diesel oil service tank vent line. This work was completed entirely by the crew while the ship was on shore power at the shipyard with no machinery operating in the engine room.

Continued Fuel Tank and Vent Problems at MOTSU

36. The engine room crew did not have any additional problems with overpressure or vacuum developing in the fuel tanks during the one-day voyage from Norfolk, VA to the Military Ocean Terminal Sunny Point (MOTSU) in Southport, NC on 13 June.

37. During the first two weeks of July, the Second Assistant Engineer noticed that the HFO settling tank developed an overpressure condition that progressively became worse. This condition was apparent during the transfers of HFO from either the port or starboard overflow tanks to the settling tank. The Second Assistant Engineer realized he needed to correct the problem when the pressure built up inside the HFO settling tank to the point where the release of pressure, upon opening the sounding tube to the HFO settling tank following a transfer, sprayed droplets of oil on his coveralls and glasses.

38. The Second Assistant Engineer discussed the overpressure situation and possible options to correct the problems with the Chief Engineer, Louis Champa, and the First Assistant Engineer, George Howard. One option discussed was to cut open the 3" HFO settling tank vent line to remove the blockage. Since the crew could not pinpoint the exact location of the blockage, they planned to cut open the vent line at several different places and use water pressure or a snake to clear the blockage. The crew had to cut into the vent line because there were no flanged

connections in the line, which could be opened to provide access. The First Assistant Engineer ordered dresser couplings to repair those sections of the vent line that would be cut.

39. The second option discussed was to disconnect the HFO vent collection chamber (a.k.a. "HFO Christmas tree") from the various vent and drain lines it serves so it could be lowered to the deck to access the vent lines for cleaning. The HFO Christmas tree is held in place by two flanged connections mounted to the starboard bulkhead on the 01 level. Once removed, the crew would have unrestricted access to the settling tank vent line so that compressed air could be used to clear the blockage. This process proved to be successful in clearing the diesel oil service tank vent in the shipyard several months earlier. With the consent of the Chief Engineer, the First Assistant Engineer ordered the Electrician, Donald Hastings, to disconnect the vent lines connected to the HFO Christmas tree on 11 July or 12 July. The Electrician worked alone to disconnect four vent line flanges and two drain line flanges that are labeled "disconnected" on Figure 2 below.

40. Also shown (on the right side of sketch) is the smaller IFO/DO vent collection chamber that was disconnected and cleaned by the crew while in the shipyard. The blank flange was found attached to the IFO/DO vent collection chamber by only one bolt. It was not determined why the crew did not secure this flange prior to the fire.

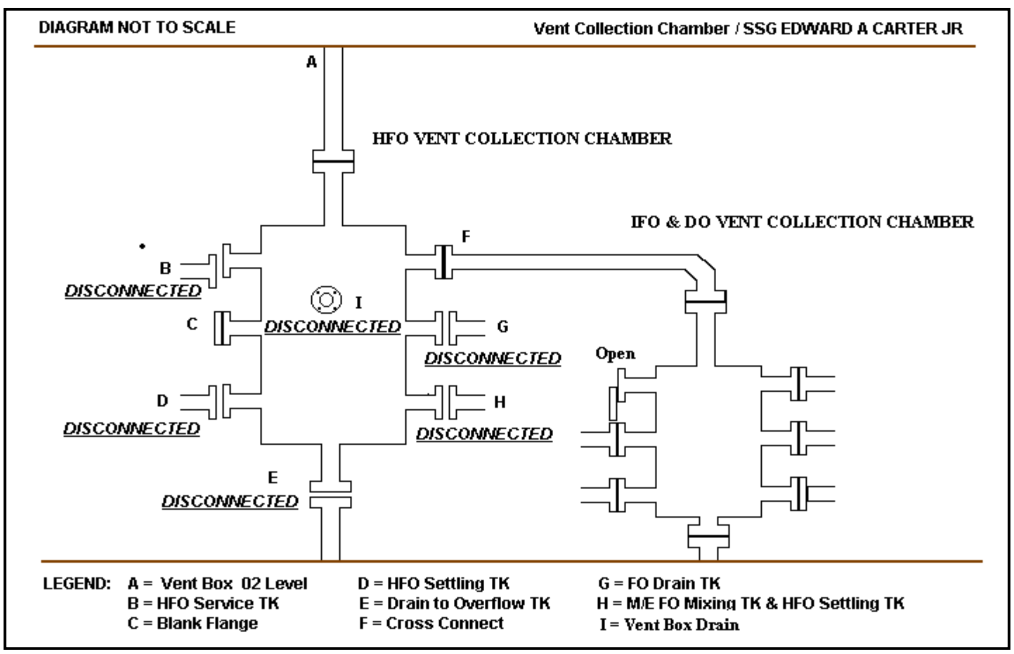


Figure 2: Schematic of HFO and IFO/DO Vent Collection Chambers

41. After disconnecting the flanges, the Second Assistant Engineer and Electrician both observed significant amounts of rust particles inside the vent lines and the HFO Christmas tree. On most of the vent lines, over 50% of the inside pipe diameter was blocked by the buildup of rust. After disconnecting the flanges, the engineers realized that the small gap between the flange openings precluded the use of compressed air to clear the blockages as performed on the diesel vent collection system. The Electrician testified that he disconnected the flanges from the HFO

Christmas tree before the engineers had traced all the vent lines to determine which tanks they served. The vent lines disconnected on the right side of the HFO Christmas tree (marked G and H in Figure 2) had yet to be traced by any of the engineers. The Electrician placed the various bolts and nuts removed from the disconnected flanges into a coffee can on the 01 level deck several feet from the HFO Christmas tree. The licensed engineers did not foresee any risks associated with keeping the vent lines open and the HFO Christmas tree disconnected while machinery was operating in the engine room. Neither the HFO transfer pump nor any of the suction or discharge valves associated with the transfer system were "tagged" out to prevent them from being operated by the engine room crew. The Chief Engineer did not inform the Master that the vent lines attached to the HFO Christmas tree were disconnected.

42. On the same day the flanges were disconnected from the HFO Christmas tree, the Chief Engineer and Electrician completed a test to determine the extent of blockage within the HFO settling tank vent line. During this test, the Second Assistant Engineer transferred approximately six tons of HFO into the settling tank while the Chief Engineer and Electrician held their hands across the disconnected flange (marked D in Figure 2). The Chief Engineer and the Electrician only felt a little vapor flow across their hands during the test. Upon securing the transfer pump, the Second Assistant Engineer opened the sounding tube cap for the HFO settling tank and felt pressure escape from the sounding tube indicating the vent line was still partially blocked. The HFO Christmas tree and the IFO/DO Christmas tree were left in the condition indicated in Figure 2 prior to the fire.

<u>HFO Transfer Operations</u>

43. The Second Assistant Engineer, Peter Donat, was responsible for transferring and accounting for all the fuels (both diesel and HFO) on board the ship. The engine room crew, including Chief Engineer Gustafson and Chief Engineer Champa, relied upon the Second Assistant Engineer to handle all the activities associated with the handling of fuel on board the ship. As part of his duties, the Second Assistant Engineer took daily soundings from the HFO settling tank, HFO service tanks and the diesel oil service tank. He completed soundings of "secondary" tanks, to include the storage and overflow tanks, once per week.

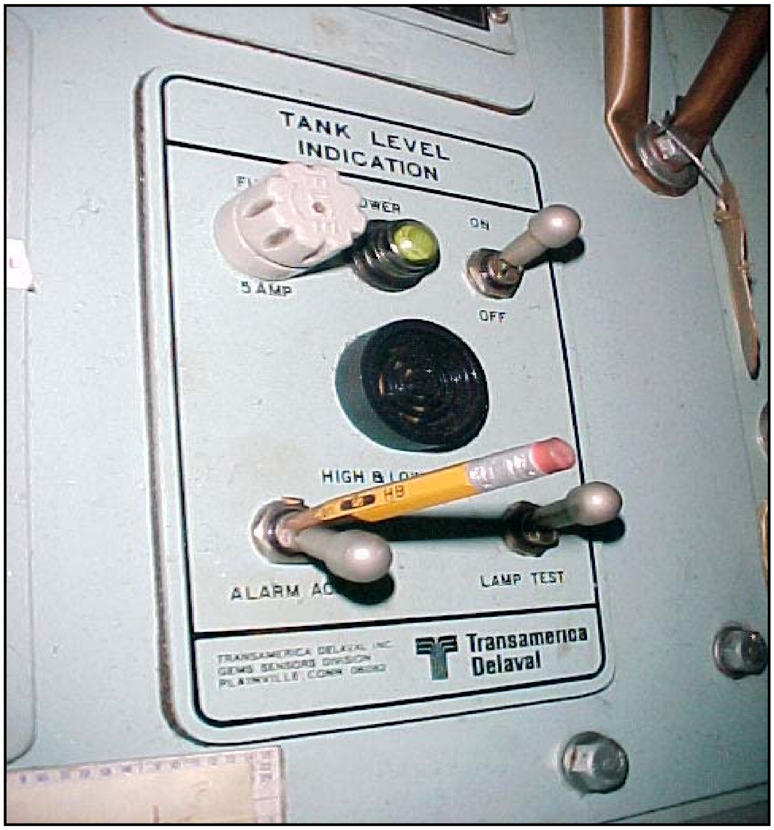
44. Under normal conditions, the port and starboard overflow tanks located at frame 50 are empty. They are designed to collect HFO in case of accidental spillover while filling any of the HFO, diesel oil, or intermediate fuel oil tanks. The port overflow tank collects liquid from any one of the port side HFO storage tanks. The starboard overflow tank collects liquid from any one of the starboard side HFO storage tanks and any overflow from the HFO, diesel oil and intermediate fuel oil service and settling tanks in the engine room. Once HFO enters either of the two overflow tanks, the only way to empty them is to transfer the fuel into the HFO settling tank via the HFO transfer pump. Inside the HFO settling tank is a series of steam coils that are used to heat the HFO to help separate any water which may have collected while in the storage tanks. The decanted water can be drained from the bottom of the HFO settling tank. Additionally, the oil from the HFO settling tank is transferred through purifiers before entering the HFO service tank (day tank). The HFO service tank can only be filled directly from the HFO settling tank.

45. The HFO transfer pump can be controlled locally in vicinity of the pump on the second platform level or from the engine control room console. The HFO transfer pump circuit breaker and automatic/manual selector switch is located in the engine control room. The Second Assistant Engineer testified that he preferred to initially start the pump from the local station and then monitor the transfers from the engine control console since pump control is within close proximity of the tank level indicators (TLIs).

46. The Second Assistant Engineer reported that HFO had entered the port and starboard overflow tanks when the First Assistant Engineer at that time, Charlie McKenna, accidentally closed a storage tank fill valve while bunkering prior to the ship's departure from Norshipco shipyard. The Second Assistant Engineer mentioned that the overfill occurred because the First Assistant Engineer mistakenly believed that the fill valve could be partially opened to control the flow. The valve was actually closed which caused the HFO to spillover into the two overflow tanks. Chief Engineer Gustafson testified that he was not aware that the First Assistant Engineer and the Second Assistant Engineer had problems during the bunkering operation.

47. Throughout the one-month period that the ship was moored at MOTSU, the Second Assistant Engineer was focused on removing the HFO from the port and starboard overflow tanks. He realized that the overflow tanks were not meant to serve as long-term storage tanks and wanted to drain them prior to the next bunkering operation. The only method to remove the oil from the overflow tanks was to transfer through the HFO transfer pump to the HFO settling tank. Transfer into the HFO settling tank could be completed automatically or manually. The automatic mode would activate the HFO transfer pump once a low level condition in the HFO settling tank was reached. Automatic control requires the transfer valves from the overflow tanks to the transfer pump, and the discharge valves from the transfer pump to the HFO settling tank to remain open. The HFO transfer pump selector switch in the engine control room would be set to the "automatic" position. The pump would automatically cycle on and off, without the crew's knowledge, based on input from a series of float-type gauges located in the HFO settling tank. A manual transfer requires the HFO transfer pump to be turned on/off.

48. Within the engine control room, there are visual and audible alarms, called the Tank Level Indicator (TLI) system, that actuate when the bilges or any liquid storage, settling, or service tank has reached a high or low level. The TLI system is connected to two different types of sensors. One type is the float-type sensor (GEMS model) that measures and displays the liquid level for various intermediate fuel oil (IFO), ballast/bilge/potable water, and miscellaneous tanks. The other type is the pressure transducer (Weschler-model) used to measure the liquid levels in the HFO and diesel oil storage, service, and settling tanks. The high and low level set points for both models are preset by the engine crew and usually remain unchanged. When a tank level is outside the preset parameters, the alarm panel gauge lights on the engine room control panel will change from yellow to red. Additionally, an audible alarm will sound within the control room and throughout the engine room space to notify the crew. Once the audible alarm is actuated, a crew member has to go to the engine control room to silence the alarm by pressing a spring-loaded toggle switch to the "acknowledge" position. Acknowledging and silencing the audible alarm does not have any effect on changing the color of the level indicator lights.



Picture 1: TLI Audible Alarm Panel in Engine Control Room
(Pencil wedged into panel to silence audible alarm)

49. The Second Assistant Engineer, Peter Donat, testified that he wedged the pencil (shown in Picture 1) in place to hold the TLI audible alarm toggle switch in the "acknowledge" position. He positioned the pencil in place several months before the fire because the TLI system was not functioning properly since the audible alarm was constantly sounding even though the tank levels were not at an alarm condition. The Second Assistant admitted that other pencils were used previously to hold the toggle switch in the "acknowledge" position. Chief Engineer Champa testified that he was not aware of any problems with the TLI system prior to the fire.

50. The Second Assistant Engineer stated that Maersk inherited problems with the TLI system when the ship was bought from U.S. Ship Management in February. Standards Calibrations, Inc. (SCI) from Chesapeake, VA, checked the TLI system while the ship was completing conversion work at Norshipco. In the SCI report dated 13 April, four of the vessel's six fuel tanks using by the GEMS-type sensors were unsatisfactory due to failed operational tests and contaminated in-tank cables and transmitters. Mr. Bill Eager (SCI) reported that the cable jackets within each of these four tanks were saturated with fuel oil. In addition, 16 out of the other 39 GEMS sensors tanks had similar problems that resulted in unsatisfactory tests. The SCI report stated that alarm problems with the GEMS system would most likely go away once the tank equipment was repaired. Mr. Eager stated that the condition of the GEMS equipment would likely send a false alarm to the TLI receiver in the engine control room. SCI submitted their report to Mr. Andy

Rabuse (Port Engineer, Maersk) in April, 2001 with a cost estimate for labor and materials of $103,000.

51. Mr. Rabuse did not complete the recommended repairs because he believed that the TLI system was working properly. He testified that he consulted with Chief Engineer Gustafson who did not report to him any problems with the TLI system. Neither Mr. Rabuse nor Chief Engineer Gustafson discussed any TLI issues with any of the other engineers. Mr. Rabuse and Chief Engineer Gustafson stated that they were not aware that the Second Assistant Engineer had placed a pencil in the "acknowledge" switch of the TLI alarm before the fire. Chief Engineer Gustafson testified that while he served onboard the SSG CARTER, he would meet daily with his engine crew in the engine control room and would expect to see the pencil in the alarm panel. Mr. Rabuse understood that the "unsatisfactory" condition reported on many of the tanks indicated that the TLI system equipment was not accurate and needed calibration. Mr. Rabuse and Chief Gustafson stated that the engine crew was not supposed to rely on the TLIs for fueling transfers. The TLI system was only to be used as a guide and not a substitution for tank soundings. Mr. Rabuse was not aware of the requirements found in 46 CFR Part 62.50-20 and SOLAS 74 (1983 Amendments), Chapter II-1, Part E, Regulation 53, that required periodically unattended engine rooms to have proper automation of machinery equipment which includes the TLI system.

52. Mr. Rabuse consulted with Mr. Dan Welch (Vice President of Engineering, Maersk) to decide that the recommended repairs from SCI were not critical and therefore did not need to be completed during the shipyard period. Mr. Rabuse testified that they agreed to correct the TLI system over a two to three year period.

53. The Second Assistant Engineer claims that he normally closes the valves at the base of each overflow tank and the HFO transfer pump discharge valve in between transfers. The closed position of these valves would prohibit true "automatic" operation of the HFO transfer system since these valves would need to be manually opened prior to each transfer. The Second Assistant Engineer testified that he handled all the fuel transfers since the rest of the engine room crew was unfamiliar with the HFO system. He refused to leave the transfer system in "automatic" because he was not confident that the HFO transfer pump would cutoff automatically once the high level was reached in the HFO settling tank.

54. The Second Assistant Engineer reported that he completed a transfer in the "automatic" mode by taking suction first from the #9B port wing storage tank and then switching to the starboard overflow tank on 12 July. A comparison of the engine room logs for 11 and 12 July indicates that the level in the HFO settling tank increased by 8 tons and the level in the service tank increased by 38 tons (taking into account the 5.5 tons consumed by machinery equipment). Therefore, approximately 46 tons were transferred from the port wing tank and the starboard overflow tank on 12 July. Following the transfer, the Second Assistant Engineer changed the HFO transfer pump selector switch from "automatic" to "manual" to avoid any accidental start-up of the transfer pump. When the selector switch is placed in the "manual" position, there are only two places to start and stop the HFO transfer pump: 1) locally at a control box adjacent to the pump; or 2) remotely from the engine control room.

55. The Second Assistant Engineer testified that he closed the HFO transfer pump discharge valve once the transfer was complete on 12 July. He stated that the port overflow tank valve was closed since he did not take any suction from this tank during the 12 July transfer. He claims that the starboard overflow tank valve, the HFO transfer manifold valve and the HFO transfer pump suction valve were the only three valves which remained open following the transfer on 12 July.

56. The Second Assistant testified that neither he nor any of the crew completed any HFO transfers after the 12 July. The engineering log does not list any HFO or diesel oil transfers between 12-14 July. The Second Assistant Engineer repeatedly denied under oath that he or anyone else was transferring any HFO on 14 July.

Low-Pressure Carbon Dioxide System History

57. The ship's engineering and cargo hold spaces are protected by a 22,000-pound low-pressure carbon dioxide (CO_2) system manufactured by Ginge Brand & Elektronik A/S of Denmark. The Ginge Brand system was installed on board the SSG CARTER and the 11 other ECON-class vessels built for U.S. Lines in Korea during the mid-1980s. In order not to delay delivery of the vessels and cause economic hardship to U.S. Lines, U.S. Coast Guard Headquarters (G-MVI-3, Systems Survival Branch, Merchant Vessel Inspection and Documentation Division) allowed Ginge Brand more time to complete the system component testing which already was in progress by Underwriters Laboratory (UL). The Coast Guard agreed to accept the CO_2 system before all of the approval requirements were met contingent upon Ginge Brand replacing any components that failed UL testing or that were not found satisfactory by the Coast Guard. Neither Ginge Brand, nor its successor Ginge-Kerr, received UL approval for all of the system components. Therefore, the Ginge-Kerr system installed on the SSG CARTER, and its 11 sister vessels, never received system and component approval as required by 46 CFR 95.15-1(b).

58. In their review of the Design, Installation, and Maintenance Manual submitted by Ginge Brand, G-MVI-3 cited several discrepancies that had to be corrected prior to final approval. One of the items listed in a March 22, 1985 letter from G-MVI-3 to Ginge Brand was to provide "simple instructions on how to discharge the CO_2 system manually in case of power failure." G-MVI-3 was concerned that during a power failure the electric solenoid valve would be inoperative, which in turn would prevent the opening of the main block valve. The UL component test files maintained by G-MVI-3 listed the results of under-voltage tests completed on this electric solenoid valve. There was no further discussion in the G-MVI-3 files regarding the installation of this electric solenoid valve in the system.

59. The Coast Guard and SOLAS regulations for carbon dioxide fixed firefighting systems do not specifically prohibit the use of electric power to control the opening or closing of control and discharge valves. However, according to [a staff member in] (G-MSE-4, Lifesaving and Fire Safety Division), Coast Guard Headquarters has been applying a standard practice to prohibit the use of electric-controlled valves in their review of carbon dioxide fixed firefighting systems. [The staff member] reported that this practice was in place during the review of the Ginge-Brand system in 1985. G-MVI-3 did not direct the removal of the electric solenoid valve during their review.

60. The general layout plan for the CO_2 System (Ginge Drawing #12-131-A38F) reviewed by G-MVI-3 listed a 1.5" ball valve in-line with the siren to the main engine room. This ball valve is prohibited because if it were to be closed, the siren would not automatically sound when the carbon dioxide is released into the engine room in accordance with 46 CFR 95.15-30. G-MVI-3 did not direct either Ginge Brand or Sea-Land to remove this ball valve from the siren line when they completed their review of the system.

61. Deliberations about the approval status of the CO_2 system resumed in 1988 when Sea-Land Service, Inc. (hereafter referred to as Sea-Land) informed G-MVI-3 that they were going to reactivate all 12 of the ECON class vessels that had been laid up by U.S. Lines. In a letter dated May 10, 1988, G-MVI-3 summarized the unfinished items that needed to be complete before the CO_2 system would be accepted. G-MVI-3 informed Sea-Land that they did not have to pursue "type-approval" since they did not manufacture the CO_2 system. However, Sea-Land had to submit a revised installation, operation, and maintenance manual that addressed all the specific comments listed in the March 22, 1985 letter and complete an internal exam of aluminum valve actuators. G-MVI-3 subsequently accepted the CO_2 system based on a satisfactory review of the revised manual and internal inspection of the aluminum valve actuators. In a letter dated September 27, 1989, G-MVI-3 informed Sea-Land that the Ginge-Kerr CO_2 system on all their 12 vessels (ECON-class) were acceptable. The electric solenoid valve and the ball valve remained in the system without any further discussion.

Low-Pressure CO_2 System Operation

62. The low-pressure CO_2 fixed firefighting system can be activated locally from the CO_2 room or remotely from two control stations. One of the remote control stations is located in the Fire Control Room along the port pipe tunnel on the second deck. The second remote control station is located in the passageway of the starboard pipe tunnel. To activate the system from the Fire Control Room or starboard pipe tunnel, one of the two pony bottle cylinder valves needs to be opened before pulling the two levers on the manifold between the pony bottles. This three-step operation is above the two-step limit as defined in 46 CFR 95.15-10. No comments were made in any correspondence by G-MVI-3 to address or correct this design.

63. Once the two levers are opened (labels 1 and 2, Figure 3), CO_2 gas from the pony bottle flows to open two pilot valves (labels A and B) located within the CO_2 room. When the two pilot valves open, CO_2 gas from the main tank flows to the 2-minute time delay before opening the two main distribution valves (combined together in label C) protecting the engine room and auxiliary machinery space. While the CO_2 gas is filling the 2-minute time delay bottle, the CO_2 siren is sounding throughout the engine room to alarm the crew to evacuate immediately. Once the distribution valve opens, an electrical signal is sent to the CO_2 instrument panel to start a timer to open the main block valve (label D).

64. Electrical power is normally supplied to the instrument panel by way of a distribution panel located just forward of the CO_2 room. Emergency power is supplied from the emergency switchboard located in the emergency generator room on the 01 level.

65. The main block valve is set to remain opened for 2.2 minutes to regulate the amount of CO_2 released to the engine room and auxiliary machinery space. This system is designed to release 91% of the total amount of CO_2 in the storage tank to the engine room and auxiliary machinery space during the 2.2 minutes. Once the 2.2 minutes have passed, the timer will cycle close the main block valve.

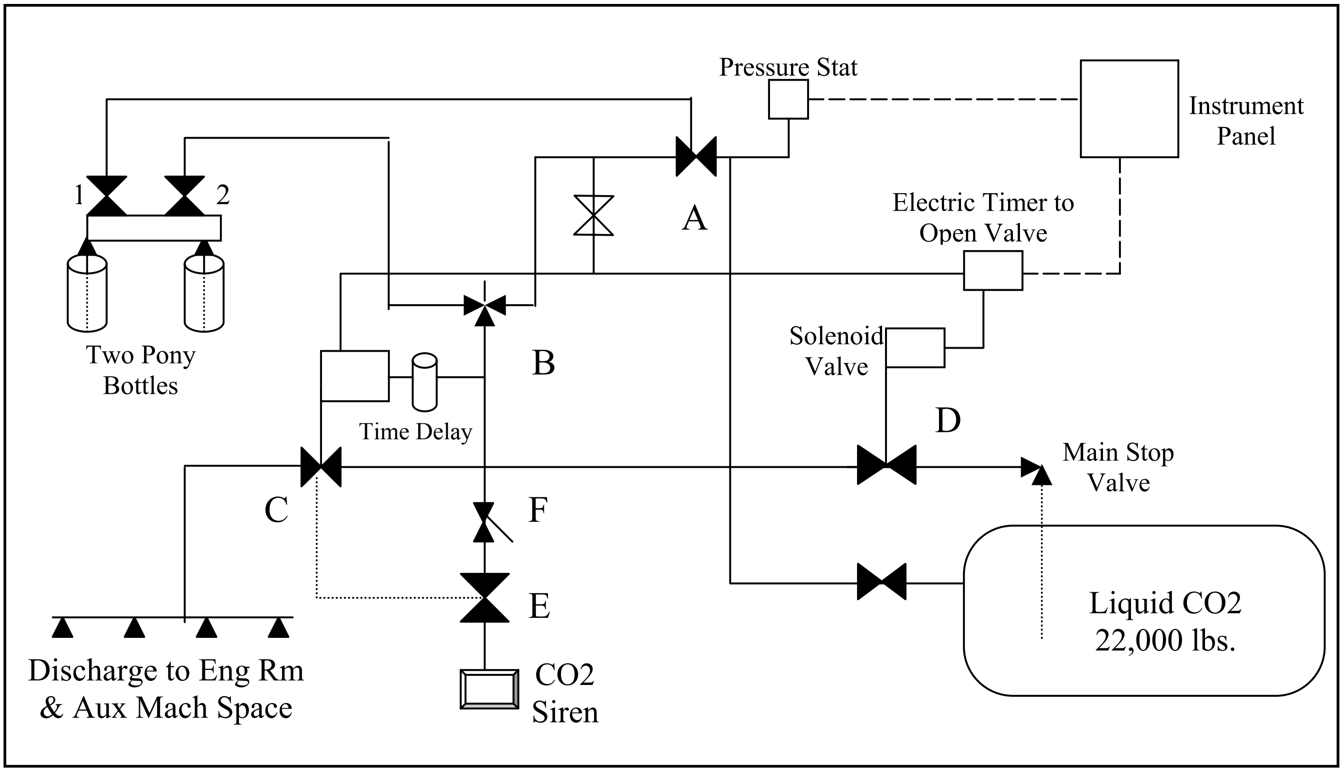


Figure 3: Simplified Drawing of Low-Pressure CO_2 System (based upon Ginge-Brand Drawing 12-131A02D-HS)

66. Mr. Stan Thompson from Fire Protection Services, Inc. (FPS) based in Houston, TX, testified that the two pneumatically-operated distribution valves (combined together in label C) will remain open following the release until the pilot valve protecting the engine room and auxiliary machinery room has been reset. However, he stated that the pneumatically operated valve for the CO_2 siren has to be manually closed with a wrench before the next release.

67. Operation of the system can also be controlled from the CO_2 room which is located adjacent to the Fire Control Room on the same deck. To release CO_2 from this space, only the two pilot valves (labels A and B) need to be opened.

68. If the system had an electrical power failure prior to release, Mr. Thompson stated that the main block valve would not open automatically. If the power failure occurred while the system was activated and the main block valve had already opened, the loss of power would immediately close the main block valve. However, the system is fitted with a manually operated bypass pilot valve that can open the main block valve during a loss of power. When this pilot valve is opened, the electric timer is bypassed which allows the main block valve to open pneumatically.

For this type of release, the amount of time the main block valve remains open, and consequently the amount of CO_2 discharged to the protected space, is controlled by the amount of time the bypass pilot valve is held open. Additionally, the main block valve and the distribution valves (Figure 3, labels A, C, D) can be opened manually through use of wrenches placed at bottom of the valve bodies. Prior to using the wrenches, the pressure in the pneumatic control lines needs to be released.

69. Mr. Thompson testified that the bypass pilot valve is located next to the instrument panel in the CO_2 room. The valve is labeled "Pilot Valve for Emergency Opening of Main Valve". Specific instructions to open this valve in case of an emergency was printed on a black placard affixed to the instrument panel.

Low-Pressure CO_2 System Testing

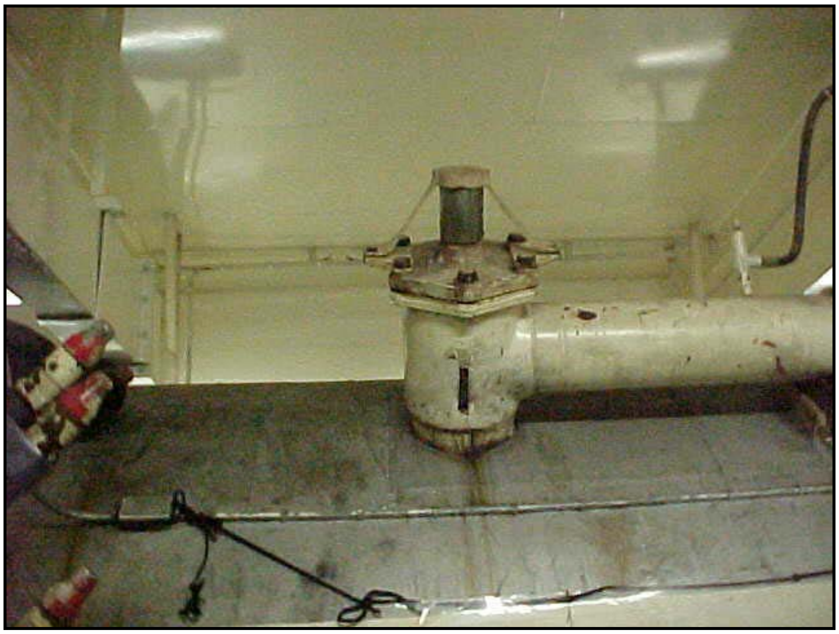
70. Representatives from FPS completed a full operational test of the CO_2 system while the vessel was in the shipyard. FPS is an ABS-authorized service provider. The CO_2 storage tank was emptied prior to this test to complete a hydrostatic test. The tank remained empty during the system operational tests. The operational tests were completed in the presence of the vessel's Master at that time, Jack Wasson, Chief Engineer Gustafson, and the ABS surveyor, Mark Patricola. Mark Patricola testified that he was satisfied the system was operational by observing the valves in the CO_2 room open and close and measuring the pre-discharge delay period. When questioned about which valves he saw open and close during the hearings, Mr. Patricola could not provide an answer. He did not observe the system tested from the remote control station located in the Fire Control Room. Mark Patricola stated that this was only the second low-pressure CO_2 system test that he had observed as a surveyor.

71. Mr. Thompson reported that the functional tests he completed demonstrated that the system was fully operational without any problems. The directional and distribution valves sequenced properly from both the remote control station and the CO_2 room. All of the discharge nozzles were confirmed to be clear of debris by the passage of compressed air through the discharge lines. The two small "pony" bottles, used to activate the system from the remote stations, were weighed to confirm that they were completely filled. Mr. Thompson reported that the two CO_2 sirens were not tested because there was no CO_2 gas in the tank used to power the sirens. Regulated CO_2 (300 psi) was used to test operation of the directional and distribution valves, pneumatic valves, and pre-discharge time delay bottles. A portable CO_2 bottle was connected to the remote station to prove operation of the two manual release valves and to ensure the pneumatic lines connected to the distribution valves were clear.

72. Mr. Thompson testified that there was a ball valve in-line with the piping that provides CO_2 gas to the siren (label F in Figure 3). Mr. Thompson observed that this ball valve was closed and had a chain and an open lock wrapped around its handle when he first arrived on board the ship in April. He did not determine how or why the ball valve was closed. Neither the ABS surveyors, nor any representatives from FPS or Norshipco required the chain to be removed nor the ball valve opened.

Placing the Carbon Dioxide System Back On-Line

73. The low-pressure CO_2 tank was refilled on 10 June. FPS was ordered by Norshipco representatives to keep the main stop valve "locked" in a closed position to prevent an accidental discharge. This "lock closed" program was in accordance with Norshipco's safety procedures for ships fitted with low-pressure CO_2 tanks while moored at their facility. Picture 2 is the main stop valve with the locking cap properly installed. One cannot tell whether the valve is in the open or closed position because it does not have a rising stem nor does it have a position indicator. The only way to check if this valve is opened is to remove the locking cap and turn the valve handle with a wrench.



Picture 2: CO_2 Tank Main Stop Valve (from sister vessel, SEALAND QUALITY)

Low-Pressure Carbon Dioxide System Maintenance

74. According to the Master's testimony, the engineering department personnel were responsible for maintaining the CO_2 system in a state of readiness. The Chief Mate, William McDonald, testified that he believed it was the duty of the Chief Engineer to maintain the readiness of the low-pressure CO_2 system. The Safety Management Plan stated that the Chief Mate was responsible for ensuring that all of the vessel's fire fighting and damage control equipment is maintained and that the crew is properly trained in its use. According to the Chief Mate, common practice on Maersk vessels is for the crew to complete training on the CO_2 system every six weeks. There was no training on use of the CO_2 system recorded in the ship's official logs from 01 June to 14 July.

75. The duty engineers were required to make at least one daily round to check on the CO_2 tank pressure to ensure the compressors were working correctly. The engineers reported no problems

with the compressors or the CO_2 tank levels prior to the fire. The duty engineers were not responsible for completing any maintenance on the valves or verifying their readiness for immediate use. The crew relied on maintenance contractors to correct any problems found with the system. The First Assistant Engineer, George Howard, testified that he was hesitant to operate any valves to verify their position because of previous accidents involving inadvertent release of CO_2 from low-pressure systems.

76. In accordance with the Station Bill, the First Assistant Engineer is assigned to activate the CO_2 system during a fire. The First Assistant Engineer had not received any training on how to activate the CO_2 system in accordance with the guidance provided in Navigation and Vessel Inspection Circular 6-91. The First Assistant Engineer did visit the Fire Control Room and CO_2 room to read the instructions posted and determine which valves had to be opened to activate the system. He was not aware of how to open the main block valve in case of power failure. He felt that his experience from serving on board other vessels with similar systems gave him the basic knowledge and confidence to carry out his responsibilities.

<u>Pre-Fire Engine Room Activities</u>

77. On 14 July, the Chief Engineer, Louis Champa Sr., secured the incinerator at approximately 1500 after burning sludge for six hours. This was the first extended test of the incinerator to see how well it burned sludge since it was installed at the Norshipco shipyard. The Chief Engineer reported no problems with the incinerator operation throughout the day. The Chief Engineer met with the Second Assistant Engineer at 1530 inside the engine control room on the 3rd platform level to take him to the incinerator room on the second deck level. The furnace temperature was reading 2,000 degrees Fahrenheit and the incinerator exhaust stack temperature was reading 570 degrees Fahrenheit. Both temperatures were decreasing while the incinerator was going through it's post-shutdown cool down cycle.

78. When the Chief Engineer and Second Assistant Engineer left the incinerator room at approximately 1540, they did not observe anything unusual within the engine room. There was no sign of fire or any oil leaking down from the upper levels of the fidley. The incinerator room is located on the second deck level along the starboard side, approximately 25 feet below and 25 feet forward of the HFO Christmas tree. The route taken by the Second Assistant Engineer to return toward the engine control room would have taken him past two decks directly under the HFO Christmas tree. The Chief Engineer departed the ship at 1545 to purchase some fans for the makeshift gym set up in the CO_2 room and attend church services in Southport, NC. He informed the Master that he was departing the ship.

79. At 1400, the First Assistant Engineer, George Howard, reminded the Third Assistant Engineer, Paul Powell, that the starboard exhaust fan damper had to be repaired. The First Assistant Engineer testified that the Third Assistant Engineer was familiar with what had to be done because this was previously assigned to him. The repairs involved straightening a metal rod that connects a pneumatic actuator which closes the fire damper on the starboard exhaust fan. In order to access the damper, the Third Assistant Engineer would have to climb two vertical ladders in the fidley from the 03 level to get to the exhaust fan casing platform on the 04 level.

Although he was assigned this task, none of the engineers saw the Third Assistant Engineer working on the damper before the fire.

80. During the afternoon on 14 July, the First Assistant Engineer was working on the second platform level with the Wiper, Horace Beasley, cleaning the lube oil backflush filters. At 1510, the First Assistant Engineer went to the engine control room to take his coffee break. Normal coffee break for the engineers was from 1500-1530. On the day of the fire, all the engineers, except the Chief Engineer, had met in the engine control room during the afternoon coffee break. The Wiper left the control room at about 1530 to continue cleaning the backflush lube oil filters. The backflush filters are located inside the lube oil purifier room located on the second platform level. The lube oil purifier room is an enclosed space that is located 51 feet below and 60 feet forward of the HFO Christmas tree. The First Assistant Engineer told the Wiper that he would meet up with him in the purifier room shortly.

81. The Electrician and the First Assistant Engineer remained in the engine control room after the coffee break to discuss some problems with repairing the ship's whistle. Earlier in the day, the Electrician and the Chief Engineer had been working together on repairing the forward air whistle which did not work during the morning's fire and abandon ship drills. The engine control room is located on the third platform level 40 feet below the HFO Christmas tree. The engine control room extends longitudinally with several windows facing inboard looking over the top of the main engine.

82. The Second Assistant Engineer testified that after leaving the incinerator room, he went to the machine shop that is located aft of the engine control room on the third platform level. The machine shop is an enclosed space located 40 below and 43 feet to port of the HFO Christmas tree. He was working in the machine shop making a drainpipe connection for the waste oil tank. The time when he started was approximately 1545.

83. The major pieces of machinery operating during the afternoon of 14 July were the #1 and #3 ship's service generators running on heavy fuel oil and the auxiliary boiler burning diesel fuel oil. The First Assistant Engineer testified that the fire door leading into the engine room from the elevator room on the second deck, and the four manual-operated watertight doors located in the port and starboard pipe tunnels on the second deck were open. The port and starboard sideport doors leading into the third platform level of the engine room were opened for ventilation purposes and to receive machinery supplies or equipment. During the afternoon of 14 July, no gangway was in place to allow for any access into the engine room through the starboard sideport door. Both the port and starboard sideport doors had remained opened since the ship arrived at MOTSU on 14 June. It takes one person about 30 seconds to operate the hand-powered hydraulic pump to close either of the two sideport doors.

Fire Detection and Initial Response

84. According to the engine room computer log, the fire detection alarm sounded at 1601:34 throughout the engine room and accommodation spaces alerting the crew about a fire. The First Assistant Engineer heard the alarm while sitting in the engine control room with the Electrician. The two of them went over to the smoke detection panel (located along aft end of

the engine control room) where they observed five separate zone indicator lights activated. The engine room spaces are protected by a total of twelve different zones. The smoke detection system is automatically linked into the fire alarm system. The First Assistant Engineer silenced the alarm by turning the key inserted in the smoke detection panel and pressing the alarm acknowledge button on the engine room control console.

85. The First Assistant Engineer and Electrician left the engine control room and passed through the double doors leading into generator room on the third platform level. They observed moderately thick smoke coming from the starboard side of the generator room. When they exited through the same double doors back into the main engine space, they noticed thicker black smoke and flames in the vicinity of the auxiliary boiler on the third platform level. The First Assistant Engineer testified seeing "burning heavy fuel oil the size of baseballs" coming down from directly above the auxiliary boiler in vicinity of the cascade room located on the second deck level. The cascade tank and auxiliary boiler are located at frame 29, one deck apart from each other. The First Assistant Engineer estimated that the fire enlarged four times in size during the 35-second period he was outside the engine control room. The First Assistant Engineer next entered the engine control room to call the Master in his stateroom to report the fire. The First Assistant Engineer did not provide a report on the location or extent of the fire and did not take a muster of the engine room personnel.

86. After receiving the phone call from the First Assistant Engineer, the Master, Robert Vranish, proceeded up to the bridge to energize the starboard fire pump. He turned the two toggle switches to align the arrows for the two fire pump valves (suction and discharge) on the control console and pushed the start button. The green start light for the pump began flashing but there was no indication on the gauge that the pump was providing pressure to the firemain. The Master waited on bridge for two minutes looking at the pressure gauge before departing to assist with the fire response. There is no means to start the emergency fire pump from the bridge. The Master passed down through the accommodations house and called the Military Ocean Terminal, Sunny Point (MOTSU) security from the starboard main deck gangway phone. The Master never returned back to the bridge during the response to the fire. According to the Station Bill, the Master's fire duties are to be "In Charge" and be positioned on the bridge.

87. The Second Assistant Engineer heard the fire alarm while he was working in the machine shop. He immediately went out to check and saw smoke and fire in the vicinity of auxiliary boiler on the third platform level. He observed burning material falling down from the base of the boiler which led him to believe that the auxiliary boiler diesel fuel line had ruptured.

88. The Electrician, Donald Hastings, used a portable dry chemical extinguisher to extinguish a fuel fire at the base of the auxiliary boiler. He initially thought that a broken diesel fuel line was the cause of the fire. After extinguishing the fire, he looked up overhead and noticed that the top of the electrical cable rack above him was on fire. Soon thereafter he heard a big "whoosh" sound come down from above which was followed by an increase in the density of the smoke. He next heard the First Assistant Engineer yell for everyone to evacuate the engine room. According to the Electrician, the smoke was so thick that the visibility was reduced to approximately one foot.

89. The Electrician escaped by proceeding up the starboard side ladder that leads up to the forward engine room catwalk on the second deck. He crossed the catwalk at frame 48 to enter the port pipe tunnel on the second deck where he met up with the Second Assistant Engineer. The First Assistant Engineer exited the engine room via the ladder forward of the engine control room which leads into the port pipe tunnel at frame 45. The First Assistant Engineer estimated that he entered the port pipe tunnel approximately 90 seconds from the time he first noticed the fire. The Second Assistant Engineer exited the engine room via the fire door leading into the elevator room and the port pipe tunnel on the second deck at frame 26.

Shipboard Firefighting Effort

90. After meeting with the Electrician in the port pipe tunnel, the Second Assistant Engineer attempted to access repair locker #1 (frame 43, port pipe tunnel) but was unable due to the heavy smoke. The First Assistant Engineer ordered the Electrician and Second Assistant Engineer to enter the Fire Control Room (frame 29) to stop the ventilation fans, fuel pumps, and close the emergency fuel valves. The Electrician and Second Assistant Engineer testified that they were able to hold their breath and enter the smoke-filled Fire Control Room. Once inside the room, the Electrician pushed the three red buttons to shutdown the various vital machinery equipment, to include fuel pumps and ventilation fans. He next pulled the four valve handles to pneumatically close the emergency fuel valves attached to each of the HFO and diesel oil storage and service tanks. The Electrician and Third Mate, Ted Dodson, entered the Fire Control Room several minutes later, equipped with breathing apparatus and fire suits (Dodson only) to confirm that the ventilation fans and fuel valve shutdowns had been activated.

91. The Third Mate, with the Electrician and an AB, made an attempt to enter the engine room to investigate the source and location of the fire. Each person was outfitted with a 30-minute self-contained breathing apparatus (SCBA). The team attempted to access the engine room through the fire door located in the elevator room on the second deck. The team did not use any fire hoses during their attempt. The Third Mate testified that even though he believed the fire door was closed, heavy smoke and intense heat were coming from the door. He decided that entry into the engine room at this location would not be possible due to reduced visibility and ordered the team to vacate the elevator room.

92. Once the Second Assistant Engineer returned from the Fire Control Room, the First Assistant Engineer instructed him to start the emergency diesel generator and place the emergency circuits on-line. The Second Assistant Engineer took approximately five minutes to provide a report back to First Assistant Engineer that emergency generator was running to provide power to the emergency circuits. Emergency power was provided approximately 10 minutes after the engineers first detected the fire.

93. The Chief Mate, William McDonald, heard the fire alarm while he was in his stateroom working on the crew's overtime sheets. According to the Station Bill, the Chief Mate is assigned to be "In Charge" at the scene of the fire. He immediately went down the starboard ladder to repair locker #2 on the 03 level where he told the Chief Cook and Chief Steward to dress out in fireman's outfits. The Chief Mate ordered the Second Mate, Horatio Vintila, to

take charge of the response team on the 03 level. When the Second Mate reached the 03 level passageway, approximately two minutes after hearing the fire alarm, there was lots of heavy smoke and intense heat. The Second Mate reported that smoke was seen escaping from three sides of the fire door which leads from the galley spaces into the fidley on the 03 level. According to SOLAS 74 (1983 Amendments), Chapter II-2, Part C, Regulation 47, fire doors fitted in boundary bulkheads of machinery spaces shall be reasonably gastight and self-closing.

94. The Chief Mate continued down through the accommodations stair tower to enter the Fire Control Room where he planned to remotely start the emergency fire pump (located in cargo hold #7). Upon entry, he noticed that neither the main or emergency fire pump had been operating because he did not see any of the valves or pump lights energized on the fire control panel. He told the First Assistant Engineer to get the emergency generator on-line to ensure the emergency fire pump would have a continuous power supply in case the main generators failed. The Chief Mate was unaware that the Second Assistant Engineer had already been ordered to get the emergency generator on-line by the First Assistant Engineer. The Chief Mate estimates that the emergency fire pump started about 30 seconds after making his request. He confirmed the pump was running because he saw the indicator light for the emergency fire pump energize on the fire control panel.

95. The Chief Steward, Chief Cook, and Steward Assistant got dressed out in fire suits and SCBAs and began to cool down the door leading from the 03 level into the fidley with water from two fire hoses. The Second Mate and an AB, Louis Balatbat, arrived at a later time to assist but there were no SCBAs available for them on that level. The Chief Steward-led fire team made an attempt to open the fire door leading into the fidley but the heat was too intense to make a safe approach. The Second Mate testified that he was concerned that opening door would have endangered the fire team or spread the fire. The team was not aware that anyone might have been in the fidley area while they made attempts to open door. As the smoke continued to build on the 03 level, it made it very difficult for the Second Mate and AB to breathe. The Second Mate gave the order for the team to evacuate the 03 level. The Second Mate noticed a drop in pressure on one of the fire hoses just prior to his departure. The three crewmembers from the Steward's Department remained on the 03 level to continue to cool the bulkhead for an additional 20 minutes until the Chief Cook's SCBA bottle became low on air. The stewards never entered the fidley area through the fire door on the 03 level. The Chief Steward, Chief Cook, and Steward Assistant evacuated down to the main deck to assist the rest of the crew with various firefighting efforts.

96. After evacuating the 03 level, the Second Mate and AB, Louis Balatbat, went up to the bridge (07 level) to start the starboard fire pump and access the bridge level repair locker. The Second Mate testified that he started the fire pump on the bridge by pushing the start button on the control station console. He verified the pump was running by seeing the green light energize. He said that the suction and discharge valves to the pumps were already aligned in the open position. A post-fire operational test of the starboard fire pump from the bridge on a sister vessel to the SSG CARTER, determined that the suction and discharge valve switches had to be fully turned past the indicated alignment arrows in order for the valves to open and the pump to operate. Written directions which stated, "turn valve switch past arrows to open"

was posted directly beneath the starboard fire pump controls on the SSG CARTER's bridge console.

97. The Second Mate next opened the port bridge wing fire station valve to provide water to cool the exterior of the exhaust stack and make an attempt to place water through the opened exhaust fan vent louvers. The Second Mate testified that he was unable to get the water from the fire hose into the exhaust vents but was able to cool the stack externally.

98. While cooling the stack, the Second Mate heard the First Assistant Engineer yell from the aft main deck to close the two exhaust fan fire dampers. The Second Mate attempted to close the dampers by releasing two cable handles from the pull station on the 04 level. He was unable to release the cables because the amount of smoke coming from the exhaust vents prevented a close enough approach without an SCBA. The Second Mate returned back to the starboard bridge wing with the AB to dress out in fire suits and SCBAs from the bridge repair locker.

99. Once dressed out, the Second Mate returned back to 04 level to attempt to close the two exhaust fan fire dampers. He testified that he was able to release one handle but could not find the other one due to the reduced visibility from the smoke. Further attempts were cut short because the alarm bell on his SCBA bottle began to ring indicating a low air level. Upon hearing the alarm, he left the 04 level immediately to pass up through two levels within the smoke-filled accommodations to get back to the AB on the bridge.

100. The Chief Mate emerged from the Fire Control Room and saw the Master on top of hatch #19, aft of the house, holding an uncharged 2.5" fire hose. The Chief Mate saw the Boatswain Mate make an unsuccessful effort to open the valve to supply water to the Master's fire hose. The Chief Mate directed the Boatswain to assist with getting a gangway placed from the pier through the opened starboard sideport door to assist the shoreside fire team with direct access to the engine room. The Boatswain took his radio with him to the pier. About ten minutes after the fire was detected, water was flowing through the first fire hose which was the 2.5" hose held by the Master. The Master directed the Chief Mate to take control of the hose along with an AB. He told the Chief Mate to direct water into the inboard supply vents along the starboard side of the engine room stack on the 01 and 02 levels. This was area where the Master and Chief Mate had seen flames, heavy smoke, and paint blistering on the outside of the vent louvers. The Chief Mate had a difficult time breathing due to intense smoke blowing downwind on top of him but was able to continue to pour water into the supply vents for 35-45 minutes. The Chief Mate observed an AB shooting water into the port side supply vents while standing atop a 40-foot container on top of hatch #19.

101. The Master used the Chief Mate's radio to try to contact the Second Mate on the 03 level. The Master saw the Second Mate as he passed him on his way down from the bridge. After getting no response, the Master went with the Boatswain's Mate to the main deck forward of the house to break out another fire hose to cool the main deck. He was concerned with this area because he had seen heavy smoke coming from the starboard overflow tank vent which terminates above the main deck. The main deck in this vicinity is also the starboard overflow tank top. The Master and Boatswain's Mate struggled for several minutes before opening the fire station valve to start cooling the deck.

102. Two firefighters from MOTSU fire department arrived on board at approximately 1620 and met the Master near the gangway. They attempted to get a muster and a summary of the fire response actions by the crew. The Master was not able to provide a muster because he did not have full accountability of the crew at this time. The Master asked for recommendations from the firefighters as to whether he should use the fixed CO_2 system protecting the engine room. The firefighters recommended use of the fixed CO_2 system to help battle the fire. Soon thereafter, the firefighters heard from the crew that there was a missing crewmember within the engine room. The two firefighters, already dressed in fire suits and SCBAs, entered the engine room without hoses to determine the location of the fire and possibly rescue the missing person. They attempted to access the engine room through the port side stairwell leading to the elevator room on the second deck. They started to go down the stairwell before the heat and smoke became too intense. The stairwell railings were extremely hot even through the gloves they were wearing. They decided to return back up to the main deck because the amount of heat and smoke made it too dangerous for entry through that location.

Man Overboard

103. While standing on the port mooring deck (located aft of the port pipe tunnel), the First Assistant Engineer overheard someone say they heard cries for help. The First Assistant Engineer looked over the port side and saw the Wiper in the Cape Fear River in the vicinity of the port sideport door. The First Assistant Engineer immediately rushed up to the port side main deck where he tossed a ring buoy with light attached into the water. The Wiper could not reach the ring buoy and it drifted away from him. The First Assistant Engineer walked forward on the main deck to follow the Wiper as he drifted toward the bow. The First Assistant Engineer tossed another ring buoy with a line attached three separate times as he followed the Wiper struggling in the water. The First Assistant Engineer testified that the Wiper made several attempts to reach the ring buoy but his splashing moved the buoy away from the Wiper each time. The First Assistant Engineer saw the Wiper stop treading water and fall beneath the surface of water in the vicinity of the accommodations ladder at frame 75.

104. The First Assistant Engineer informed a firefighter that the Wiper was in the water and to call for assistance. The First Assistant Engineer testified that he first saw the firefighters about 25 minutes after he had left the engine room. The firefighter left the ship and ran down the pier to report the Wiper overboard and find a radio to call for help. Within three minutes of last seeing the Wiper, the First Assistant Engineer saw a Coast Guard 41-foot utility boat approach the ship. The Coast Guard boat from Station Oak Island passed back by the stern of the ship before making a closer approach to look for the Wiper. The First Assistant Engineer estimates that it was about four minutes after he last saw the Wiper in the water before the first close approach by the CG boat. He yelled to the CG boat crew to give them an indication of where he last saw the Wiper. Two firefighters continued to look for the Wiper in the water from the pier. When they saw the CG boat near the ship, they left their positions to continue assisting with the fire effort. The Wiper was not seen again by anyone that day.

Attempts To Discharge the Fixed CO_2 System

105. After watching the CG utility boat search continue for several minutes, the First Assistant

Engineer went back down to the port mooring deck with the Electrician and Third Mate. When he arrived he overheard the Master order the Third Mate to release the fixed CO_2 system. The order was given approximately 35 minutes after the fire was reported. The Electrician and Third Mate donned SCBAs to enter the port pipe tunnel to access the Fire Control Room together. The two attempted to release the CO_2 that protects the engine room spaces by opening the two master control valves. They testified that the amount of smoke prohibited them from seeing the small "pony" bottle cylinder valves that needs to be opened to activate the system. The Electrician reported back to the Master that they were unsuccessful in releasing the CO_2.

106. The Master then provided the Electrician and Third Mate with specific instructions on how to activate the system from the CO_2 room. The Electrician and Third Mate went into the CO_2 room with two MOTSU firefighters to make a second attempt to activate the system. The Third Mate did not reach the CO_2 room because his SCBA was low on air. The smoke in the CO_2 room was more intense than within the Fire Control Room which made it difficult for the Electrician to see the pilot valves or read the posted instructions. The Electrician opened the two pilot valves. The Electrician and a MOTSU firefighter, Douglas New, testified that they heard a rush of gas flow inside the CO_2 piping which they assumed meant that the system had discharged. They reported to the Master that the pilot valves were opened and gas was heard flowing through the piping. None of the crew or any of the firefighters heard the CO_2 siren. Many of the crew, including the Master and Chief Mate, reported seeing the smoke change color from black to gray and decrease in intensity as it exited from the exhaust vent louvers at the top of the fidley within minutes after the CO_2 was reported to have been released. They believed this was an indication that the CO_2 system had been released into the engine room.

Crew Accountability

107. As part of his fire response assignments, the First Assistant Engineer was responsible for providing a muster of the engineering department to the Chief Mate. The Chief Mate collects the muster from each of the Deck, Engineering, and Steward departments before making a report to the Master. The First Assistant Engineer never provided a muster of his department to the Chief Mate or anyone else during the fire response. The Second Assistant Engineer reported to the Master that the Third Assistant Engineer was unaccounted for and was reportedly working in the fidley. There was no report made by the engineers to the Master, Chief Mate, or anyone else about the location of the Wiper in the engine room. The only engineers that the Chief Mate saw during the initial response to the fire were the First Assistant Engineer and Second Assistant Engineer. All the licensed officers and the Boatswain's Mate have radios assigned to them full-time. Only the Chief Mate and Boatswain Mate had radios with them when the fire alarm sounded. The only person who is required to carry one at all times is the duty watch stander.

108. The Chief Mate knew the Steward and Deck department personnel were accounted for because he either saw them on the 03 level on his way down to the main deck or when they were responding to the fire on the main deck. The Chief Mate informed the Master that he had accounted for all personnel with the exception of the Engineering department. After directing water into the supply vents for 40 minutes, the Chief Mate overheard discussions

that someone was missing in the engine room. Once the crew realized that someone was missing, none of them made any attempts to locate the missing person by making an approach into the engine room with charged fire hoses and protective gear.

Continued Firefighting Efforts by the Crew

109. The crew used four fire hoses to direct water into the supply louvers and cool the main deck areas just forward of the house. All the fire stations on the weather decks are fitted with 2.5" fire hoses. The Chief Mate manned a 2.5" fire hose to cool the stack and direct water into the starboard supply fan vent louvers. The Steward Department personnel were similarly shooting water through the port supply fan vent louvers from hatch #19 with a 2.5" fire hose. There were two 2.5" fire hoses manned on the garage deck area forward of the house between frames 33 and 49. The garage deck level is directly above the forward half of the engine room. The Master directed the crew and firefighters to flood cargo hold #19 with water to protect the pipe insulation, flexible piping, rags, and 20 pallets of paint stored in the hold. The team flooded the space by inserting a 2.5" fire hose through a small access hatch along the top of cargo hold #19 on the main deck.

110. No attempts were made by crew to shut any watertight or fire doors to form a fire boundary around the engine room. The amount of smoke that filled the port pipe tunnel soon after the fire started, limited the crew's ability to access the emergency gear stored in repair locker #1. The thick, black smoke prevented the crew from mustering at repair locker #1 as they had been trained to do before during fire drills. Alternatively, the crew gathered along the port mooring deck in located aft of the port pipe tunnel.

111. The First Assistant Engineer could not standby inside the CO_2 room as assigned on the Station Bill because the smoke was too intense. The First Assistant Engineer testified that there was no time for the engine crew to close the port or starboard sideport doors before evacuating the engine room.

Arrival of the Shoreside Firefighters

112. A four-person response team from MOTSU's Station #2 arrived on the pier with a pumper truck at about 1610 after receiving the call from the dispatcher. The Acting Fire Chief, Scott Brown, arrived in a separate vehicle along with three additional firefighters from Station #1 with a fire truck. At the time of the call, only nine persons were on duty at MOTSU, including the dispatcher. Two members from Station #2 met with the Master on the main deck near the gangway at approximately 1620.

113. The Master escorted the firefighters to the port side mooring deck to show them where to make entry into the engine room. The Master then showed two other firefighters the fire plan which was removed from the tube located near the gangway. The Master showed the firefighters how to enter cargo hold #17 to check on the effects of the fire on the aft bulkhead which is common to the forward engine room bulkhead. On his way back to the port mooring deck, the Master overheard that there was a man overboard. He met up with the First Assistant Engineer on the main deck by hatch #15 to find out that where the Wiper was last

seen in the water.

114. The Chief Mate connected the international shore connection to a valve located on the starboard aft end of the second deck in vicinity of the vertical ladder leading up to the man deck. According to the MOTSU Fire Chief Scott Brown, who assumed incident commander duties when he arrived on scene, this shore connection could not be used because a crew member had inadvertently stepped on and broke the valve hand-wheel when climbing down from the vertical ladder. The only way to open the valve was by using a wrench which was not immediately available. The shoreside firefighters were unaware that there was a second international shore connection along the port aft end of the second deck.

115. The fire control plan which the Master first showed to the firefighters when they arrived, was inadvertently placed in a handrail and could not be found. Neither Chief Brown nor any of the shoreside firefighters were aware that there was another fire control plan located on the port side of the house on the main deck.

116. Six firefighters gained access into the engine room with two charged hoses through the already opened starboard sideport door. The Boatswain's Mate worked with the firefighters to position a gangway from the pier through the opened sideport door. The shoreside fire hoses were charged by fire trucks located on the wharf which were supplied water from nearby fire hydrants. The shoreside fire teams did not use any of the ship's fire hoses because they determined that pressure was too low. Chief Brown observed low water pressure exiting from the 2.5" hoses used on the main deck by the crew.

117. Two teams were set up inside the engine room on the third platform level along the port and starboard sides of the main engine. The teams used a water and foam mixture to cool the hot spots which were predominately located below the main engine in the aft sections of the engine room. A total of 1300 gallons of Aqueous Film Forming Foam (AFFF) was used in the firefighting effort. The foam was collected from local fire department inventories. The team was initially unable to advance aft of the center portion of the main engine on the third platform level due to the intense smoke and heat. The water sprayed onto the back end of the main engine produced a lot of steam because it was extremely hot. The firefighting teams inside the engine room could not establish radio contact with their support teams on the pier due to interference from the ship's metal structure. The teams had to relay information to the pier through a messenger system.

118. The shoreside firefighters were surprised to see the Second Mate and AB come down to the main deck after evacuating from the bridge around 1800. The Second Mate and AB came down from the bridge level because the emergency fire pump stopped running when the emergency generator failed. The Electrician and Second Assistant Engineer attempted to restart the emergency generator but were unsuccessful. The Electrician testified that he observed the low lube oil pressure alarm light activated.

119. When the emergency generator failed, the firefighters told the crew to evacuate the ship. The First Assistant Engineer, Second Assistant Engineer, and Electrician remained on board to provide assistance to the shoreside firefighters. By this time, enough firefighters and

equipment were staged on the pier to completely take over fighting the fire. The shoreside fire response included approximately 150 firefighters from 30 surrounding volunteer, city and county fire departments.

120. The 32-foot fire boat from the Wilmington Fire Department arrived on scene at approximately 1820. Chief Brown directed the fire boat to use their fire monitor to cool the sideshell plating along the port side of the engine room space and cargo holds #16 and #17. The 107-foot tug operated by MOTSU arrived on scene two hours later at approximately 2030. According to the Southern Coastal North Carolina Marine Firefighting Contingency Plan, MOTSU's fire boat can be deployed immediately between the hours of 0800-1700 on weekdays. After scheduled work hours, the six-person crew can be operational within three hours. The tug's crew directed their three fire monitors (total of 7500 gpm) to cool the aft end of the engine room exhaust stack above the main deck. The location of the fire within the confines of the engine room prevented the fire tugs from having any direct impact on fighting the fire.

121. The fire teams noticed a significant amount of diesel fuel oil within the engine room. MOTSU firefighter Douglas New testified that his turnout gear, along with several others, were soaked in diesel fuel oil which was picked up along the deck gratings inside the engine room on the third platform level. After fighting the fire for about an hour and a half, a thermal imaging camera was brought on board by a volunteer fire department to assist with the firefighting efforts. The camera allowed the two fire teams to attack the fire and move further aft because it helped to identify the hot spots. The camera identified the highest concentration of heat right below the main engine on the third platform level. The fire was declared to be under control by 2200 and extinguished by 0130 on July 15th. The two ship's service generator prime movers, which were on-line prior to the fire, were still running and were manually shutdown by the shoreside fire team at approximately 2030.

Post-Fire Condition of the HFO Fuel Transfer System

122. In the weeks following the fire, the Coast Guard completed a preliminary investigation into the matters surrounding the fire. The investigation team consisted of several investigators from Marine Safety Office (MSO) Wilmington along with CWO John Gonzales from MSO Hampton Roads. Mr. John Sullivan and Mr. John Golder assisted the team as subject matter experts. John Sullivan, a self-employed marine consultant for Vessel Engineering, Inc. (Charleston, SC) served as Chief Engineer for 11 years on six different ECON-class vessels, including the SSG CARTER from 1990-1996. John Golder is an agent from the Wilmington, NC office of the U.S. Bureau of Alcohol, Tobacco, and Firearms.

123. On 20 July, the CWO Gonzales and Mr. Sullivan discovered valves opened in the HFO transfer system which would allow fuel to be transferred from the port and starboard overflow tanks into the HFO settling tank. The "open" position of all the valves was confirmed by cycling the valve hand wheels. The overflow tank suction valve, which serves both overflow tanks, was the only valve opened on the HFO transfer manifold (total of five valves). The team did not confirm the position of the diesel oil transfer system valves.

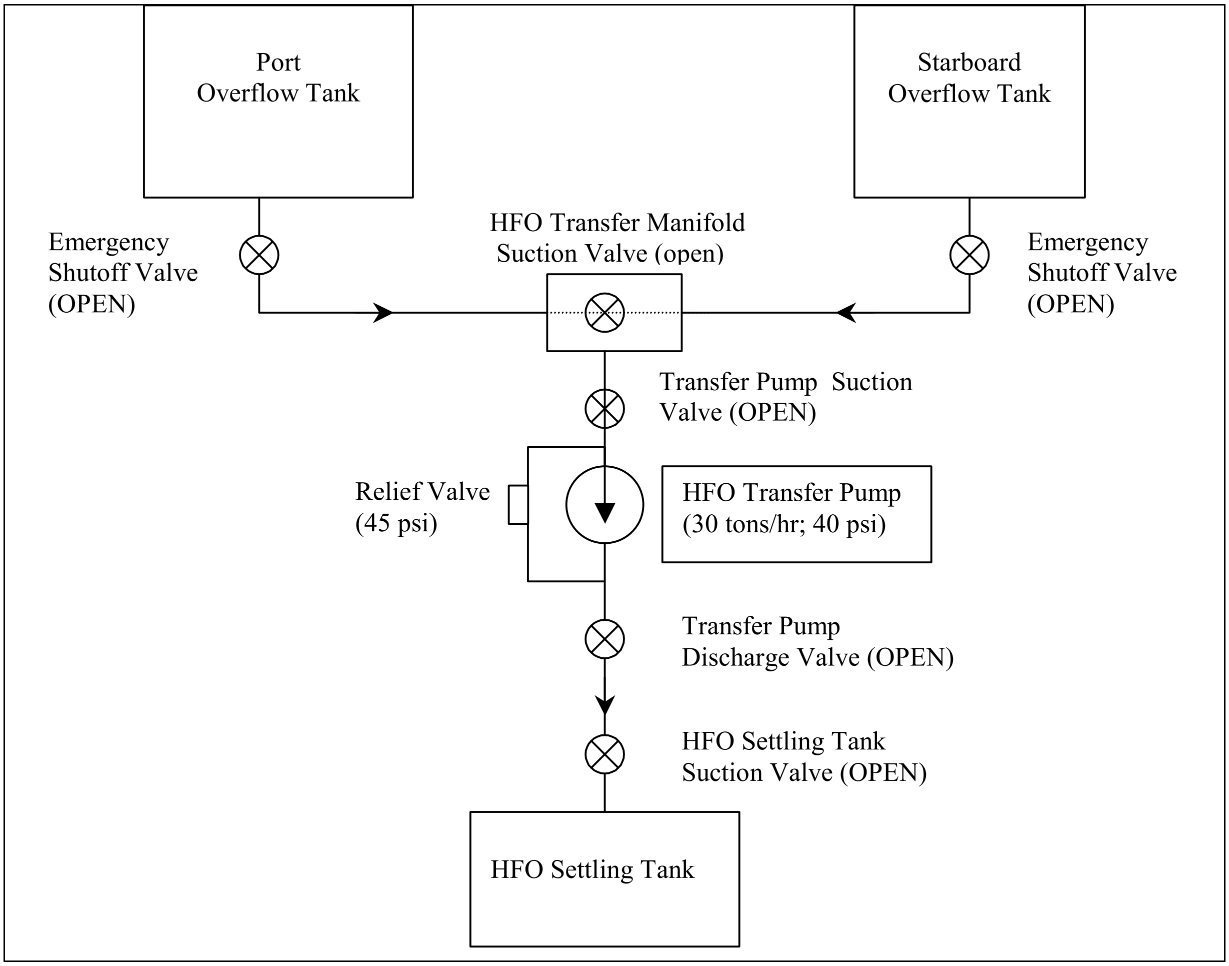


Figure 4 – Post-Fire Fuel Piping Arrangement for HFO Transfer from Overflow Tanks to the HFO Settling Tank (taken from F.O. Filling and Transfer System Drawing)

124. The HFO transfer pump circuit breaker was found to be in the "tripped" position. The pump circuit breaker does not trip during normal operations of the pump. The Second Assistant Engineer testified that the breaker had not "tripped" during the previous transfer several days before the fire. The breaker will "trip" when the remote shutdown button located on the fire control panel in the Fire Control Room is pushed or there is an electrical discontinuity detected in the wiring providing power to the pump.

125. The HFO transfer pump selector switch near the circuit breaker was found in the "manual" position. The "manual" position of the pump's selector switch requires someone to manually shutdown the pump when the desired level in the tank is reached. The manual position bypasses the automatic start/stop of the HFO transfer pump based on the level readings in the HFO settling tank.

126. According to the manufacturer's design drawings, the HFO transfer pump's relief valve is set for 44 psi. The Second Assistant Engineer testified that the HFO transfer pump's discharge pressure ranged from 29-43.5 psi. Following the fire, the HFO transfer pump relief valve was

removed from the SSG CARTER and tested in the presence of CWO John Gonzales at Norshipco yard in Norfolk, VA. CWO Gonzales testified that the relief valve opened at 40 psi.

127. The Second Assistant Engineer testified that the pencil wedged into the "acknowledge" position on the TLI panel prevented the audible alarms from sounding in the engine room. Chief Engineer Gustafson testified that he temporarily wedged a pencil into the "acknowledge" position on the TLI panel to silence a continuous sounding of a high bilge level alarm while the ship was completing conversion work at Norshipco. John Sullivan testified that keeping the alarm in the "acknowledge" position prevented the display of a high tank level by the Siemens computer and the recording of the event on the sequence log. With the TLI audible alarm bypassed, the only way to identify a high level condition in any of the fuel tanks would be through a visual inspection of the bar gauge or meters on the TLI panel in the engine control room. The bar gauge changes color from yellow to red when a high tank level condition is reached. The meters are circular dials. There were no high level alarm conditions recorded in any of the computer event sequencing logs between 1-14 July. The First Assistant Engineer and Second Assistant Engineer testified that they never heard the TLI audible alarm sound on the SSG CARTER.

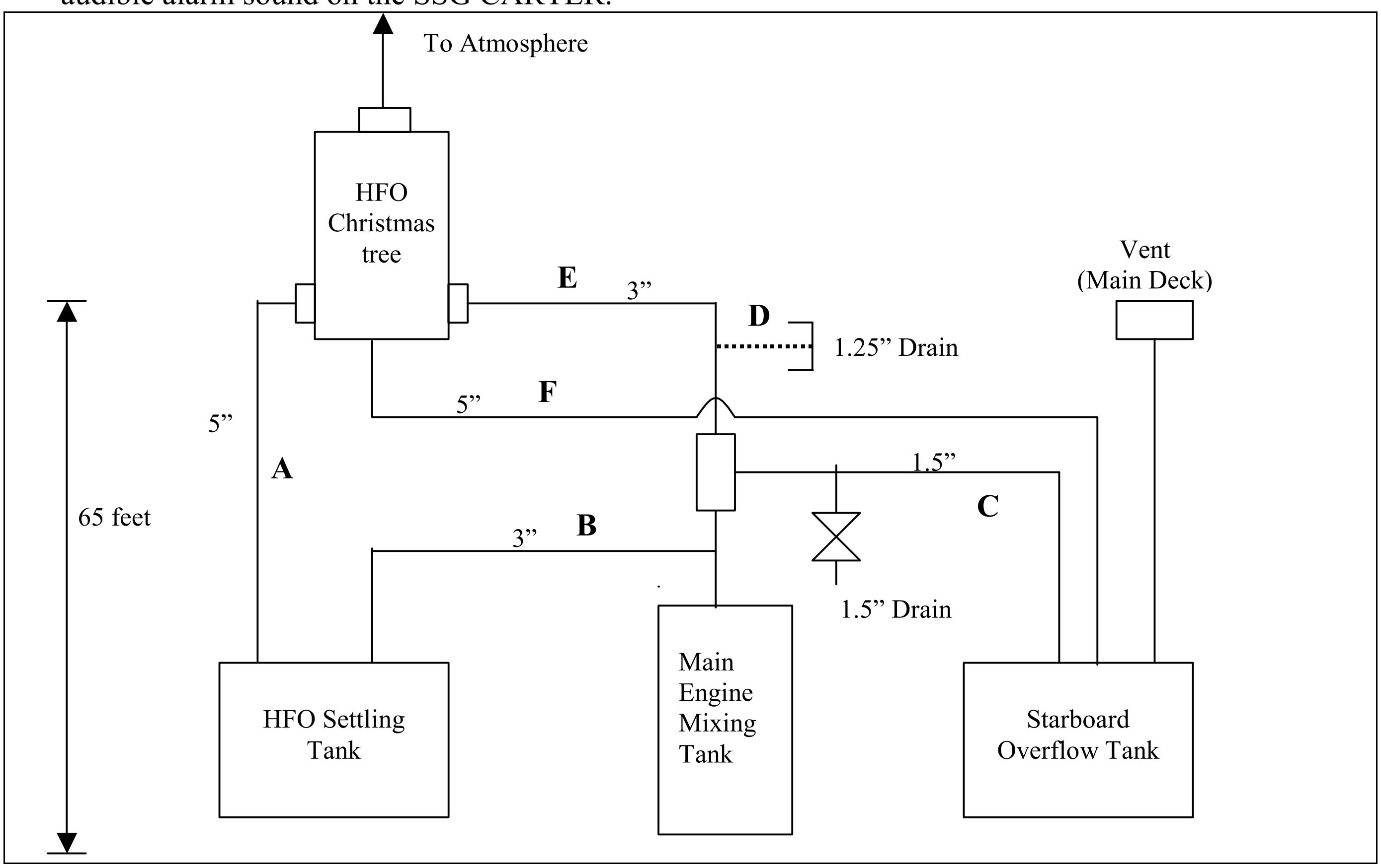


Figure 5: HFO Settling Tank and Main Engine Mixing Tank Vent System
(from F. O. Service System Piping Diagram)

128. Figure 5 is the HFO settling tank and main engine mixing tank vent collection piping

arrangement within the engine room. The HFO settling tank's primary vent extends from its tank top located on the second deck level (label A). A 5" diameter welded vent line proceeds from the tank top to the HFO vent collection chamber (a.k.a. HFO Christmas tree) located on the 01 level. The vent line connects to the HFO Christmas tree by a bolted flange.

129. A separate 3" diameter vent line rises from the HFO settling tank top and connects to a small chamber located above the main engine mixing tank (label B). The main engine mixing tank serves as a transition tank to accommodate a change of fuel from HFO to diesel or vice versa. This tank mixes and supplies fuel only when the main engine is operating. Chief Engineer Gustafson testified that the main engine operated on diesel fuel while the ship transited up the Cape Fear River to MOTSU on 14 June. A 1.5" diameter drain line extends from a small chamber located above the top of the main engine mixing tank to the starboard overflow tank (label C).

130. The main engine mixing tank and diesel oil service tank share a common gravity-fed pipe connection which allows for the diesel fuel inside both tanks to reach the same level. There are no automatic level indicators or means to sound the level of fuel in the main engine mixing tank. A stop check valve is in-line between the diesel oil service tank and the main engine mixing tank. The stop check prohibits the back-flow of diesel oil from the main engine mixing tank into the diesel oil service tank.

131. Since the diesel oil service tank and main engine mixing tank share a common connection, the level of diesel oil in the service tank determines the level of diesel oil in the main engine mixing tank. The maximum amount of diesel oil remaining in the diesel oil service tank was approximately 19.9 tons on 14 July. This amount corresponds to approximately 1.0 ton of diesel fuel within the main engine mixing tank. The total capacity of the main engine mixing tank is 1.2 tons.

132. The Chief Engineer was not aware of any leaks in the steam heating coils located in the various fuel tanks, including the main engine mixing tank, before the fire. A review of the event sequencing logs for the two weeks preceding the fire indicated that the diesel fuel in the main engine mixing tank remained at a constant 102 degrees Fahrenheit.

133. None of the engine crew members were aware of the temperatures maintained within the HFO settling tank or HFO service tank when questioned during the hearings. The temperatures of the HFO within these tanks taken on board the SEALAND QUALITY, a sister ship to the SSG CARTER, ranged from 184-188 degrees Fahrenheit. The Chief Engineer testified that no excess water was found in the HFO settling or service tanks in the days before the fire. The Second Assistant Engineer drains about 15-20 gallons of condensed water from the HFO settling tank every two days.

134. The First Assistant Engineer was not aware of any steam leaks into any of the fuel tanks. The First Assistant Engineer testified that he did not see any oil in the cascade tank in the days preceding the fire. A cascade tank collects the condensed steam returning from the steam coils in the fuel tanks. If there was a steam leak in a coil, the oil would enter through the coil and circulate back to the cascade tank. The oil would float on the top of the water within the tank and

be visible through one of the inspection ports located on the tank.

135. Table 1 is a listing of the soundings for the various HFO and diesel fuel tanks completed by the Second Assistant Engineer on 14 July and 16 July. Additionally, a Saybolt representative completed soundings on 3 August after the ship returned to Norshipco to make repairs. The soundings taken on 14 July were completed at 0630 and recorded on a hand-written note pad which the Second Assistant Engineer provided during the hearings. The soundings taken on 16 July were verified in the presence of ATF agent John Golder. There were no fuel transfers completed following the fire since no electrical power was available to the HFO or diesel oil transfer pumps.

TANK LEVELS (TONS)/DATES	7/14	7/16	8/3	Difference (7/14 to 8/3)
HFO Settling	50.3	50	49.5	-0.8
HFO Service	80.4	80.4	60.4	-20.0
HFO Port Overflow	49	29	28.6	-20.4
HFO Starboard Overflow	62.7	65.7	65.3	+2.6
Diesel Oil Service	9	19.9	20.8	+11.8

Table 1: Comparison of Various Fuel Tank Levels

136. The Second Assistant Engineer testified that he completed a transfer of diesel oil from the port diesel oil storage tank through the diesel oil purifier #5 to the diesel oil service tank on 14 July prior to the fire. This event was not logged into the 14 July engineering logs. This was the only fuel transfer which the Second Assistant Engineer testified that he completed on 14 July. The diesel oil service tank can hold approximately 22 tons.

137. According to the engineering logs and the Second Assistant's testimony, the last transfer completed to the HFO service tank was on 12 July. The level in the HFO service tank recorded in the engineering logs following this transfer was 78.1 tons. The Second Assistant testified that the ship service generators usually consume between 5-6 tons of HFO daily based on electrical demand from cargo operations. The SSG CARTER worked cargo all day on the two days preceding the fire. Based on this, the estimated amount of HFO consumed by machinery from 12-14 July would be between 10-12 tons. Therefore the level in the HFO service tank during the morning of 14 July should be between 66-68 tons vice the 80 tons reported by the Second Assistant Engineer.

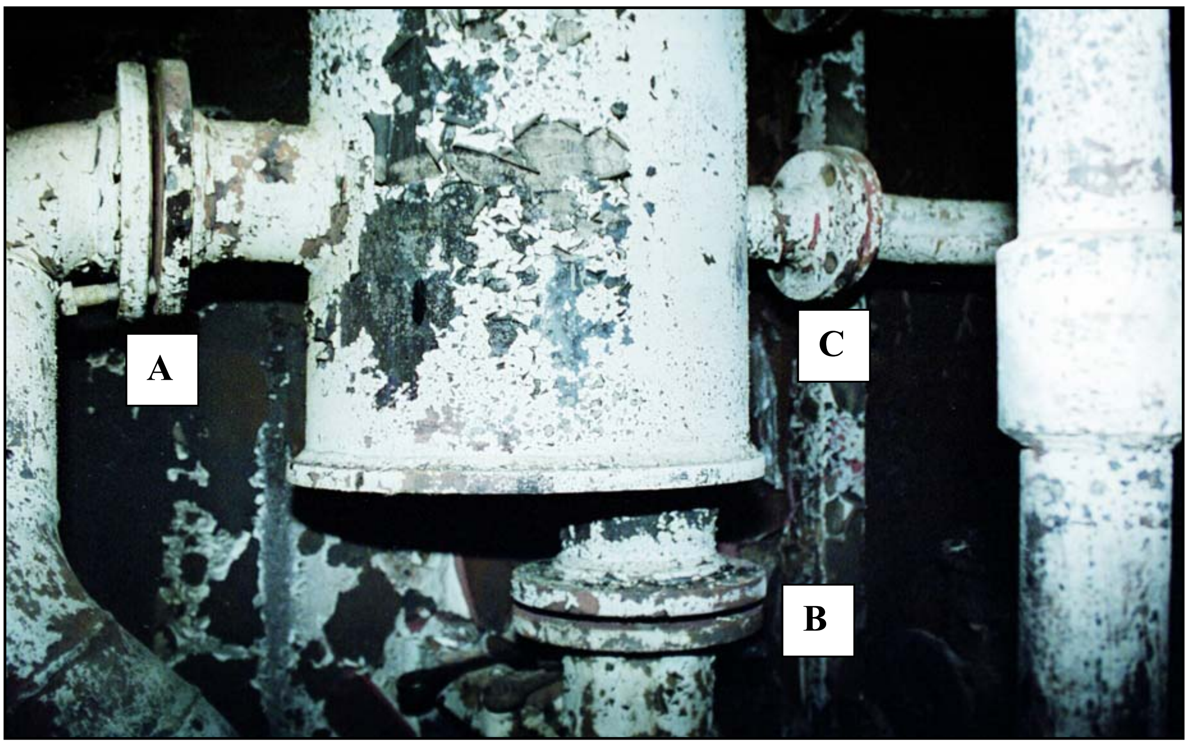
138. John Golder testified that a comparison of the Second Assistant Engineer's recordings determined that all the HFO tanks were approximately at the same level before and after the fire with the exception of the port overflow tank. The Second Assistant Engineer told John Golder that, "the fuel difference in the port overflow tank was due to transfer from port overflow to the HFO settling tank." The HFO settling tank levels show no changes between the soundings taken on 14 July, 16 July, and 03 August. The Second Assistant Engineer testified that he always tries to keep the HFO settling tank full. The 50 tons in the HFO settling tank is 90% of full capacity. John Sullivan testified that, while he served as Chief Engineer, he would typically maintain the HFO settling tank at 75% of full capacity to

prevent an accidental overfill of the tank.

139. The Second Assistant Engineer denied that neither he nor any other crew member completed any transfer of HFO on 14 July.

Discovery of HFO in the Engine Room

140. A post-fire examination of the engine room by the investigation team determined that there were two to three inches of HFO covering the majority of the solid deck plating on the 01 level. The only place on the 01 level which did not have any standing oil residue was at the base of the HFO Christmas tree. There was no HFO detected along the flanges of the Christmas tree or any evidence of oil on the bulkhead behind the Christmas tree that is located along the starboard side of the fidley at approximately frame 29. There was no oil residue found in the vicinity of the blank flange seen hanging from the IFO/DO Christmas tree (see Figure 2). Only rust particles were observed inside this opening.



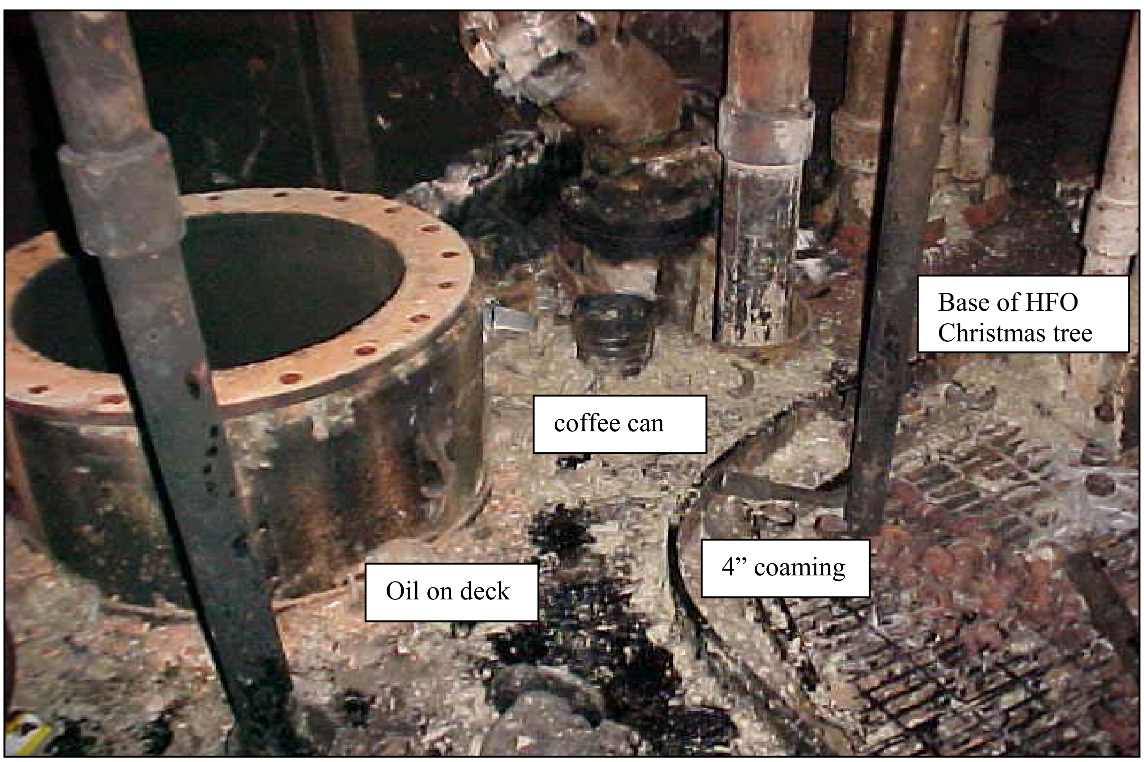
Picture 5: Lower Section of the HFO Christmas tree on 01 Level (Post-Fire)

141. Picture 5 is the lower section of the HFO Christmas tree taken after the fire. The vent pipe on the left (depicted by label A) is the 5" vent line from the HFO settling tank to the HFO Christmas tree. All but one of the bolts were completely removed from the flanged connection. The one bolt remained because the bolt length was too long to back out all the way. The vertical pipe at the bottom of the picture (label B) is the 5" drain line from the HFO Christmas tree to the starboard overflow tank. The gap in between the disconnected flange was measured to be 0.75". The 3" vent pipe on the right of picture (label C) is from the main

engine mixing tank. All the bolts were removed from this flange leaving an approximate 0.5" gap. The two flange faces were offset horizontally by about 0.5". The dark areas in the background are where the paint was peeled from the bulkhead.

142. Various samples of HFO and diesel oil collected from deck plating and tanks following the fire were sent to Dr. John Graham of the Coast Guard's Marine Safety Lab in Groton, Connecticut for analysis. Dr. Graham used Gas Chromatography and Gas Chromatography/Mass Spectrometry methods to analyze the various samples to determine if they originated from the same petroleum source. The results from Dr. Graham's tests determined that the HFO samples collected by the investigative team from the 01 level, the second deck level (in vicinity of incinerator room), the HFO settling tank, and the port starboard overflow tanks were derived from a common source of petroleum. In addition, the HFO sample drawn by CWO Gonzales from a drain line connected to the 1.5" piping between the main engine mixing tank to the starboard overflow tank (label C in Figure 5) also matched the HFO samples drawn from the HFO tanks and collected from the two decks.

143. The sample taken from the main engine mixing tank did not entirely match with the samples taken from the 01 level or from any of the HFO tanks. Although the main engine mixing tank sample had similar characteristics of the heavier hydrocarbons with the HFO samples, some differences were noted. The Marine Safety Lab concluded that the sample from the mixing tank contained an intermediate to heavy fuel oil with characteristics similar to a blend of diesel oil collected from the diesel oil service tank and the heavy fuel oil from the HFO tanks.



Picture 6: 01 Deck Level in Vicinity of the HFO Christmas Tree After the Fire

144. Picture 6 was taken several days following the fire in the vicinity of the HFO Christmas tree. In the foreground is the HFO that was found on the majority of the solid deck plating on the 01 level. Separating the solid deck plating from the grating (foreground, right) is 4" high deck coaming. The bolts and nuts on top of the grating were from the expansion joint removed from the incinerator exhaust stack (left side of picture) which was accessed during the investigation. The small coffee can contained the nuts and bolts removed by the Electrician from the HFO Christmas tree flanges several days before the fire. CWO Gonzales testified that there was oil trapped beneath the can once it was removed from the deck. The vertical pipe pictured to the right of the coffee can is the 5" vent line from the HFO settling tank. The upper right corner of the picture is the base of the HFO Christmas tee. The white material in the picture is the part of the insulation material removed from the incinerator exhaust stack.

145. The investigative team completed an exam of all the levels within the fidley and engineering spaces to determine if there were other potential sources of fuel that could have initiated the fire. The team found a 1.25" diameter opening at the base of a 90-degree pipe elbow attached to the 3" main engine mixing tank vent line along the overhead on the second deck (label D in Figure 5). This drain line was a "home-made" design alteration to the vent piping arrangement. Mr. Rabuse testified that the drain line was made from a combination of steel piping, rubber hose, and a threaded bronze fitting. According to Mr. Rabuse, the rubber hose was clamped to the end of a short section of steel piping which was welded onto the vent line elbow. The bronze fitting was connected to the rubber hose with a hose clamp. Mr. Rabuse found the bronze fitting below the vent line elbow in the vicinity of the #1 ship service generator exhaust stack on the second deck. The fitting was cracked. The cap that supposedly would be placed over the end of this fitting was not located. Mr. Rabuse and Chief Engineer Gustafson testified that they were unaware of this drain line installed on the main engine mixing tank vent elbow prior to the fire.

146. The location of this drain opening was along the second deck approximately ten feet inboard of the main engine mixing tank. The opening was approximately 20-30 feet from the warped bulkhead between the main engine space and incinerator room on the second deck. The position of the opened drain line was such that any oil flowing through this opening would discharge directly on the deck grating along the second deck level in vicinity of the #1 ship's service generator. A large quantity of heavy fuel oil was located on the deck directly below this opened drain line. The HFO found in this area was consistent with the HFO found on the 01 and main deck levels. John Golder reported that there was extensive heat damage in the vicinity of the opened drain line. CWO Gonzales testified that any oil coming from this opening would first pass through the opened deck gratings into the lower levels of the engine room behind the main engine.

147. There were dresser couplings fitted on each side of the 90-degree elbow connected to the main engine mixing tank vent line above the second deck. Both dresser couplings were found intact by the investigative team post-fire.

148. Small amounts of HFO were located in the vicinity of the main engine mixing tank on the second deck. The source for this HFO was determined to have come from leaking gaskets in

the vent line flanges located above the tank. John Golder testified that although there was heavy fire in the vicinity of the main engine mixing tank, there was no indication that the fire started at this tank.

149. Chief Engineer Gustafson testified that the fractured weld found during a post-fire hydrostatic test of the steam coils in the main engine mixing tank was a hairline crack which was repaired with one weld pass. Chief Gustafson testified that the repair work he observed indicated that this was a small fracture which would not lead to overpressurization.

150. There was no fuel found in any significant amount on any level above the 01 level within the fidley.

<u>Analysis of Flow through the HFO Vent Collection System</u>

151. Mr. John Sedlak from the Coast Guard's Marine Safety Center (MSC, Engineering Division) completed calculations to determine the flow rate of the HFO from the HFO transfer pump up through the vent collection piping to the HFO Christmas tree. His fluid flow analysis was completed based on specific data about the vent piping arrangement and the capabilities of the HFO transfer pump provided by the investigation team. Mr. Sedlak made the following assumptions to complete his calculations:

- The HFO temperature flowing through the vent lines was 176 degrees Fahrenheit;
- Pipe entrance and exit losses through the open flanges at the HFO Christmas tree and within the starboard overflow tank were negligible and not considered; and
- Effective lengths for elbows, tees, reducers, etc. were used based on data from National Fire Protection Association.

152. The first assumption is consistent with average temperatures recorded for the HFO settling tank taken from a visit to the SEALAND QUALITY (sister ship to SSG CARTER) taking into consideration a slight cooling effect since the vent lines are not heated. The second and third assumptions are consistent with general engineering practice to calculate fluid flow through pipes.

153. Mr. Sedlak testified that the HFO transfer pump could transfer HFO to a vertical height (i.e., pump head) of approximately 90 feet. The HFO Christmas tree is located approximately 65 feet above the HFO transfer pump. Using the nominal values for the HFO transfer pump, Mr. Sedlak determined that the HFO would flow from the port and starboard overflow tanks to the HFO settling tank at a rate of 30 tons/hour. Mr. Sedlak reported that the HFO would continue to flow at this rate through the HFO settling tank vent line over to the small chamber located above the main engine mixing tank (see Figure 5).

154. Once the HFO reached this small chamber, the flow would split into two separate streams. One stream would flow up to the disconnected main engine mixing tank vent flange on the HFO Christmas tree at a flow rate equivalent to 24.5 tons/hour (label E in Figure 5). The second stream would flow from the small chamber to the starboard overflow tank at a flow

rate equivalent to 5.5 tons/hour (label C in Figure 5). Mr. Sedlak reported that all the flows were in the laminar region which makes his calculations predictable with a large degree of accuracy. Based on Mr. Sedlak's findings, it would take approximately 10 minutes to fill up the HFO settling tank from 50 tons (90% volume) to 55 tons (100% volume). The HFO would then enter the HFO settling tank vent piping and proceed over to the main engine mixing tank.

155. Mr. Sedlak was not able to determine the flow rate through the opened drain line connected to the main engine mixing tank vent line (label D in Figure 5). The flow through this 1.25" opening was considered unpredictable because it was no longer considered laminar but rather in a transition zone between laminar and turbulent flow. Mr. Sedlak could not comment on how this open drain line would affect the flow rate and pressure of the other two streams.

Properties of HFO and Diesel Oil

156. Saybolt Laboratory (Wilmington, NC) completed an open cup fire analysis tests in accordance with American Standard for Testing Materials (ASTM) Method D-92 for the various HFO and diesel fuel samples removed from the ship. The tests included a determination of the sample's flash point and fire point. According to Title 46, Code of Federal Regulations, Part 30.10-27, flash point is defined as the temperature at which a liquid *gives off* a flammable vapor when heated in an open-cup tester. Fire point is defined as the temperature at which the liquid gives off enough flammable vapors to *sustain* a fire when the heat source is removed. Table 2 is a summary of their findings.

TANK	**FLASH POINT (F)**	**FIRE POINT (F)**
HFO Settling	275	355
HFO Service	180	210
HFO Port Overflow	245	300
HFO Starboard Overflow	265	330
Main Engine Mixing Tank (HFO & DFO)	215	220
Diesel Oil Service (DFO)	190	205

Table 2: HFO/Diesel Fuel Flash and Fire Points
(Saybolt Labs, ASTM D-92 open-cup test method)

Internal Examination of HFO Vent Collection System

157. On 16 August, CWO Gonzales completed an internal examination of the HFO Christmas tree and five of the vent lines that form part of the HFO vent collection system. While the SSG CARTER was in Norfolk, VA for repairs, an internal exam was completed with a flexible boroscope borrowed from Coast Guard Naval Engineering Support Unit in Portsmouth, VA. To facilitate the internal exams, the HFO Christmas tree was disconnected from the bulkhead and lowered to the 01 level. The boroscope was fitted with a light and connected to videotape

equipment to record the internal conditions of the HFO Christmas tree and the vent lines leading up to it.

158. The boroscope inspection inside the HFO Christmas tree revealed that the chamber was dry with no residue visible. A black substance, resembling the HFO found on the 01 level deck, was found in the HFO main engine mixing tank vent line (label E in Figure 5). The oil-like substance first appeared to cover the entire internal pipe walls for the first 9-10 feet (as measured from the HFO Christmas tree flanged connection) inside the line. The piping was completely dry with a white substance observed along the walls of the pipe when the boroscope reached 14 feet into the vent pipe. Samples of the white substance were not removed for further analysis. Oil residue reappeared again along the walls of the pipe until the camera reached the disconnected dresser coupling located above the 90-degree elbow above the second deck level. CWO Gonzales testified that the wet and dry conditions found within this pipe were consistent with the surrounding areas of high heat damage.

159. The HFO Christmas tree drain line, which extends back to the starboard overflow tank, was dry (label F in Figure 5). As the boroscope traveled through the drain line, large pieces of debris were seen breaking from the pipe walls and falling down inside of the pipe. At six feet into this line, the boroscope encountered debris and could not go any further. CWO Gonzales testified that the debris did not totally block the drain line but prevented the boroscope from passing. The boroscope was unable to dislodge the debris. CWO Gonzales could not determine how much of the drain line was blocked by the debris.

160. There was heavy wet black substance, similar to that found in the HFO main engine mixing tank vent line, inside the vent line between the main engine mixing tank and the starboard overflow tank (label C in Figure 5). CWO Gonzales reported that the inside of this line was more wet than the other vent lines examined. A probe located within this line prevented the boroscope from completely examining the entire length of this line.

161. CWO Gonzales testified that a heavy wet substance was found in the piping between the HFO settling tank and the main engine mixing tank (label B in Figure 5). There was so much of this viscous oil present in this line as observed from the broken flange in vicinity of the main engine mixing tank, that CWO Gonzales decided not to risk using the boroscope to examine this line.

162. The HFO service tank vent line could not be completely examined because the boroscope could not navigate through the radical pipe bends. CWO Gonzales observed lots of debris inside the short length of pipe examined. No oil residue was seen inside this line.

163. CWO Gonzales discovered debris that completely blocked the HFO settling tank vent line (label A in Figure 5) at approximately 14 feet from the HFO Christmas tree flange. Several attempts were made to proceed through this debris that blocked the entire inside of the vent line. The boroscope was unable to dislodge or penetrate the substance. There was no sign of oil residue above the location of the debris. CWO Gonzales testified that the blockage he observed would restrict any vapor flow through this line.

164. The HFO settling tank vent line was eventually cut open in the vicinity of the blockage to remove the debris. The material was sent to Dr. Graham and Oxford Laboratory (Wilmington, NC) for analysis. Dr. Graham reported that the debris contained traces of petroleum oil which included compounds observed in moderately weathered HFO. The debris had significant amount of non-petroleum contamination, which appeared to be similar to a gasket material. Dr. Graham could not report on the exact type of contamination since his test equipment only can analyze petroleum-based compounds. Oxford Laboratories determined that the material had a weight composition of 14.5% iron.

Clearing and Testing of the Vent Lines

165. After the SSG CARTER returned to Norshipco to make post-fire repairs, Maersk contracted the shipyard crew to check all the vent lines connected to the HFO Christmas tree. Norshipco representative, Mr. Michael Truitt, completed a water flow test through the vent lines to check that they were clear of debris.

166. Mr. Truitt replaced 80-feet of the 5" diameter HFO settling tank vent line (label A in Figure 5) due to the blockage which was found during the boroscope exam. Additionally, Mr. Truitt replaced the entire 100-feet of the 2.5" diameter HFO service tank vent line connected to the HFO Christmas tree because of the presence of several dresser couplings.

167. Mr. Truitt reported that the 5" drain piping from the HFO Christmas tree to the starboard overflow tank (label F in Figure 5) was plugged with heavy fuel, resembling heavy molasses, and rust in the vicinity of a low point as the pipe extended through the starboard pipe tunnel. Mr. Truitt reported that the amount of fuel occupied about two-thirds of the pipe diameter over a length of five feet. This length of piping also was replaced due to the conditions found.

168. The 3" diameter elbow with the attached drain line connected to the main engine mixing tank vent (label E in Figure 5) was replaced with a 6-foot section of piping. This new piping replaced the dresser couplings located on both sides of the elbow.

169. Mr. Truitt reported to Mr. Rabuse (Maersk) that all the piping sections attached to the main engine mixing tank were free and clear (labels B, C, E in Figure 5). These lines include the main engine mixing tank vent line up to the HFO Christmas tree, and the two piping connections between the main engine mixing tank with the HFO settling tank and the starboard overflow tank.

Potential Sources of Heat and Ignition

170. The investigation team completed an exam of all the potential sources of heat that could have ignited the fire. The auxiliary boiler stack and the incinerator exhaust stack were examined first due to their close proximity to the HFO Christmas tree on the 01 level. The auxiliary boiler stack is located three feet aft of the HFO Christmas tree. The deck coaming surrounding the auxiliary boiler stack in this area is 1.5" high. The team focused on this area because they observed paint peeling from the bulkhead directly behind the HFO Christmas tree which indicated an area of intense heat. CWO Gonzales discovered a wrench, which was

laying on top of the lower bracket connected to the HFO Christmas tree, that was discolored (annealed) from the heat of the fire.

171. The incinerator exhaust stack is located four feet from the HFO Christmas tree. As depicted in Picture 5, an expansion joint on the incinerator exhaust stack was removed on the 01 level to examine the internal condition of the stack. The interior of the stack looked clean and undamaged with no indications that fire started inside the stack. Sections of the incinerator exhaust stack insulation were removed between the main deck and 01 level. There was no sign that fuel had contaminated any of the insulation on the incinerator exhaust stack.

172. The investigative team completed an external exam of the auxiliary boiler exhaust stack by removing the sheathing and rock wool insulation (fiberglass) from the stack between the main deck and 01 level. This area was selected due to the discovery of melted rivets used to hold the sheathing together. Along the upper portion of the exhaust stack near the 01 level, there were two black stains found which were not present on any other portion of the stack. Picture 7 below shows the two black stains found by the team. ATF agent, John Golder, testified that these stains were consistent with markings left behind from fuel combustion. Upon closer examination, Mr. Golder identified residue from burned oil evident on the insulation adjacent to the exhaust stack where the stains were located. Mr. Golder described the insulation showed signs of a "wicking effect" where the fuel moved through the fiberglass layers from the outside toward the inside before making contact with the hot auxiliary boiler stack.

Picture 7: Auxiliary Boiler Exhaust Stack (between Main Deck and 01 Level)
[Arrows depict location of black stains]

173. A small part of the fiberglass insulation had become hardened from heat exposure. Portions of the oil-saturated insulation were sent to the Dr. Graham (Coast Guard Marine Safety Lab) to compare it with the fuel samples collected from the two deck levels, the main engine mixing tank, and the HFO tanks. Dr. Graham concluded that the heavier hydrocarbon compounds from the main engine mixing tank and the HFO tanks were similar to those found on the insulation indicating that these samples are related. He could not conclusively state that the oil on the insulation matched any of the other samples because the dissimilarities were not consistent with weathering, including any evaporation losses from heat exposure. Dr. Graham testified that there were no signs of combustion on the insulation sample due to the lack of pyrogenic compounds.

174. The investigation team collected scrapings of black material from the auxiliary boiler exhaust stack in the vicinity depicted by the arrows in Picture 7. Dr. Graham compared these scrapings with the insulation removed from the same vicinity. Dr. Graham concluded that the two samples share many characteristics of the heavier hydrocarbons but not enough to consider them a match. He noted that the black scrapings more closely resembled the heavier hydrocarbon profile observed from the various samples collected from the HFO tanks and from the second deck in the engine room. The smaller hydrocarbon compounds detected in the insulation were more consistent with the samples taken from the main engine mixing tank and the diesel oil service tank. The black scrapings did not show any signs of elevated pyrogenic compounds typical in samples impacted by fire.

175. Mr. Sullivan testified that he visited a sister vessel to the SSG CARTER, in order to determine the temperature on the external sections of the auxiliary boiler exhaust stack in the vicinity of the HFO Christmas tree. He recorded a temperature of 212 degrees Fahrenheit using a thermocouple placed on the auxiliary boiler exhaust stack with the boiler operating. The ship's Chief Engineer witnessed and concurred with the test results.

176. According to the event sequencing logs removed from the SSG CARTER following the fire, the main engine exhaust gas boiler (commonly referred to as the economizer) thermocouple registered a temperature of 55 degrees Fahrenheit at 1602:08. The thermocouple is located inside the main engine exhaust stack 15 feet above the HFO Christmas tree. This temperature is considered normal considering the economizer was not in use and the main engine had not been operating on the day of the fire. Twenty-four seconds later, at 1602:32, the same thermocouple recorded a temperature of 518 degrees Fahrenheit. The thermocouple is not designed to measure any temperature above 518 degrees Fahrenheit.

177. The investigative team externally examined the three generator exhaust stacks which passed up through the fidley as well as various 110-volt lights and 440-volt electrical power panels in the vicinity of the heaviest fire damage. Each of the generator exhaust stacks were found intact and the insulation surrounding the stacks showed no signs of damage. Many of the overhead light lenses and power panel indicating lights were melted in the fidley area. The power panel doors were opened in order to examine the inside for any signs of arcing. No oil residue or any signs of arcing were observed inside any of the power panel boxes. Mr. Golder ruled out the possibility that an electrical panel initiated this fire.

Remote Fuel Valve Shutoffs and Ventilation Damper Shutdowns

178. The investigation team examined the air-actuated, quick-closing valves associated with the HFO and diesel fuel systems. All the valves were found opened with the exception of the diesel oil service tank feed to the auxiliary boiler. Mr. Sullivan testified that these type of quick-closing valves need to have periodic maintenance to make sure the springs will close them during an emergency. The investigative team found a piece of angle iron attached by wire to the quick-closing valve supplying fuel to the generators. Mr. Sullivan testified that pieces of steel, like this one, are used to hold open the valve during a test of the remote shutdowns so as to prevent the generators from shutting down. The angle iron was not in a position that would have prevented the valve from closing during the fire.

179. The post-fire investigation revealed that neither of the two manually-released exhaust vent dampers, located on the aft end of the fidley on the 04 level, were closed during the fire response. The six exhaust vent openings along the aft end of the engine room exhaust stack (frame 29) between the 06 and funnel top levels each have an opening which measures 38 ft^2 (total opening - 228 ft^2). These vents remained opened through the entire fire event.

180. The double doors leading into the two supply fan rooms on the starboard side of the exhaust stack on the main deck were found opened after the fire. The doors on the port side of the stack leading to the two supply fans on the same level were found closed. Eight vent openings are located on the 01 and 02 levels to supply air to the four supply fans (2 vents each) at the base of the fidley. The louvered openings are not fitted with any means for closure. Each of the openings measures 32.3 ft^2 (total opening 258.4 ft^2). Pneumatic-operated dampers are fitted to the four supply fan units. Each of the two large sideport doors on the port and starboard sides of the engine room measure 6.5 ft. wide by 10.2 ft. long (total open area of each: 132.2 ft^2). These doors remained opened throughout the entire fire event.

181. Lieutenant Holly Najarian, from the Marine Safety Center (MSC, Engineering Division), determined that the size of the sideport doors openings, combined with the openings in the exhaust stack, would have decreased the effectiveness of the fixed CO_2 fire fighting system if it had been released into the engine room. LT Najarian was unable to provide the exact loss calculations because the conditions of the fire (i.e. burn rate, progression, smoke movements) were unknown. Using an extremely conservative computer model, however, she calculated that the outflow of CO_2 from the sideport doors would have ranged from 38,000 to 120,000 cubic feet per minute (cfm). The total volume of the machinery space, including the auxiliary generator room, is approximately 420,000 cubic feet.

182. LT Najarian calculated the mass flow rate of air up through the opened exhaust vent openings during the fire would range from 100,000-120,000 cfm. The mass flow rate of air into the bottom of the fidley through the opened supply vent openings was 52,000 cfm. These flow rates were determined by using a conservative burning rate of 20.5 grams/second. Based on these results, LT Najarian concluded that the fidley served as a “chimney” during the fire as fresh air was brought in through the opened sideport doors and supply vent louvers. This large quantity of air provided enough oxygen to sustain the fire.

Condition of the Fixed Low-Pressure CO_2 System

183. On 16 July, CWO Gonzales examined the position of various valves and controls for the low-pressure CO_2 system along with Mr. Gil Mabry from Koorsen Fire Protection Services. CWO Gonzales testified that he found the main stop valve (see Figure 3) located on top of the CO_2 tank open. The CO_2 main stop valve did not have its locking cap installed. The locking cap was found on the deck next to the CO_2 tank. A sign which read, "Main Valve Closed, Open Main Valve Before Activating System" was seen hanging from the main stop valve body. The investigation did not determine who had placed this sign on this valve. Chief Engineer Champa testified that he saw the sign hanging from valve since his arrival on board but was not sure what was written on it.

184. CWO Gonzales confirmed that the engine room distribution valve and the main block valve (labels C and D in Figure 3) were closed based upon the position indicators on the two valve bodies. The pneumatically-operated valve in-line with the CO_2 siren was found open. CWO Gonzales did not confirm the position of the 1.25" ball valve (label E in Figure 3) along the CO_2 siren line. This ball valve needs to be opened to provide CO_2 gas to the pneumatically-operated valve in order for the siren to sound. The two pilot valves (labels A and B in Figure 3), which are designed to open the main block valve and engine room distribution valve, were found open.

185. CWO Gonzales found that the safety seal attached to the right-side pony bottle cylinder valve (Figure 3) was broken. The two control valves positioned on the manifold in between the pony bottles were found open.

186. The level in the CO_2 tank was not confirmed by manual checks. The manual checks include opening a series of vent line valves attached to the side of the CO_2 tank. The four vent line valves correspond to the 100%, 95%, 75% and 0% levels within the CO_2 tank. If CO_2 gas exits from a vent valve, then the CO_2 liquid level is below the height of that vent valve. If "snow" exits from the vent valve, this indicates the liquid level of CO_2 is above that vent valve. The electronic level gauge was not working since no power was provided to the instrument panel. CWO Gonzales testified that he found leakage of CO_2 gas from the pilot valve manifold connections when the two 1-pound pony bottle cylinders in the Fire Control Room were opened. The wire tamper seal for the right-side pony bottle was found broken. The wire tamper seal attached to the cylinder valve for the left-side pony bottle was intact.

187. On 26 July, CWO William Perkins (MSO Wilmington, NC) completed a second examination of the CO_2 system in the presence of John Bacon, Conseps Fire Protection. A second test was ordered to determine the CO_2 storage tank level through manual checks. Snow released from the vent valve positioned at the 75% level and CO_2 gas was released from the 95% level. A separate "frost-line" test was completed the same day which showed the liquid level in the tank to be at approximately 75% of total capacity.

188. Under normal conditions of operation, the temperature of the liquid CO_2 is maintained at 0 degrees Fahrenheit which corresponds to a CO_2 gas pressure of 300 psi. When the temperature of the gas rises and the gas pressure increases to 330 psi, one of two refrigeration

compressors will activate automatically to chill the liquid CO_2 to lower the pressure. If power to these compressors fails, the temperature of liquid CO_2 in the tank will rise and begin to boil off into gas. The excess boil-off gas is designed to flow to atmosphere through a series of vent valves.

189. According to the Ginge-Kerr manual for this low-pressure system, approximately 660-880 pounds per day of CO_2 will boil-off following the first 24 hours after power is lost to the compressors. Based on this loss rate, the amount of liquid CO_2 boiled-off lost following the twelve days the compressors were not operating is estimated to be 7,260 – 9,680 pounds. This equates to roughly 33-44% of the CO_2 storage tank's total capacity.

190. On 31 July, a test of the CO_2 system was completed in the presence of CWO Gonzales, John Bacon, Mr. Rodney Bradley (Fire Protection Services, Inc.) and two representatives from Maersk. The group planned to test the operation of the system by opening one of the two pony bottles and the two manifold valves located in the Fire Control Room. Prior to the test, electrical power had to be restored to the CO_2 instrument panel. When the power source was connected, the instrument panel failed to energize. The group discovered that two 1-amp fuses were blown which prevented the instrument panel from working. One of the fuses replaced was for the "normal" source of power and the other one was from the "emergency" source of power. After the two fuses were replaced, power was restored to the instrument panel and the group proceeded to complete the test.

191. CWO Gonzales and Mr. Bradley testified that the hose lines connecting the pony bottles to the pilot valve manifold in the Fire Control Room had to be tightened to prevent the escape of CO_2 gas during the test. Mr. Bradley stated that the loose connection of the hose lines would not prevent the system from operating but wanted to secure them for safety reasons. After the hose connections were tightened, the pony bottle cylinder valve and the two pilot valves were opened. Almost immediately after opening these valves, the CO_2 siren was heard loud and clear by the group as the discharge cycle proceeded. Shortly after hearing the siren, the instrument panel lost power which prevented the opening of the main block valve. The 1-amp fuse that forms part of the circuit for a pressure-operated switch to the engine room was found blown within the panel. Since the main block valve never opened, the CO_2 gas did not release into the engine room during the test. The two main engine room distribution valves, along with the siren pneumatically-operated valve, all had opened properly.

192. Another operational test was attempted once the system was reset. Once again, the same 1-amp fuse blew during the discharge cycle which prevented the main block valve from opening. The CO_2 siren was heard and the main engine room distribution valves had opened. The main block valve failed to open automatically during any of the operational tests made on 31 July because electrical power could not be continuously provided.

193. Mr. Bradley later determined that the electric cable that supplies power to the re-release button on the remote control station in the starboard pipe tunnel had burned during the fire. He found a 25-30 foot section of cable melted along the overhead of the second deck level within the engine room. This burned cable was the source for the ground short which continued to blow the 1-amp fuse within the instrument control panel.

194. Mr. Bradley testified that when the crew opened one of the pilot valves identified as label A (Figure 3) from the CO_2 room during the fire response, a pressure switch activated which provides electric power to the re-release buttons located at both of the remote control stations. The purpose for the re-release button is to provide the ability to discharge additional amounts of CO_2 to any of the protected spaces. As long as the release button is depressed, the main block valve remains open to discharge CO_2. The re-release button provides the option to discharge the full contents of the CO_2 tank.

195. Mr. Bradley believes that the cable providing power to the re-release button at the starboard pipe tunnel station had already melted prior to the opening of valve A. The ground short caused by the melted cable would have blown the 1-amp fuse causing the loss of normal power supply to the instrument panel. Upon loss of normal power, the system is designed to automatically switch to an emergency power supply which has a separate set of electrical circuitry. Since valve #19 remained opened and the pressure switch still activated, the 1-amp fuse connected to the emergency circuitry blew causing a total loss of power to the unit. Mr. Bradley stated that there is no battery source of power to the instrument panel. A total loss of power would result in all the instrument panel lights to turn off. Additionally, there are no audible alarms to indicate a total loss of power. The total loss of electrical power to the instrument panel prevented the opening of the main block valve and the discharge of any CO_2 to the engine room.

196. Mr. Bradley testified that if the crew activated the CO_2 release properly from the remote control station in the Fire Control Room, they would have found the main pilot valves in the CO_2 room (Figure 3, labels A and B) already open. Since the Electrician had to manually open these two valves in the CO_2 room, this is an indication that his attempt to open from the remote control station failed.

<u>Recovery of the Third Assistant Engineer and Wiper</u>

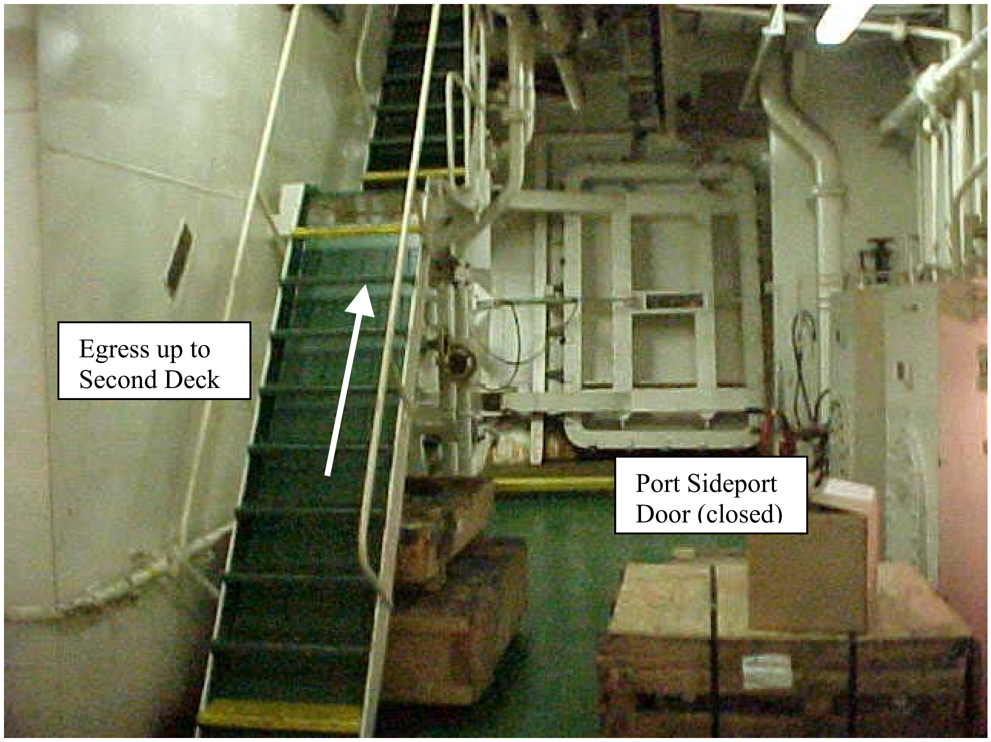
197. The Third Assistant Engineer was discovered by the shoreside firefighters laying face down flat on the grating located on the 03 level at 2250 on 14 July. His body was positioned facing the fire door, located 12 feet away, which leads into the galley spaces. The grating upon which he was lying provides an open exchange of air, heat, and smoke with the levels located directly below within the fidley and engine room space. No tools were found in the immediate vicinity of his body. The lower parts of the Third Assistant Engineer Engineer's legs were found draped over an aluminum ladder which was laying flat on the 03 level. The position of the ladder was such that his feet were found inside the ladder rungs. Another ladder was found leaning up on its side against the railing adjacent to the three generator exhaust stacks. The two aluminum ladders were crossed to form a vee-shape with the ladders ends crossed near the main engine exhaust stack located in the middle of the level. The ladders separated from each other to form an opening near the base of the vertical ladder that leads up to the 04 level on the port side of the fidley. These two ladders are normally stored in this area of the fidley. There was no indication that the Third Assistant Engineer was using these ladders to access the exhaust ventilation fan damper.

198. According to testimony received from the coroner, Dr. Thomas Clark (Office of Chief

Medical Examiner at the University of North Carolina), the Third Assistant Engineer died from smoke inhalation. His blood was saturated with 33% carbon monoxide. Dr. Clark reported that the Third Assistant Engineer Engineer's body was severely charred with thermal burns, especially the anterior surfaces of the legs. Portions of his feet were missing from the thermal burns. Dr. Clark discovered soot in the trachea and larynx. His coveralls and skin were lightly coated with a thin to moderately thick layer of black substance resembling oil. No ethanol was detected in his blood.

199. The engine crew reported that the Third Assistant Engineer was supposed to be working on the starboard exhaust ventilation fan damper on the 04 level. After the fire, a pipe wrench was found in the vicinity of the starboard exhaust fan platform that is located above the 04 level. No other tools were found in the vicinity of the fan. The only escape route from the exhaust fan platform was down two flights of vertical ladders to the 03 level and out the fire door into the accommodation spaces. The fire door is five feet from the base of the ladder, leading up to the exhaust fan platform. During the initial response to the fire, the Stewards department staff led by the Second Mate, were using two fire hoses to cool down the other side of this fire door and the adjacent bulkhead. There is no window on this door.

200. The First Assistant Engineer reported that the Wiper was supposed to be working in the separator room located on the starboard side of the second platform deck during the moments preceding the fire. The separator room extends between frames 25-50 and can be accessed through two doors which face toward the centerline of the ship. The after door is located at approximately frame 34 and the forward door is located at frame 47. There is a ladder that leads upward from the second platform deck to the third platform deck at frame 32. The top of this ladder is within close proximity of the auxiliary boiler located at frame 28 on the third platform deck. The closest ladder from the forward door of the separator room going upward to the third platform deck is located on the centerline in front of the main engine. Once on the third platform deck, another escape ladder that leads up to the port pipe tunnel on the second deck is about 33 feet away (Picture 8 below). This ladder on the left of picture is marked on the vessel's safety plan as an egress route. The port sideport door is located on the right of this picture (closed) approximately 25 feet outboard of the ladder.



Picture 8: Third Platform Level looking toward Port Sideport Door (Frame 46)

201. On the day after the fire, a Coast Guard investigator spotted a yellow line tied off to a metal ladder rung in the vicinity of the port sideport door on the third platform level. The other end of the line was seen in the Cape Fear River directly below the sideport door. Chief Engineer Gustafson testified that this yellow line was normally tied to a bucket used for bunkering operations. A pair of earplugs that matched those used by the Wiper were recovered in the vicinity of the port sideport door. No one saw the Wiper jump into the water from the ship. The height of the sideport door opening above the Cape Fear River at the time of the fire was approximately 15 feet.

202. A post-fire examination of the engine room spaces found one Emergency Escape Breathing Apparatus (EEBA) located next to the escape trunk door on the second platform deck. Another EEBA was next to the escape trunk within the engine control station on the third platform deck. A lifejacket was also located within the engine control station. No lifejackets were in the immediate vicinity of the opened port sideport door.

203. The Wiper's body was recovered on 17 July in an area approximately three miles south of the SSG CARTER along the Cape Fear River. The autopsy report for the Wiper stated that he died from drowning. No burns were found on any part of his body.

Damage Assessment of Engine Room

204. Mr. Golder testified that the engine room damage assessment was consistent with a "fall-down" type of fire that started up high at first and then proceeded to create secondary and

tertiary fires in the lower levels below. He stated that the only direct connection between the damaged areas found on the upper and lower levels in the engine room were from oil dripping down from above. He testified that the fires that burned on the lower levels were separate and distinct from the fires located on the second deck and above.

205. The majority of the fire and heat damage sustained within the engine room and fidley was limited to the areas between frames 23 and 35. According to the Mr. Rabuse (Maersk), the fire caused an estimated $15 million in damages to the ship. Most of the heaviest damaged areas were located on three decks between the main deck and the second platform deck. Additional damage was noted in shaft alley which is located on the floor level. The areas above the main deck, throughout the fidley and within the port and starboard pipe tunnels, were covered with a thick layer of soot from the smoke generated by the fire.

206. Mr. Rabuse reported that the exhaust fan louvers located on the aft side of the fidley on the 06 and 05 levels were deformed from the heat that passed up through the fidley. He stated that the manually controlled cables that close these louvers were intact but not working because the louvers were warped. It could not be determined if this louvers were warped prior to the Second Mate's attempts to close them during the fire.

207. On the main deck and second deck levels, the steel gratings and handrails were severely twisted and warped from the intense heat. The areas near the HFO settling tank on the second deck suffered intense heat as evident by the warped steel bulkhead separating the incinerator room to the main engine room and the damaged auxiliary boiler exhaust stack sheathing and control panel. The steel bulkhead that forms the HFO settling tank was not warped. Mr. Golder testified that steel melts at approximately 1700 degrees Fahrenheit and aluminum melts at 1100 degrees Fahrenheit.

208. The flames and heat destroyed the set of access doors leading to the starboard supply fan room on the main deck. Mr. Rabuse testified that the doors and framing had to be cut away from the bulkhead because of severe distortion. The surrounding bulkheads in the vicinity of the starboard supply fan room had paint missing and were buckled and warped. The two starboard supply vent fan units had burned and were removed for restoration of the motors. The pneumatic-actuated fire dampers attached to the four supply fan units (port and starboard supply fan rooms) had to be replaced due to heat damage. The vent louvers for the four supply fans along the exterior of the fidley on the 01 and 02 levels were distorted and replaced. The port supply fan room doors did not sustain as much heat damage as the starboard doors. The port doors only needed to be realigned following the fire.

209. Along the exterior on the main deck, the bulkhead that forms part of the engine room fidley just forward of hold #19, is damaged and its paint blistered. The aft engine room bulkhead on the second deck (which forms forward bulkhead for hold #19) was also damaged. Along the second and third platform levels, the four access doors leading to the auxiliary generator room had to be replaced. The forward bulkhead of the auxiliary generator room on the second platform level was cracked. The entire 28-foot length of this bulkhead was replaced due to the extent of the cracking.

210. The Class A self-closing fire screen door between the main engine space and the elevator room on the second deck level was renewed due to heat damage. The investigative team found a hold-back installed directly behind this door. Hold-backs are not permitted according to the regulations found in SOLAS 74 (1983 Amendments), Chapter II-2, Part C, Regulation 47. Mr. Rabuse reported that all hold-backs found on board the ship were removed during the post-fire repairs. The four watertight doors that form the exterior boundary of the main engine room along the port and starboard pipe tunnels on the second deck were replaced with quick-acting watertight doors to better accommodate closure in port. Mr. Rabuse testified that normal practice was to keep these watertight doors open while in port and close only at sea.

211. Mr. Rabuse testified that some of the quick-closing valves connected to the various fuel tanks throughout the engine room were repaired due to valve seat problems and bad springs. One of the quick-closing valves (he could not identify which one) was missing a control actuator altogether.

212. Along the floor level, the aluminum housings for the main engine lube oil pumps had melted. The 24” diameter stub shaft (between the main engine flywheel and intermediate shaft) had warped and was measured to be 3 millimeters out of tolerance. The cast iron plating along the aft section of the main engine block along with the foundation in the vicinity of the cylinder number one had to renewed due to severe heat damage.

213. Extensive electrical damage resulted from the fire including melted light fixtures, damaged power cables, and burned motor controllers.

214. The forward engine room bulkhead, designed to meet A-60 structural fire protection requirements, remained intact. There was no evidence of any direct flame impingement or effects from sustained elevated temperatures on this bulkhead which makes up the aft end of the port and starboard overflow tanks. This bulkhead is designed to A-60 standards to prevent heat from progressing forward to any potential explosive cargoes located within cargo hold #17. The paint along the main deck in the garage area (frames 33-48) had peeled from the intense heat in the engine room directly below. The paint on the main deck forward of frame 49 remained intact. The aft end of cargo hold #17 is at frame 50. The aft end of hold #16, where the explosive cargoes were stored, is at frame 59 which is approximately 25.5 feet forward of the areas where paint was peeling on the main deck.

Condition of the Emergency Generator

215. Mr. Rabuse testified that the emergency generator was examined and tested post-fire under a no-load condition. The emergency generator started and ran for a short period without any problems. Mr. Rabuse did not have any reason to explain why the emergency generator had shut down after running for approximately two hours during the fire. He had heard that one possible reason for the shut down was due to low lube oil pressure. The lube oil level, as well as the fuel oil level, were checked and confirmed to be adequate. Mr. Rabuse stated that one possible explanation for the shutdown was due to a faulty low lube oil pressure sensor. He had this pressure sensor replaced following the operational test.

CONCLUSIONS

1. The proximate cause of this casualty was human error on the part of the Second Assistant Engineer who failed to monitor the transfer of approximately 20 tons of heavy fuel oil (HFO) from the port and starboard overflow tanks to the HFO settling tank on the afternoon of 14 July. The approximate time the transfer started was 1530. As a result in failing to monitor this transfer, the HFO settling tank, and its vent cross connection to the main engine mixing tank, became filled with HFO. The HFO mixed with approximately one ton of diesel fuel oil contained in the main engine mixing tank and the oil mixture continued to flow up to HFO Vent Collection Chamber (a.k.a. Christmas tree) on the 01 level within the fidley. (Findings 43, 44, 45, 47, 53, 54, 55, 78, 82, 123, 124, 125, 126, 128, 129, 130, 131, 135, 137, 138, 143, 150, 153, 158, 160, 161, 169)

2. Part of the oil mixture flowed out from the main engine mixing tank vent line flange that was disconnected from the HFO Christmas tree and spilled onto the 01 level deck plating. Part of the oil mixture entered the HFO Christmas tree and flowed down through the partially blocked drain line to return to the HFO starboard overflow tank. The partially blocked drain line restricted the flow which allowed the oil mixture to spill through the drain line flange which was also disconnected from the HFO Christmas tree. The HFO did not flow up the HFO settling tank's primary vent line because it was completely blocked with rust and debris. The oil mixture at first collected on the 01 level deck before eventually spilling over into the levels directly below within the fidley and main engine room areas. The oil mixture flowing through the main engine mixing tank vent line caused an installed "homemade" drain line to fail. This failure resulted in additional amounts of the oil mixture flowing directly on the second deck grating and areas below. (Findings 42, 140, 141, 142, 144, 145, 159, 163, 164)

3. The investigation could not determine the exact reason why the HFO settling tank was only 90% full following the fire. One possible theory is that HFO continued to flow from the top of the HFO settling tank through the vent collection system after the crew secured the HFO transfer pump. The HFO continued to flow due to the volumetric expansion of the oil and water mixture inside the HFO settling tank as a result of thermal heating. The investigation revealed that there was extreme heat present in the areas adjacent to the HFO settling tank. The investigation could not determine if the contents of the HFO settling tank became hot enough to expand to the extent necessary to increase the pressure inside the HFO settling tank and "force" approximately five tons of HFO up through the vent collection system. (Findings 101, 135, 138, 207)

4. The exact source for the ignition of the oil mixture could not be determined. The most likely source of ignition was the auxiliary boiler exhaust stack which passed within three feet of the HFO Christmas tree. Although the temperature of the auxiliary boiler exhaust stack at the time of the fire was hot enough to ignite the diesel oil component within the mixture, samples of insulation and scrapings removed from the boiler exhaust stack did not conclusively match the fuel oil samples analyzed. Other potential sources of ignition considered were the incinerator stack, the three ship's service generator stacks and various lighting and power panels within the fidley. (Findings 156, 170, 171, 172, 173, 174, 175, 177)

5. The fire developed very rapidly and filled the entire engine room and fidley with fire, smoke and

intense heat. The initial fire was most likely located in the vicinity of the HFO Christmas tree on the 01 level. The fire burned hot enough to consume the residual oil which flowed through the upper sections of the main engine mixing tank vent line and the HFO Christmas tree drain line. As the fire dropped down from the 01 level, secondary and tertiary fires readily ignited from the main deck down to the bilges. The damaged areas were consistent with a vertical "fall-down" type fire event contained within a longitudinal length of 32 feet. (Findings 84, 85, 87, 88, 91, 93, 95, 100, 146, 148, 176, 204, 205, 206, 207, 208, 209, 212, 213)

6. Although the two Chief Engineers denied knowing of any problems with the TLI system before the fire, it is reasonable to expect them to have seen the pencil in the alarm panel based on their daily workings in the engine control room and the conspicuous nature of the violation. Both Chief Engineers failed to report the problems with the TLI system and insist on making the proper repairs prior to the fire. (Findings 49, 50, 51)

7. The steam coil leak that was discovered in the main engine mixing tank after the fire did not contribute to this casualty. (Findings 132, 134, 149)

8. The smoking vapor seen by the Master venting from the starboard overflow tank vent piping on the main deck was due to the heated HFO which flowed through the line connected to the main engine mixing tank. (Findings 101, 131, 154)

9. The crew's failure to close the fire and watertight doors to set boundaries around the engine room allowed heavy smoke to advance into the port pipe tunnel, the Fire Control Room, and the CO_2 room. This black smoke made it difficult for the crew to access the repair locker #1 equipment and to see the posted instructions on how to activate the CO_2 system. (Findings 62, 67, 69, 90, 105, 106, 110, 111)

10. The attempt by the Third Mate and Electrician to release the CO_2 from the Fire Control Room failed because they did not open the series of valves in the correct order to properly activate the system. Their attempt to activate the system was hindered by the amount of smoke in the space which made it difficult to see the posted instructions. (Findings 62, 63, 105, 185, 186, 196)

11. The Electrician's second attempt to release CO_2 from the CO_2 room failed because the fire had already damaged the cable providing electrical power to the re-release button for the starboard remote control station. This damaged cable ground shorted the normal and emergency power supplies to the instrument panel which prohibited the main block valve from opening. The "whoosh" sound heard by the Electrician and shoreside firefighter was not the flow of CO_2 through the discharge lines but rather the flow of pilot gas to a series of pneumatic valves and time delay bottle. No CO_2 was released into the engine room to fight the fire. (Findings 64, 67, 68, 106, 187, 188, 189, 191, 192, 193, 194, 195)

12. The change in density and color of the smoke seen exiting from the fidley exhaust louvers was not due to the release of CO_2. More than likely, the change in color and intensity was due to the effect the shoreside firefighters were having in attacking the fire from within the engine room. (Findings 106, 116, 117)

13. The design of the main stop valve installed on top of the CO_2 storage tank for the Ginge-Kerr systems makes it difficult to determine whether the valve is open or closed. (Finding 73, 183)

14. The in-line ball valve installed along the line which supplies CO_2 gas to the siren was closed prior to and during the fire event. This closed valve prevented the CO_2 siren from working when the Electrician opened the two pilot valves in the CO_2 room. (Findings 72, 75, 106, 184)

15. U.S. Coast Guard Headquarters (G-MVI-3) failed to enforce their standing policy to prohibit the use of electrical power to control the operation of CO_2 discharge valves during their review of the low-pressure CO_2 system. G-MVI-3 did not order the in-line ball valve to the engine room CO_2 siren to be "locked open" or removed so as to allow automatic operation as required by the regulations. G-MVI-3 did not order any design changes to the three-step procedure to activate the CO2 system from the remote control stations. The "acceptance" letter for the Ginge-Kerr system was issued by G-MVI-3 despite knowing about the system's dependence on electricity for normal operation, the presence of the in-line ball valve, and the three-step process to activate. At least 11 other sister vessels to the SSG CARTER may have the same type of Ginge-Kerr system as the SSG CARTER with erroneous acceptance letters issued by G-MVI-3. (Findings 1, 57, 58, 59, 60, 61, 62, 189, 190)

16. The fire team on the 03 level was ineffective in attacking the fire because the Second Mate, who was the designated team leader, was overwhelmed by smoke and not able to stay with the team for a prolonged period. Without any further guidance or direction, the team was limited to maintaining a fire boundary. (Findings 93, 95)

17. The loss of water pressure in one of the two fire hoses used by the fire team on the 03 level was due to the opening of several 2.5" fire hoses by the crew on the main deck. The emergency fire pump could not provide enough pressure to the four opened 2.5" hoses on the main deck and the two 1.5" hoses on the 03 level. The Second Mate acted quickly by starting the main fire pump from the bridge, increasing the water pressure so that additional fire hoses could be used. [Findings 29, 95, 96, 97, 100, 101)

18. An unrestricted flow of air entered the engine room through the opened starboard supply fan room doors, the opened port and starboard sideport doors, and the opened fire doors around the engine room. Smoke and hot gases exited from the top of the fidley through the opened exhaust vent louvers. With the fire burning in an area close to the bottom of the fidley, a chimney effect was created which provided the fire with a sufficient supply of oxygen to continue burning. The chimney effect helped to keep the fire in a relatively concentrated area and did not allow the heat of the fire to spread forward to affect the ammunitions located in the cargo holds. (Findings 2, 83, 98, 99, 100, 109, 110, 111, 179, 180, 181, 182, 205, 206, 208, 210, 214)

19. If the low-pressure CO_2 system had been discharged properly with the sideport doors open, the CO_2 gas would have been displaced by the large amounts of air passing through the vent openings. The degree of reduced effectiveness could not be determined. (Findings 181, 182)

20. The port and starboard sideport doors remained open prior to the fire for ventilation purposes. There are no regulations or Maersk company policy which requires these doors to be closed while

the vessel is inport. The opened starboard side port door provided the shoreside firefighters with direct and convenient access to the engine room to fight the fire. (Findings 5, 83, 116)

21. The #1 and #3 ship's service generator main engines continued to operate for 4.5 hours after the fire started because the HFO and diesel oil service tank quick-closing shutdown valves failed to close properly. The cause of the failure was due to lack of maintenance on the spring that closes the valve once pneumatic pressure is released. The engine crew failed to perform the required maintenance on a majority of the quick-closing valves to make sure the springs would operate correctly. (Findings 83, 90, 96, 121, 178, 211)

22. The two ship's service generators and the emergency generator continued to run concurrently and provide normal and emergency power to the ship's circuits. It cannot be determined how long the two ship's service generators continued to provide power. The emergency generator ran for approximately two hours before shutting down. The exact cause for the failure of the emergency generator could not be determined. The most likely reason is that a faulty low lube oil pressure switch shut down the generator prematurely. (Findings 94, 96, 118, 119, 215)

23. The ABS surveyor failed to complete tests of the remote shutdown for the fuel quick-closing valves in accordance with ABS and Coast Guard policy. The surveyor incorrectly documented in the ABS condition report that these fuel valves were tested on the ABS classification report. (Findings 26, 28)

24. The ABS surveyor failed to witness a full operational test of the low-pressure CO_2 system in accordance with the ACP program. His lack of experience with the design and operation of low-pressure systems contributed to his inability to recognize that the in-line ball valve to the siren was closed. (Findings 70, 72)

25. Fire Protection Services, Inc. representatives failed to ensure that the in-line ball valve to the CO2 siren was open during their June, 2001 service exam. (Findings 70, 71, 72)

26. With the exception of the closed in-line ball valve on the siren line, the low-pressure CO_2 system was fully operational prior to the fire. (Findings 70, 71, 72, 73, 75)

27. The Third Assistant died as a result of smoke inhalation while he was attempting to escape from the fidley. The thick smoke and intense heat which developed quickly within the fidley made it difficult for him to breath and see as he made his way down from the exhaust fan platform near top of fidley. Once he reached the 03 level, he became disoriented and could not find the fire door leading from the fidley to the galley spaces. He tripped over a ladder, lost consciousness, and died. Although the time of his death could not be determined, he most likely died within the first few minutes of the fire. (Findings 79, 93, 95, 107, 196, 197, 198)

28. The Wiper died from drowning in the Cape Fear River. There was no indication that smoke inhalation was a contributing cause for his death. The Wiper entered the Cape Fear River, without a lifejacket, by jumping approximately 15 feet from the opened port sideport door to escape from the burning engine room. It could not be determined if he attempted to hold onto the yellow line that was attached to a ladder rung in the vicinity of the port sideport door to help him remain afloat.

His inability to swim or tread water for a short period of time prevented him from reaching the two ring buoys that were tossed to him by the First Assistant. It was not determined why the Wiper could not remain afloat even though he met the basic safety survival standards. The First Assistant and the nearby CG 41-foot boat took the appropriate actions in attempting to rescue the Wiper. (Findings 8, 103, 104, 200, 202)

29. The exact escape route taken by the Wiper to get from the separator room on the second platform level to the port sideport door was unknown. The most likely route would have been up the ladder in front of the main engine to the third platform level. Directly in front of him was the ladder that led up to the port pipe tunnel on the second deck. It could not be determined why the Wiper chose not to climb this ladder to safety. (Findings 80, 199)

30. There is evidence to support that the Wiper knew about the location of the Emergency Escape Breathing Apparatus (EEBA) and lifejacket located in the engine control room. He would have passed these items during his daily activities in the engine control room since his arrival on 16 May. Documentation records showed that he received the proper pre-sail shipboard familiarization training which includes a review of the location of lifejackets and EEBAs throughout the ship. (Findings 20, 22, 201)

31. The broken valve hand wheel to the starboard side international shore connection prevented the shoreside team from using the ship's firemain system. The Incident Commander, Chief Scott Brown, was not aware that the ship was fitted with another international shore connection on the port side. (Finding 114)

32. The MOTSU fire tug took too long to arrive on scene to provide assistance to the Incident Commander. The two fire tugs from MOTSU and the City of Wilmington did not have any direct impact in helping to control or extinguish the fire. (Finding 120)

33. The Incident Commander overcame the shortfall of not having a fire control plan available by relying on the crew to identify major pieces of equipment and location of access doors. (Findings 113, 115)

34. The thermal imaging cameras used by the shoreside firefighters enabled them to go on the offensive and attack the fire since the camera helped identify the hot spots. (Finding 121)

35. There is no evidence that any member of the crew was influenced by drugs or alcohol at the time of this fire. (Finding 24)

36. There is evidence to support that the Master failed to complete his duties as the person designated to be "In Command" of a fire response. He did not order all the crew to gather at one central location, he did not order or receive an accurate and timely muster, he failed to set fire boundaries, he was not aware that two crew members attempted to enter the burning engine room without fire hoses, he did not assign duties to crew members in accordance with the Station Bill, and he failed to establish working communications with the fire parties. (Findings 76, 85, 91, 101, 102, 105, 107, 108, 110, 118)

37. The Master failed in his attempt to start the main fire pump from the bridge. He did not know the proper procedures to open the suction and discharge valves prior to starting the pump. The Master's inability to be able to open the fire pump valves led to a 10-minute delay before water was provided to the firemain. This delay was minimized by the quick actions taken by the Chief Mate to place the emergency fire pump on-line. (Findings 12, 92, 94, 96)

38. There is evidence to support that the Master acted with negligence by waiting 35 minutes to issue the order to release the low-pressure CO_2 into the engine room space. This lengthy delay allowed the fire to continue to burn that resulted in increased temperatures within the engine room spaces. This increased temperature would have reduced the effectiveness of the CO_2 to extinguish the fire since it does not have good "cooling" properties. (Findings 102, 105)

39. The Master was aware that the opened port and starboard sideport doors would reduce the effectiveness of the CO_2 system, but made no attempts to close them before giving the order to activate the CO_2 system. (Findings 83, 100, 102)

40. There is evidence to support that the Master falsified the crew's ship familiarization forms under the company's Safety Management Plan. (Findings 20, 21)

41. There is evidence to support the Chief Engineer acted with negligence by not tagging out the HFO transfer pump and associated valves to ensure the transfer system remained off-line while the HFO Christmas tree flanges were disconnected for maintenance while continuing to operate machinery. (Findings 37, 38, 39, 41, 77, 83)

42. There is evidence to support the Chief Engineer failed to inform the Master that the HFO Christmas tree vent lines were disconnected due to clogged fuel vent lines in the engine room in violation of the company's Safety Management Plan. (Findings 19, 41)

43. There is evidence to support that the Chief Engineer violated the regulation found in SOLAS 74 (1983 Amendments), Chapter II-2, Part C, Regulation 47 by allowing a holdback to be installed on the Class A self-closing fire door between the engine room and the elevator room on the second deck. (Finding 210)

44. There is evidence to support the Second Assistant Engineer acted with negligence when he jammed a pencil into the "acknowledge" switch on the TLI alarm panel several months prior to the fire. The Second Assistant silenced the audible alarm several months prior to the fire to avoid the constant nuisance alarms triggered by false signals received from cables which were contaminated with fuel within several of the HFO tanks. The pencil prevented the audible warning that would have notified the engine crew that the HFO settling tank exceeded the 95% level prior to the fire. This advanced warning may have prevented this casualty from occurring. The Second Assistant was the only one aware that a transfer was in progress and was not present in the engine control room to monitor the TLI gauges. (Finding 48, 49, 50, 127)

45. There is evidence to support that Mr. Andy Rabuse and Mr. Dan Welch failed to make the proper repairs to the TLI equipment required for periodically unattended engine room manning allowances prior to the vessel leaving the shipyard. Mr. Rabuse incorrectly assumed that the TLI

sensor problems were limited to only calibration errors. Mr. Rabuse did not fully investigate the extent of the problems by not checking with the Second Assistant Engineer. (Findings 50, 51, 52)

46. There is evidence to indicate that the Chief Mate failed to ensure the crew received training and knew how to operate the CO_2 system, including "emergency" procedures to activate the system in case of power failure. (Findings 23, 76, 105)

47. There is evidence to indicate that the Chief Mate failed to ensure that the low-pressure CO_2 system was properly maintained and ready for use in accordance with the company's Safety Management Plan. (Findings 19, 74, 183)

48. 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 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 his casualty.

RECOMMENDATIONS

1. That the American Bureau of Shipping review guidance and training programs provided to their surveyors to ensure they are instructed on and familiar with how to complete operational tests for fixed firefighting systems, especially the low-pressure types.

2. That the U.S. Coast Guard initiate a rulemaking to the marine safety regulations which would require the ability to remotely close sideport doors which form part of the hull from a position outside the protected space during an emergency. The U.S. Coast Guard should propose a similar amendment to the SOLAS rules.

3. Should the efforts to pursue regulations fail, Maersk Line Limited and other vessel operators with similar sideport door arrangements, should include a policy in their respective Safety Management Plans to keep these doors closed when the engineers are not receiving machinery supplies or equipment. The policy should specifically prohibit allowing these doors to remain open for ventilation purposes only.

4. That the U.S. Coast Guard initiate a 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 simulate activating the fixed firefighting system. The U.S. Coast Guard should propose a similar amendment to the SOLAS rules.

5. That the U.S. Coast Guard initiate a rulemaking to the marine safety regulations that would require a position indicating device to readily determine if the main stop valve on a low-pressure CO2 tank is open or closed. The U.S. Coast Guard should propose a similar amendment to the SOLAS rules.

6. That Military Ocean Terminal, Sunny Point (MOTSU) fire brigade obtains at least one thermal imaging camera and become familiar with the general arrangements of each vessel that calls at their facility.

7. That U.S. Coast Guard Marine Safety Office Wilmington, NC and MOTSU work together to reduce the response time for MOTSU's fire tug from four hours to one hour, and update the Southern Coastal North Carolina Marine Firefighting Contingency Plan.

8. That the Officer in Charge, Marine Inspection Wilmington, NC consider initiating administrative Suspension and Revocation actions against the licenses issued to the following individuals: Robert Vranish (Master), Louis Champa, Sr. (Chief Engineer), William McDonald (Chief Mate) and Peter Donat (Second Assistant Engineer).

9. That civil penalty actions be taken against Maersk Line Limited for failing to correct the problems associated with the TLI sensors.

10. That Commandant (G-MOC-2 and G-MSE-4) work together to determine which ships still have the Ginge-Kerr low-pressure CO2 system and notify the owners of the potential problems associated with the failure of the main block valve to open in case of power failure. G-MSE-4 should review and approve all design and operation plan modifications to include removal of the electric solenoid valve. Additionally, G-MSE-4 should review and approve modifications to reduce the number of steps (from three to two) needed to release CO2 from the remote control stations. During the interim, G-MOC-2 should inform the owners, as well as ABS surveyors and USCG marine inspectors, on the importance of ensuring the crews on ships fitted with a Ginge-Kerr system know how to operate the bypass valve in case of power failure.

11. That Maersk Line Limited amend their shipboard familiarization program to be consistent with the guidance set forth by STCW 95, Section A-VI/1.

12. That a copy of this investigative report be provided to the following organizations: Military Sealift Command, Military Ocean Terminal Sunny Point, Maersk Line Limited, American Bureau of Shipping, International Maritime Organization, U.S. Coast Guard Marine Safety Office Wilmington, NC, and the estates of Mr. Paul Powell and Mr. Horace Beasley.

13. That this investigation be closed.

R. J. Raksnis

R. J. RAKSNIS