

DEPARTMENT OF TRANSPORTATION



COAST GUARD

MARINE CASUALTY REPORT

M/V VENUS; EXPLOSION AND FIRE ON THE
ST. LAWRENCE RIVER ON 4 MAY 1972 WITH LOSS OF LIFE

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

ACTION BY
NATIONAL TRANSPORTATION SAFETY BOARD

REPORT NO. USCG/NTSB - MAR-74-5

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16. Abstract On May 3, 1972, operations to clean the cargo tanks were started on the M/V VENUS, anchored in the St. Lawrence River. The washing of the tanks commenced at 1800. Shortly after midnight on May 4, the chief mate instructed the third mate to supervise the gas-freeing of the tanks. At approximately 0050, an explosion occurred in the No. 1 center tank. Within a minute, a second and more severe explosion caused extensive structural damage in the No. 1 port and center tanks. The master of the VENUS was killed as a result of the second explosion. This report contains the action taken by the National Transportation Safety Board in determining the probable cause of the casualty and in making recommendations to prevent its recurrence. The report also contains the Marine Board of Investigation report and the action taken by the Commandant, U.S. Coast Guard. The National Transportation Safety Board determines that the probable cause of the initial explosion was (1) the presence of explosive gasoline vapors in the forward deckhouse, where ignition sources were permitted, and (2) the existence of a trail of vapor from the deckhouse back to the gases within the No. 1 center tank. The source of ignition for the second explosion could not be determined from the evidence. However, the continued blowing of air into the tank replaced the oxygen consumed in the first explosion and probably made the second explosion possible.			
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TABLE OF CONTENTS

	<u>Page</u>
ACTION BY THE NATIONAL TRANSPORTATION SAFETY BOARD	
Synopsis.....	1
Probable Cause.....	8
Recommendations.....	8
ACTION BY THE COMMANDANT - U. S. COAST GUARD	
Remarks.....	11
Action Concerning the Recommendations.....	12
MARINE BOARD OF INVESTIGATION	
Findings of Fact.....	14
Conclusions.....	30
Recommendations.....	33



NATIONAL TRANSPORTATION SAFETY BOARD
DEPARTMENT OF TRANSPORTATION
WASHINGTON, D.C. 20591

M/V VENUS
St Lawrence River
4 May 1972

ACTION BY THE NATIONAL TRANSPORTATION SAFETY BOARD

This casualty was investigated by a U. S. Coast Guard Marine Board of Investigation which convened at Ogdensburg, New York, on May 9, 1972. A representative of the National Transportation Safety Board observed part of the proceedings. The National Transportation Safety Board has considered only those facts in the investigative record which are pertinent to the Safety Board's statutory responsibility to determine the cause or probable cause of the casualty and to make recommendations.

SYNOPSIS

On May 3, 1972, operations to clean the cargo tanks were started on the M/V VENUS, anchored in the St. Lawrence River. The washing of the tanks commenced at 1800. Shortly after midnight on May 4, the chief mate instructed the third mate to supervise the gas freeing of the tanks.

The third mate had no previous experience in this activity. Under his direction, air blowers were placed over the Butterworth openings to the No. 1 center tank. The gasoline vapors expelled from the hatch opening entered the forward deckhouse through open doors, small openings in the bulkhead, and a vent to the officers' washroom. Smoking and equipment which was not explosion-proof were permitted in the forward deckhouse.

At approximately 0050, on May 4, an explosion occurred in the No. 1 center tank. Within a minute, a second and more severe explosion caused extensive structural damage in the No. 1 port and center tanks.

As the crew began to fight the fire, crewmembers found the master of the VENUS unconscious on deck. Attempts to revive the master failed.

The National Transportation Safety Board determines that the probable cause of the initial explosion was (1) the presence of explosive gasoline vapors in the forward deckhouse, where ignition sources were permitted, and (2) the existence of a trail of vapor from the deckhouse back to the gases within the No. 1 center tank. The source of ignition for the second explosion could not be determined from the evidence. However, the continued blowing of air into the tank replaced the oxygen consumed in the first explosion and probably made the second explosion possible. Contributing to the accident were:

1. The failure to maintain a fume-tight boundary between the crew quarters and the gasoline vapors exhausted from the No. 1 center tank.
2. The uncontrolled discharge of voluminous explosive vapors in the deck area, and the lack of flame screens on the tank discharge to prevent gases accidentally ignited outside of the tank from reaching the contents of the tank.
3. The absence of specific procedures for cleaning cargo tanks which contained gasoline residue.
4. The inability of the tank-venting supervisor and crew to recognize the hazardous situation that had developed.

ANALYSIS

Initiation of Explosions

Before the first explosion, flammable gasoline vapors enveloped the deck area in the vicinity of the No. 1 tanks, the adjoining areas alongside the ship, and the area of the crew quarters in the forward deckhouse. The existence of these vapors was subsequently confirmed by eyewitness descriptions of the location and outline of the burning vapors which constituted the first explosion. No witness, however, was able to describe whether the flame traveled from the forward crew quarters toward the No. 1 center tank, or vice versa. A roar or rumble that can be associated with a traveling flame front preceded the explosive flames that were emitted from the No. 1 center tank trunk opening. Although a flame front could propagate within the tank, no rumble was heard before the second explosion, which was not

associated with any burning vapors in the crew quarters. Therefore, since the only activity near the No. 1 center tank immediately before the first explosion was the draining of condensate from one of the blowers (which could not have caused ignition), the most probable origin of the first explosion was the ignition of the gasoline vapors inside the forward crew quarters.

In response to a specific question, a witness said that he saw a blue flame in the crew quarters before the second explosion. He was not asked whether he saw the flame before or after the first explosion. Thus, the blue flame could have been associated with the first explosion. Although the specific source of ignition was not determinable from the evidence, since the forward crew quarters was neither designed with explosion-proof devices nor operationally controlled to prevent the occurrence of ignition temperatures, discovery of the specific ignition source would merely confirm which one of the numerous available sources actuated the first explosion.

The first explosion was reported to have done very little visible damage outside the tanks. After the explosion, the steam-driven blowers continued to blow air into the No. 1 center tank. The additional oxygen forced into the tank combined with gasoline vapors generated from the heated gasoline residue in the bottom of the tank and exploded. The delay of about 1 minute until the second explosion may have resulted from the time required to generate the gas vapors, exhaust the burned gases in the tank, and supply sufficient oxygen to support a new explosion in the still hot tank. Thus, if it had been possible to turn off the blowers immediately after the first explosion, the probability of a second explosion would have diminished.

When the No. 1 port tank exploded violently in the second explosion, the master was killed and the ship was seriously damaged. It is, however, unlikely that the second explosion initiated within that tank. If the first explosion had ruptured the bulkhead between the No. 1 center and port tanks, the explosive gases in the No. 1 port tank would have been more easily ignited immediately than after a delay. On the other hand, heat conducted from the No. 1 center tank to the No. 1 port tank through the steel bulkhead possibly could have ignited the gases in the No. 1 port tank after a delay. However, this is unlikely, since the No. 1 starboard tank, which should have been subjected to the same heating, did not explode. Thus, the mechanism by which the explosive vapors in the No. 1 port tank ignited cannot be explained from the evidence available.

Minimizing the Risk of Explosion

The quantity of explosive gases admitted to the forward crew quarters on the VENUS through the wireway openings and through the washroom vent opening cannot be determined. However, since they did contribute to the hazard, such openings should be eliminated. In addition, the adequacy of the closed wooden companion doors to prevent passage of gasoline fumes should be confirmed.

Upon commencement of gas-freeing operations, the risk of explosion increases greatly because of (1) the opening of the tank boundaries and (2) the activities conducted inside the tanks. To minimize the risk of explosion, gasoline vapors should be diluted to below the lower explosive level in the least possible time; the gases should contact the least possible number of surfaces and should be discharged into unconfined regions not likely to have ignition sources.

The commonly used method of blowing air into the top of a tank results in a relatively long time to achieve gas-free conditions, because most of the dense gasoline-rich vapors emitted by the gasoline residue are at the bottom of the tank. Since these vapors must be distributed throughout the tank before they can be forced out, the process is slow and inefficient. Furthermore, this ventilation process causes the actual volume of explosive gases to increase by destroying the overly rich layers of vapors at the bottom of the tank. If a suction method could be devised to remove these overly rich gases from the bottom of the tank, a safe zone free of explosive gases would be established at the top of the tank and could then be extended downward. The destruction of the overly rich layer at the bottom would then be avoided. Some mixing would still occur because of turbulence, but the gas-freeing system would be much faster, safer, and more efficient.

The method of blowing air into the top of the tank also produces a small pressure within the tank. As a result, since each tank is equipped with a vent pipe and since these pipes are often interconnected, explosive gases can be forced from one tank into another during the approximately 1 hour that each tank is ventilated. A suction system would avoid unknown blowing of explosive gases into a supposedly safe tank. In case of an explosion in one tank, however,

neither system can insure that the interconnected vent pipes might not serve to ignite other tanks with explosive atmospheres. To preclude such a possibility, separate vent pipes are necessary or a flame screen must be used to interrupt any vent piping from one tank to another.

So many variables affect the gases blown out of tanks that the distribution of vapors and the limit beyond which they will not ignite cannot be predicted. The strength of the gasoline odors can provide a rough guide. As was the case in the casualty, however, the sense of smell of the men involved in the gas-freeing operation is impaired by the very strong odors in the work area. Neither a mechanical nor a human detection system sufficiently reliable to discover the entry of explosive gases into unwanted areas appears feasible.

Establishment of fume-tight boundaries to exclude entry of explosive gases was the generally understood protection standard aboard the VENUS. However, neither the operational procedures nor the ship design and inspection procedures precluded explosive gases from entering the crew quarters area through the washroom vent (installed within 9 feet of tank trunk opening), the obscured open wireway holes (within 6 feet), and the open companionway doors. The many possible paths and accumulations of gases forced out of the tank openings make it difficult to devise operational procedures suitable for all situations and still not so onerous as to invite violations. On the VENUS, it was generally understood that the companionway doors were "to be kept closed" during tank ventilation. However, this general rule was interpreted to imply "except when in use." There was no limitation on the frequency of use and no assurance that normal traffic through the doors would not have admitted sufficient vapors into the unventilated crew quarters area which could still have been ignited. Once ignited, a flame could have traveled back to the tank even if the doors had been closed, because these wooden doors were not designed to prevent the passage of flames.

Control of the vapors blown out of the tanks would avoid some major problems of explosive vapors drifting into dangerous areas. Means can be developed to duct the vapors and direct them downward over the side of the ship. The explosive vapors will then be exiting close to the water where sparks are less likely to occur; the heavy gases will remain close to the water surface while diluting. As a further safeguard, a flame screen placed over the tank opening would prevent the tank contents from exploding even if the ducted gases

should be ignited.

Supervisor Qualifications

The third mate had never worked on board a tankship before April 26, 1972, when he joined the VENUS. He was deemed to be qualified in accordance with Coast Guard standards for employment on the vessel, even though he had no previous knowledge of the procedures used in cargo-tank cleaning operations. There are no Federal regulations which require that only qualified personnel supervise tank washing and gas-freeing activities. The absence of such regulations has created a question as to who is required to train personnel to supervise these activities.

The Marine Board of Investigation stresses the need for Coast Guard involvement in the qualification procedures. If the remarks noted in the Marine Board's recommendation No. 2 to the Commandant are acted upon, tankship officers would have to have at least a basic knowledge of cargo-tank cleaning operations and related hazards.

Shipboard Training

The supervisors. The training that the third mate received on the VENUS consisted of on-the-job experience when the cargo tanks were being washed on May 13. He was not aware of and was not instructed on the hazards which could have existed when the gasoline vapors were expelled from the tank. As a result, he showed no concern when the vapors were not dispersed from the immediate area of the accommodation spaces.

Cargo-tank cleaning procedures cannot be standardized for all tankships. Many variables exist which necessitate that the procedures meet the requirements of the individual vessel. These variables include the design of the vessel, the size and location of the cargo tanks, the product residue within the tanks, and the degree of cleanliness required before the next cargo is received.

At the present time, officers are considered qualified as tankermen by the merit of their general license and are not required to have actual prior experience or training. The Coast Guard Marine Board has recommended that this defect in the licensing system be eliminated by requiring tankerman endorsements on the licenses. Such action would ensure that an officer who serves on a tankship is

basically qualified to supervise tank-cleaning operations. However, in order for the supervisor to have a clear understanding of the specific procedures used on a particular tankship, he must receive training on board the vessel.

The chief mate had knowledge of the third mate's inexperience. He relied, however, on the proficiency of the crewmembers engaged in gas-freeing the tanks. When he directed the third mate to supervise the gas-freeing operations, his only instructions were "If there are any questions or difficulty, just let me know and we'll take it from there."

The crew. The reliance on the VENUS crewmembers, who were not required to have training in tank cleaning, was based on the amount of service they had on tankships. There were no written procedures or safety instructions specifically for tank cleaning on the VENUS. Publications on the hazards of dangerous cargoes were not readily available to the crew.

A training program on a tankship should include more than just on-the-job education. The necessity for recognizing and reporting hazards discovered during tank cleaning by all crewmembers is apparent. Information taken from Coast Guard and other publications regarding dangerous-cargo hazards could be used during safety meetings to stress to the crew the dangerous situations that can occur when cargo tanks are cleaned. For example, the tank-washing methods used on the VENUS include connecting the Butterworth equipment to a fire hydrant, which impairs the firefighting capability of the ship. If safety meetings had been held before the casualty, discussions about the hazards that gasoline vapors might cause on the VENUS could have alerted the crew to the hazards that existed on May 4. ^{1/} As a result, the explosions could have been prevented.

^{1/} On May 4, 1972, the vented gasoline vapors were not being dissipated from the immediate vicinity of the forward accommodation spaces, the odor of the fumes permeated the forward accommodation spaces, and the doors to the accommodation spaces, when discovered open, were not closed.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the initial explosion was (1) the presence of explosive gasoline vapors in the forward deckhouse, where ignition sources were permitted, and (2) the existence of a trail of vapor from the deckhouse back to the gases within the No. 1 center tank. The source of ignition for the second explosion could not be determined from the evidence. However, the continued blowing of air into the tank replaced the oxygen consumed in the first explosion and probably made the second explosion possible. Contributing to the accident were:

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2. The uncontrolled discharge of voluminous explosive vapors in the deck area, and the lack of flame screens on the tank discharge to prevent gases accidentally ignited outside of the tank from reaching the contents of the tank.
3. The absence of specific procedures for cleaning cargo tanks which contained gasoline residue.
4. The inability of the tank-venting supervisor and crew to recognize the hazardous situation that had developed.

RECOMMENDATIONS

The National Transportation Safety Board concurs in recommendations 1 through 4 of the Coast Guard Marine Board of Investigation and further recommends that the U. S. Coast Guard:

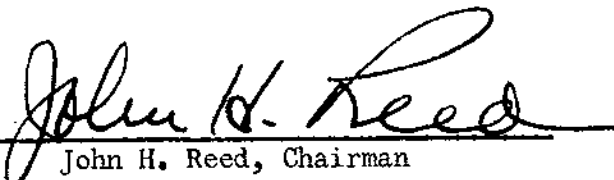
1. Require that safety meetings be held on tankships to instruct supervisors and crewmembers in the specific procedures used to wash and gas-free cargo tanks on the particular tankship. (Recommendation No. M-74- 20)
2. Conduct a special inspection on the VENUS and similar tank vessels operating on the Great Lakes to make certain that inadequacies concerning the

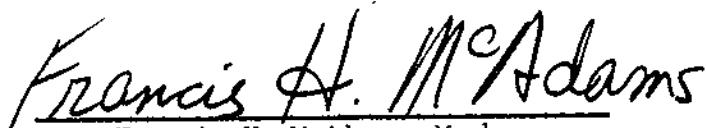
prevention of entry of inflammable vapors into the deckhouses which were revealed in this investigation have been corrected. (Recommendation No. M-74-21)

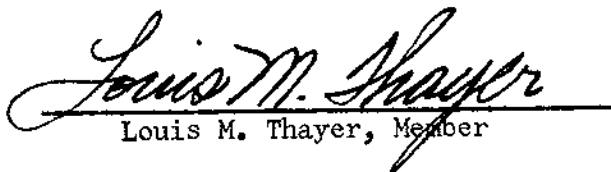
3. Require that all hazardous gases forced out of cargo tanks during gas-freeing operations shall be ducted to the safest areas available, preferably over the downwind side of the ship. In addition, a flame screen should be required in the duct or at the tank opening. (Recommendation No. M-74-22)
4. With the assistance of industry, develop methods to gas-free cargo tanks by suction processes which remove the vapors from the densest regions of the tank. (Recommendation No. M-74-23)
5. Evaluate the need for all future installations of normal cargo vent piping to contain an individual flame screen for each tank, in lieu of permitting a flame screen from a header to serve several tanks. (Recommendation No. M-74-24)

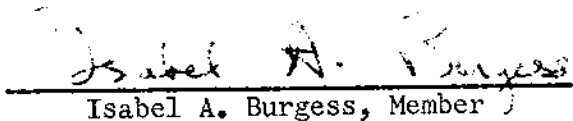
BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

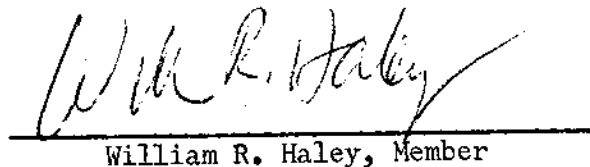
Adopted this 27th day of June 1974:


John H. Reed, Chairman


Francis H. McAdams, Member


Louis M. Thayer, Member


Isabel A. Burgess, Member


William R. Haley, Member



DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

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U.S. COAST GUARD (GMVI-3/83)
400 SEVENTH STREET SW.
WASHINGTON, D.C. 20590
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5943/VENUS
A-9 Bd

18 APR 1973

Commandant's Action

on

The Marine Board of Investigation convened to investigate circumstances surrounding the explosion and fire on board the M/V VENUS on the St. Lawrence River on 4 May 1972 with loss of life

1. The record of the Marine Board of Investigation convened to investigate subject casualty has been reviewed; and the record, including the Findings of Fact, Conclusions and Recommendations is approved subject to the following comments and the final determination of the cause by the National Transportation Safety Board.

REMARKS

1. Concurring with the Marine Board of Investigation it is considered that the primary cause of the casualty was the ignition of gasoline vapors by some smoking article in the forward lower crew accommodations or the spontaneous combustion of apparel left on the radiator or rags stored in the deck gear locker.

2. It seems clear that this casualty resulted from many deficiencies and the lack of clear operating procedures that prevailed on the VENUS. Concurring with the Board's Conclusion No. 5, the lack of training and the careless and inattentive manner of operation of the VENUS contributed heavily to the cause of the casualty.

3. The Facts and Conclusions that allude to possible violation of law or regulation or negligence in the performance of duty, were closely examined. The decision of the Board not to pursue this matter due to insufficient evidence to sustain a charge under R.S. 4450 is concurred with. This case of possible negligence is considered to have been

effectively dealt with due to the obvious deterrent effect that the Board's searching investigation will have upon the officer involved and upon the others examined in this instance.

4. The Board also determined that the vessel had in fact failed to conduct fire and boat drills as required during the three weeks preceding the casualty. This violation of regulations requiring weekly fire and boat drills was not considered to have contributed to the crews performance during the fire and explosions. Again due to the development of all of the facts and the references to the regulations requiring said drills during the Board Proceedings, the ship's officers and crew were more than adequately reminded of the requirement for compliance with the regulations. The Board's decision not to cite the vessel or operators for this violation is considered in keeping with the real purpose of casualty investigation - findings of facts to prevent similar casualties in the future, rather than to issue Violation Notices. The deterrent of such citations had already been accomplished by the thorough investigation conducted including, especially, the interrogation of witnesses. In addition, the owner/operators have been reminded officially of the requirement of regulations requiring weekly fire and boat drills. This reminder was accomplished by letter from Coast Guard Headquarters.

5. The Facts and Conclusions which relate to the possibility that the fire hose was not tested in accordance with Title 46 Code of Federal Regulations 31.01-18(g) will be investigated. Although the hose failure in this casualty did not contribute to the incident, steps to eliminate improper testing procedures, if they exist, are a part of the Coast Guard's standard procedure in improving marine safety inspections.

ACTION CONCERNING THE RECOMMENDATIONS

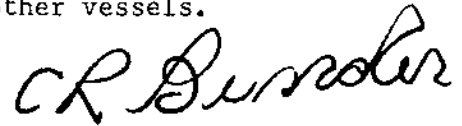
1. The recommendation that this report be given wide dissemination in the marine field by means of the Marine Safety Council Proceedings after final Action by the Commandant and the National Transportation Safety Board is concurred with and will be accomplished. All Marine Boards are given wide dissemination in the marine field by direct copies of the Board's Findings, Commandant's Action and the final Action by the National Transportation Safety Board. Some 400 copies of each Marine Board are distributed automatically at the time of publication. This distribution includes industry associations and operating companies.

2. The recommendation that the Coast Guard review 46 USC 391a(6) which permits licensed officers of inspected vessels of the United States to serve as tankerman is concurred with. The specifics of recommendation #2 will be studied and appropriate action taken to amend the existing regulations if found to be necessary.

3. The recommendation that the rules and regulations for tank vessels be amended to include a section on safety for tank cleaning and tank gas freeing operations will be considered along with a general review of tanker operations that is presently underway pertaining to tank cleaning operations. The results of this literature review could include regulation changes.

4. The Manual for the Safe Handling of Inflammable and Combustible Liquids, CG-174, is presently under contract for revision. The revision will include dangerous products presently regulated under 46 CFR Part 151. The recent casualties involving tank cleaning have been brought to the attention of the contractor personnel that are preparing this manual and safe tank cleaning procedures will be considered in the rewrite.

5. The recommendation to amend the Merchant Marine Safety Manual to include in Chapter 3 a section on proper testing of fire hose in the field is not concurred with. The inspection and testing of fire hose is adequately covered in the Rules and Regulations for Tank Vessels, CG-123, and in the appropriate sub-chapters for the inspection of other vessels.



C. R. BENDER
Admiral, U. S. Coast Guard
Commandant



DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:

11 October 1972
5943 M/V VENUS

From: Marine Board of Investigation
To: Commandant (GMVI)

Subj: M/V VENUS (O.N. 227895); explosions and fire in the St. Lawrence
River on 4 May 1972, with loss of life

FINDINGS OF FACT

1. At approximately 0050 EST on 4 May 1972, the inspected tanker M/V VENUS, at anchor in Wilson Hill Anchorage in the St. Lawrence River, sustained two explosions and a fire while gas-freeing tanks. The casualty resulted in the loss of one life and injuries to four crew members. Monetary loss to the vessel was estimated at \$160,000.00.

2. Vessel Data:

Name:	VENUS
Official Number:	227895
Service:	Tankship
Built:	Lorain, Ohio
Year:	1928
Gross Tons:	2935
Net Tons:	1994
Length:	334.0'
Breadth:	51.2'
Depth:	18.9'
Propulsion:	Diesel
Horsepower:	3200
Home Port:	Wilmington, Delaware
Owners:	Cleveland Tankers, Inc. 100 West 10th Street Wilmington, Delaware 19801
Operators:	Cleveland Tankers, Inc. 1000 One Erieview Plaza Cleveland, Ohio 44114
Master:	Charles S. Stanley License No. 397086 USMMD Number Z-398638
Last Inspection Date:	9 April 1972

Marine Board of Investigation, M/V VENUS

Port: Sturgeon Bay, Wisconsin
 Route: The Great Lakes
 Issued at: Chicago, Illinois
 Capacity: 35,714 bbls.
 Grade: "A"
 Loadline Certificate Issued by: ABS
 Number: GL-876-4

3. The VENUS is a steel hulled tank vessel in the common Great Lakes configuration. The forward housing contains the navigation bridge, deck officer and unlicensed deck personnel crew quarters. The remainder of the crew are quartered aft over the machinery space and surrounding recreational and messing areas. The vessel is divided by transverse bulkheads into five cargo tanks numbered from forward to aft. All tanks are subdivided into port wing, starboard wing and center compartments by two longitudinal bulkheads. None of the tanks are provided with cathodic protection nor are they specially coated for protective or cleaning purposes. Venting for the No. 1 tank compartments is by individual 3-inch pipe branch lines from the expansion trunks of each compartment. Seven feet aft of the No. 1 center tank trunk, the vent lines join together at a cross fitting and continue on through 4-inch piping to a Vac-Rel pressure vacuum relief valve located in a header system with the other tank vents. The 3-inch vent lines from the wing tanks to the cross connection measure approximately 14 feet on the port side and 19 feet on the starboard side. Inasmuch as the No. 1 tanks are not independently vented, there are no manually operated closure valves in the vent lines. Each No. 1 tank compartment is provided with two round tank cleaning openings on deck (Butterworth holes) approximately 13-1/2 inches in diameter. Closure is by a 19 inch in diameter round heavy plate fitted over 10 deck studs capable of being gasketed and bolted down. Each tank compartment trunk provides the access into the tank and has large gasketed rectangular steel covers capable of being dogged down. The center tank cover is 5' x 7' with 14 dogs and the wing tank covers are 4' x 6' with 10 dogs. Each wing tank cover has two 9 inch ullage openings fitted with portable flame screens and gasketed steel covers with 4 dogs. The center tank has an ullage opening in the deck provided with a portable flame screen and a gasketed steel cover with 4 dogs. Tank measurements and capacities for the No. 1 tank are as follows:

<u>No. 1 Wing Tanks (each)</u>		<u>No. 1 Center</u>	
Length	36'08"	Length	36'08"
Width	8'03" (average)	Width	33'08"
Height	17'06"	Height	27'06"
Capacity	5284.125 ft ³ 1,060.3 bbls.	Capacity	27,214.5 ft ³ 5,439.98 bbls.

Marine Board of Investigation, M/V VENUS

4. Primary fire fighting equipment for the VENUS consists of a foam smothering system for the cargo holds. The system operates from a 200 gallon capacity foam concentrate tank through a foam proportioner to a 1/4" deck main with a foam monitor and an auxiliary foam hose station at No. 1 and No. 3 tank and a monitor and two auxiliary foam hose stations at the after end of No. 5 tank. The proportions utilized are 3% foam concentrate to 97% injected sea water. A deck fire main system is provided with hydrants located at 9 stations throughout the vessel provided with 1-1/2" lined hose and approved combination nozzles. A total of 650 feet of hose is required on the vessel. In addition to numerous portable and semiportable fire extinguishers located throughout the vessel, there is a 100 pound CO₂ fixed system for the pump room and a steam smothering system for the paint locker. The foam system has a 200 gallon per minute centrifugal pump with a relief valve setting of 125 p.s.i. The vessel is also provided with two fire pumps with relief valves set at 125 p.s.i.

5. List of dead and injured:

a. The following person lost his life as a result of this casualty:

<u>Name and Address</u>	<u>Capacity</u>	<u>Next of Kin</u>
Charles S. STANLEY 663 Radford Drive Highland Heights, Ohio - 44124	Master License No. 397086 MMD No. Z-398638	Martha STANLEY (wife) 663 Radford Drive Highland Heights, Ohio - 44124

b. The following persons were incapacitated in excess of 72 hours as a result of this casualty:

<u>Name and Address</u>	<u>Capacity</u>	<u>Summary of Injuries</u>
Emery C. DUGAN Pleasant Street Rockdale, Mass.	3rd Mate License No. 38114 MMD No. Z-769080-D1	Facial burns
Edwin MAREK P.O. Box 223 Sturgeon Bay, Wisc.	Deckhand MMD No. Z-1237482	First degree facial burns - Second degree burns of the lower back - Third degree burns of both hands
Edward M. Kuhn 4360 S. 112th St. Greenfield, Wisc.	Deckhand MMD No. 397 26 6477	Facial burns Laceration of right hand (minor)

Marine Board of Investigation, M/V VENUS

<u>Name and Address</u>	<u>Capacity</u>	<u>Summary of Injuries</u>
Kenneth R. Callahan 3344 Michigan Avenue East Chicago, Indiana and 204 Nichols Street Dalton, Georgia	AB-Watchman MMD No. Z-1139741	Facial burns Left hand burns Right hand laceration (minor)

6. Weather data:

a. The weather data recorded at the time of the casualty at the Eisenhower Lock Control Tower, 9.5 statute miles from the Wilson Hill anchorage, was hazy with easterly winds at 4 MPH and visibility of one mile.

b. Weather observed aboard the VENUS was light airs from the relative direction of the vessel's stern or quarter. No precise record was made of the local temperature but it was above freezing and estimated to be in the 45° - 50° F. range. Weather conditions were not considered severe by those working on deck. Visibility just prior to the casualty was generally described as hazy. After the explosion, the Seaway Pilot William C. McCorkell noted a E to SEly light wind and approximately 15 minutes after the explosion dense fog set in.

7. On 2 May 1972 at 1815 EST the VENUS arrived at the Agway Corporation dock in Ogdensburg, New York and discharged bulk petroleum products previously loaded at the Ashland Refinery in Tonawanda, New York on 30 April and 1 May 1972. The cargo consisted of approximately 21,000 bbls house brand gasoline, 7,000 bbls premium gasoline, and 6,000 bbls kerosene. The number 1, 3 and 5 tanks contained the house brand gasoline; the number 2 tanks contained the kerosene; and the number 4 tanks contained the premium gasoline. Ullages and temperatures taken at Tonawanda, New York on 1 May 1972 for the house brand gasoline in the number 1 tanks were as follows:

<u>No. 1</u>	<u>Ullage</u>	<u>Temperature</u>
Starboard	0'-5"	56°
Port	0'-6"	56°
Center	1'-1-1/2"	62°

Analysis of the regular or house brand gasoline loaded aboard the VENUS on 30 April and 1 May 1972 for delivery to Ogdensburg, New York was as follows:

Gravity: 64.0

Marine Board of Investigation, M/V VENUS

Initial Boiling Point:	94°F.
5%	103°F.
10%	118°F.
50%	190°F.
90%	324°F.
95%	360°F.
End Point:	410°F.
Recovery:	98%
Residue:	1.1%
Loss:	0.9%
Reid Vapor Pressure:	10.8
Corrosion:	1 A
Doctor Test:	Sweet
Research Octane:	94.2

Analysis figures were provided by Ashland Oil, Inc., Frontier Division.

8. On 3 May 1972 at 1130 EST, the VENUS departed Ogdensburg, New York, light, for Montreal, Province of Quebec, Canada. The recorded draft was 8 feet forward and 14 feet aft. Pilot William C. McCorkell, License No. 391785, BK No. 133371 was assigned as the District Great Lakes Pilotage Act pilot. Pilot McCorkell had Certificate of Registration No. 104 issued by the Director of the Great Lakes Pilotage Staff of the U. S. Coast Guard authorizing him to perform pilotage service on the waters of the St. Lawrence Waterway - District 1. The vessel transited Iroquois Lock from 1355 EST to 1410 EST. Due to fog conditions in the St. Lawrence Seaway, the dispatcher at the Eisenhower Lock directed the VENUS to proceed to anchorage and await further orders. The VENUS anchored at 1550 EST in the Wilson Hill Anchorage. The approximate anchorage position was determined by radar distances to be Latitude 44°-56'-30" N and Longitude 75°-03'-00" W in Canadian waters. The VENUS was equipped with a DECCA radar (RM 316), tuned for statute miles, and provided with a cursor and dummy bearing ring. The vessel lay on the starboard anchor with 3-1/2 shots of chain in approximately 65 feet of water. The vessel was borne by a 1/4 to 1/2 MPH current on a general heading of 235°T with little perceptible yawing. An anchor watch of one deck officer and one AB-Wheelsman was maintained on the bridge. During the transit from Ogdensburg, No. 2 port and starboard wing tanks had been three-quarters filled with sea water for ballast purposes. The ventilation system for the forward crew accommodation spaces was not in operation due to the cool weather.

9. At 1800 EST on 3 May 1972, tank washing and gas-freeing operations for the Nos. 1, 3 and 5 tanks were commenced by Chief Officer Truman Hagbloom. Chief Officer Hagbloom was licensed as Master of Steam and Motor vessels of any gross tons upon the Great Lakes, their connecting and tributary waters and First Class Pilot between Duluth, Gary, Buffalo and North Tonawanda (License No. 397176) and USMMD Z-1132852. Chief Officer Hagbloom has had nine years experience in the marine field with six years as a deck officer and five years on tankers.

Marine Board of Investigation, M/V VENUS

10. This operation was normally carried out underway or at dockside. In this instance it was carried out at anchor to take advantage of the Seaway traffic delay, inasmuch as vessel policy precluded tank cleaning operations while transiting locks. Removal of slops from No. 2 and No. 4 center tanks and ballast from No. 2 Port and Stbd wing tanks were planned for dockside in Montreal. Final cleaning of all empty tanks, and the washing and gas-freeing of the No. 2 and No. 4 tanks were also planned for dockside in Montreal. In carrying out the tank washing and gas-freeing operations, extra seamen were provided to augment the routine watch standers. An extra deck officer and the AB-Watchman and deckhand from a watch below assisted. The pumpman, Robert W. Baugh, USMMD Z-1036634-D1, was also on deck coordinating and performing the necessary pumping operations. Pumpman Baugh has an endorsement for Tankerman, Grade B and Lower, and had been on the VENUS for 14 years of a 20 year marine experience on tankers. The tank deck was illuminated with floodlights permanently installed at intervals along the catwalk. There were no portable electric lights in use. Chief Mate Hagbloom left the deck at 2330 EST and turned in for rest. Tank washing had commenced with the No. 1 tank compartments at 1800 EST and progressed to the No. 5 tank compartments. As the compartments were washed, Pumpman Baugh stripped the slop from the tanks by pumping through the open starboard cross-over valves. The slop was then pumped into the No. 4 center tank and later to No. 2 center tank through the open port cross-over valves.

11. At 0000 EST, 4 May 1972, the Third Mate, Emery C. Dugan, was on deck in charge of and supervising the tank washing and gas-freeing operations. Third Mate Dugan was licensed as Second Mate of steam and motor vessels of any gross tons upon oceans and as First Class Pilot of steam and motor vessels of any gross tons upon the Great Lakes and their connecting and tributary waters between Duluth, Minnesota, Gary, Indiana and Buffalo, New York (License No. 381114, Z-769080-D1). Although he had been licensed as a deck officer for approximately twenty years, Third Mate Dugan's experience on tank vessels was limited to his eight days on the VENUS, having joined the vessel on the 26th of April 1972. The Second Mate, Arthur R. Bristow, (License No. 391820, Z-1190504) was in the wheelhouse and had the bridge anchor watch along with AB-Wheelman Joseph S. Daymound (USMMD No. Z-53972-D1). The bridge watch was set to maintain an anchorage position watch and a phone watch. The men under the Third Mate's direct supervision on deck in the vicinity of No. 1 tank were as follows:

<u>Name</u>	<u>Capacity & Watch</u>	<u>Qualifications</u>
Stuart S. Schmidt MMD Z-7612-D1	AB Watchman 8 - 12 Watch	No Tankerman Endorsement. 7 - 8 years experience on tank vessels
Edward M. Kuhn MMD Z-397-26-6477	Deckhand 12 - 4 Watch	No Tankerman Endorsement. 2 years experience on tank vessels

Marine Board of Investigation, M/V VENUS

<u>Name</u>	<u>Capacity & Watch</u>	<u>Qualifications</u>
Kenneth R. Callahan MMD Z-1139741	AB-Watchman 12 - 4 Watch	No Tankerman Endorsement. 3 years experience on tank vessels
Edwin Marek MMD Z-1237482	Deckhand 8 - 12 Watch	No Tankerman Endorsement 5 years experience on tank vessels

12. Washing operations in the No. 5 tank compartments were completed at approximately 0040 EST and, as directed, Third Mate Dugan made this report to Chief Mate Hagbloom in his room. The Chief Mate thereupon directed Third Mate Dugan to commence blowing the tanks. The Third Mate had never performed this operation before in his marine experience. After returning on deck, the Third Mate had the No. 1 center tank hatch cover lifted. After the hatch cover was opened by those working on deck at that time, the Coppus blowers were activated and commenced blowing air into the tanks. The blower over the port forward Butterworth opening was started first and approximately 5 minutes later the blower over the starboard after Butterworth opening was started. The hatch covers of all other cargo tank compartments were closed but not dogged. The other Butterworth openings were covered with their closure plates over the deck studs, but were not bolted down. There had been no safety check made of the area prior to commencing the tank venting operation. The operation was considered routine and there were no formal step-by-step vessel or company precautionary procedures followed prior to commencing this work. As the blowing of the No. 1 center tank continued, several crew members in the vicinity, including the Third Mate, remarked of the unusually strong gas smell in the area. Shortly after the tank venting commenced, Callahan left the deck and proceeded to the forward lower quarters through the port companionway. The door was open and was not closed behind him. Schmidt had gone aft to obtain a wrench to tighten the blower hose connections. Pumpman Baugh was in the vicinity of No. 5 tank completing the stripping operations on No. 5 center tank. Deckhand Kuhn was draining condensate from the starboard blower. Wheelsman A. V. Coomer (USMMD Z-1079860) off watch since 0000 EST and lying awake in his bunk on the port side, smelled gas fumes and heard a person descend the ladder from the tank deck and pass close to his cabin door. Deckhands Kuhn and Marek stated that they observed that the port companionway door was open at this time. Deckhand Marek further stated that as Watchman Callahan passed him on his way below he noted him taking a pack of cigarettes from his coat pocket. Watchman Callahan, on the way to his room for a flashlight, noted nothing unusual as he passed the deck locker and proceeded through the crew hall.

Marine Board of Investigation, M/V VENUS

13. At approximately 0050 EST, an explosion occurred in No. 1 center tank compartment. The explosion was described as a loud "whooshing" noise accompanied by a bright yellow-orange fireball coming from the open No. 1 center tank hatch. Third Mate Dugan was thrown from the No. 1 center tanktop to the No. 1 port wing tanktop ten feet below, where he then retreated aft to the port quarter. Deckhand Marek was thrown to the No. 1 center tanktop deck and crawled to a point between No. 2 and No. 3 tanks where he was assisted by Watchman Schmidt. Deckhand Kuhn, crouched over the starboard Coppus blower, was protected from the main force and heat of the explosion by a deck winch although the blower tipped up and settled down in the Butterworth opening. He retreated to midships first and then returned to the general area of No. 1 center tank. Second Mate Bristow, on the bridge, immediately commenced ringing the General Alarm and rang a special call bell system to the Captain's cabin. Wheelsman Daymound, on the bridge, saw a figure run aft from the Captain's cabin door located on the starboard side.

14. The area around the explosion was engulfed in a mixture of steam and heavy smoke. Watchman Callahan stated he heard the first explosion just after he entered his room and had proceeded approximately 6 feet to where his flashlight was stowed. Watchman Callahan denied he was smoking at this time. He did not know whether the curtained screen door to the room was open or not.

15. Shortly after the first explosion, a louder and sharper sounding explosion shook the VENUS. The time interval in testimony varied somewhat, but it is estimated to have been approximately one minute in view of several events that transpired during the period. Chief Mate Hagbloom, aroused by the first explosion, was thrown back as he proceeded up the starboard stairway leading to the tank deck. Third Officer Dugan, standing on the port quarter, witnessed the second explosion and saw the flames coming from the direction of No. 1 port wing tank and No. 1 center tank. He also heard debris hitting the water around the vessel. Wheelsman Schmidt and Deckhand Marek, in the vicinity of No. 2 and No. 3 center tanks, were knocked to the deck. Deckhand Kuhn, returning to the starboard side of No. 1 center tank, witnessed a high and bright yellow fireball coming from the general area of No. 1 center tank hatch. Through the dense smoke and steam he was aware of another person, whom he could not identify, near him but further forward and to the starboard of him. Deckhand L. Smith, asleep in his cabin near the deck gear locker, was knocked out of his bunk to the deck. He noted the curtains over the screen door to his room were on fire. He put out the curtain fire by slapping with his hand. He then went out into the crew hall and, along with Wheelsman Coomer and Wheelsman H. Williams, put out several burning newspapers which had been scattered about the decks. After the newspaper fires had been extinguished, mainly by stomping, the crew members below, including Chief Mate Hagbloom and with the exception of Watchman Callahan, exited the lower berthing area by using the emergency escape ladder in the forward end of the compartment to the forecastle deck.

Marine Board of Investigation, M/V VENUS

The after companionways were at this time filled with dense smoke and flames beyond the door. Deckhand Smith noted a fire glow through the smoke in the general direction of the deck gear locker as he departed.

16. Just prior to the second explosion Watchman Callahan, who was leaving his room on the starboard side of the crew hall, observed a blue flame flash low over the crew hall deck followed by the violent explosion. The direction from which it came or went was not ascertained. Callahan noted the burning newspapers and the other men emerging from their rooms. He used the starboard companionway to escape.

17. As the Chief Mate Hagbloom emerged on the forecastle deck from the lower crew accommodations, he proceeded around the starboard side and found the Master, Captain Stanley, lying face down on the deck near the starboard companionway leading below. Joined by other crew members and the Second Mate Bristow, who had come from the bridge, a quick examination of the Master was made and it was decided to take him aft to the quarters there. Second Mate Bristow attempted to get a pulse but none was felt. The Master was put on a blanket and taken aft to the First Assistant Engineer quarters by Deckhands Kuhn and Smith and Watchman Schmidt. Deckhand Kuhn stated that he noted the Master breathing when he first came upon him and turned him over. He further stated that he attempted to stimulate the Master's breathing by chest pressure while in the First Assistant Engineers quarters, but to no avail.

18. Shortly after the two explosions, Pilot McCorkell returned to the bridge and by radio telephone informed the dispatcher at Eisenhower Lock of the situation aboard the VENUS. Crew members commenced converging on the scene to fight the fires evident in No. 1 port wing and center tank compartments. The foam extinguishing system pump was started by the engineer on watch. Foam was directed into the open No. 1 center tank hatch opening by Watchman Callahan using the forward foam monitor at No. 1 tank. Watchman Schmidt commenced to rig one of the auxiliary foam stations at the forward monitor but the hose broke as pressure was applied to it. The foam system was continued in use even after the foam supply was expended. Ordinary sea water through the system was utilized at the forward and midship monitors to cool the decks. Chief Mate Hagbloom, Second Mate Bristow and Watchman Callahan combined efforts to extinguish the fire that had developed in the deck gear locker on the after end, port side of the crew hall. The fire which was both hot and smoky was successfully fought from the port companionway stairs with water from a 50 foot length 1½" hose connected to the foam system main. As the fire came under control, the fire hose burst in two places.

19. Chief Mate T. Hagbloom, realizing the condition and possible fate of Captain Stanley, assumed the role of Acting Captain. Although the fires were now under control, the VENUS was developing a list to port. A check over the bow indicated the forward draft had increased considerably. Concerned over the vessel's stability and watertight integrity, Acting Captain Hagbloom coordinated with Pumpman Baugh and commenced pumping operations. The No. 1 tank compartment valves were closed off and pumping of No. 2 port

Marine Board of Investigation, M/V VENUS

wing tank ballast was commenced through open crossover valves in the starboard line. As soon as the VENUS was on an even keel, pumping was commenced from No. 2 center tank. The No. 2 tank compartments were pumped down partially to prevent possible hydrostatic pressure carrying away the bulkheads.

20. Pumping the slops and wash water residue from the No. 2 center tank resulted in some pollution of the St. Lawrence River.

21. The Vessel Traffic Controller at the Eisenhower Lock, Mr. R. Sheets, was first aware of the explosion and fire on the VENUS at 0100 EST. The first report was transmitted by radio-telephone from the Canadian vessel GUARD MAVOLINE, also anchored in the Wilson Hill Anchorage. Shortly thereafter this report was confirmed by Pilot William McCorkell's radio message from the VENUS. The St. Lawrence Seaway tug ROBINSON BAY moored near the Snell Locks was alerted to get underway. The McAllister Towing Company Ltd., tug SALVAGE MONARCH moored on the upstream guide wall was advised of the situation on board the VENUS. Captain Bouchard of the SALVAGE MONARCH agreed to assist and embarked St. Lawrence Seaway Development Corporation Operations Superintendent John C. Cartin, two SLSDC personnel and the Massena Rescue Squad. The SALVAGE MONARCH then proceeded to assist under conditions of dense fog and zero visibility, aided by radar. The Canadian workboat CONSTRUCTOR and the SLSDC workboat FOURTH COAST were also dispatched, but they became fogbound at 0120 and were unable to continue. The SALVAGE MONARCH arrived at the VENUS at approximately 0230 EST. The tug crew immediately ran out fire hose assisted by SLSDC personnel and the Massena Rescue Squad administered first aid to the injured VENUS crewmen. An inspection of the damaged areas by Mr. Cartin and Acting Captain Truman Hagbloom established that the situation had stabilized and the vessel was in no immediate danger of sinking or of further fire. At 0458 EST the USCGC MAPLE was directed by the Cleveland Coast Guard Search and Rescue Coordinator to monitor the situation. The USCGC MAPLE arrived on scene at approximately 1100 EST.

22. At 0345 EST, in zero visibility the Canadian tug SALVAGE MONARCH left the VENUS with the body of Captain Stanley and four injured personnel of the VENUS for Eisenhower Lock where they were met at 0435 EST by Dr. L. C. Weston, M.D. of 14 Hospital Drive, Massena, New York, and St. Lawrence County Coroner David E. Donaldson. Captain Charles S. Stanley was pronounced dead at this time. Death was described as "immediate". The four injured personnel were removed to Massena Memorial Hospital, Massena, New York for treatment. Edwin Marek, deckhand, was admitted for in-patient treatment while the remainder were treated and released.

23. An autopsy was performed on Captain Charles S. Stanley at 1200 EST on 4 May 1972 at the Massena Memorial Hospital, Massena, New York. The provisional autopsy report issued by the St. Lawrence County Laboratory on 9 May 1972 provided a gross diagnosis indicating multiple skull fracture, extensive cerebral lacerations, pulmonary contusions of the upper lobes, second degree burns of the right arm and bilateral peri-orbital hematoma.

Marine Board of Investigation, M/V VENUS

24. At approximately 0530 EST, the St Lawrence Seaway tug ROBINSON BAY arrived alongside the anchored VENUS and transferred additional foam concentrate to replace the exhausted supply on board and supplemented the fire fighting equipment. The draft of the VENUS was recorded at 12'-6" forward and 13'-09" aft. During the remainder of the day, the Coast Guard's Port Safety and Marine Inspection personnel, officials from the Canadian Ministry of Transport, the St. Lawrence Seaway Authority, the St. Lawrence Seaway Development Corporation and Cleveland Tankers, Inc., visited the vessel. An underwater survey was conducted by a diver under the guidance of Salvage Master, Keith A. Rusby of the Mc Allister Towing Co., Ltd., of 20 Grey Nuns Street, Montreal, Quebec. At 0935 EST, 5 May 1972, the VENUS proceeded under proper authorization by the Coast Guard, the St. Lawrence Seaway Authority and the St. Lawrence Seaway Development Corporation to the Vickers, Ltd. Shipyard at Montreal. The authorization stipulated the vessel was to proceed in daylight hours, under tow, and to tie up starboard-side-to in all locks enroute. The vessel proceeded with the tug SALVAGE MONARCH on the bow and the tug DANIEL McALLISTER on the stern. The VENUS had available propulsion and steering, if needed.

25. Hull and materiel damage to the VENUS after the two explosions and fire was as follows: The side hull plating in way of No. 1 port wing tank was bulged out and ruptured. The bottom hull plating in way of No. 1 port wing tank was set up and was holed by plate fractures and pulled or missing rivets. The hatch trunk to No. 1 port wing tank was buckled and torn and the hinged cover was missing. The port bulwark was distorted. The port deck stringer plate in way of No. 1 port wing tank was torn and bulged upwards. The after bulkhead of No. 1 port wing tank was torn loose at the shell connections and set back. The port side of No. 1 center tank above No. 1 port wing tank level was torn from the deck with the tank top bulged upwards. The No. 1 center tank trunk cover was blown free and the hinges broken. The port longitudinal bulkhead in No. 1 center tank was torn and set in, and the starboard longitudinal bulkhead was bulged into the center tank about 4 - 5 inches. In the No. 1 center tank, a 9" internal diameter cast iron piping from the manifold to the port wing tank suction was broken. Three branch 12" diameter cast iron cargo manifolds were fractured. A 3-1/2" internal diameter section of obsolete piping was fractured at the flange in the bulkhead between No. 1 center and No. 1 port wing tank. Many associated internal structural members were also damaged.

26. On 4 September 1969, the VENUS sustained an explosion and fire in No. 1 center tank compartment while gas-freeing operations were being conducted. One crew member was burned in the fire-fighting operations that followed the explosion. The cause was not conclusively determined. Points of similarity of the 1969 casualty to the present casualty were as follows:

- a. The same tank was initially involved.
- b. The previous cargo was gasoline.

Marine Board of Investigation, M/V VENUS

c. The trunk hatch was open exhausting gas fumes during the gas-freeing operations by a mechanical blower.

Points of dissimilarity of the 1969 casualty to the present casualty were as follows:

- a. The vessel was underway.
- b. The wind conditions were 15 knots with a relative direction from the starboard beam.
- c. All other tank compartments in the vicinity were either ballasted or gas-free.
- d. The tank blowing was conducted by one electric Coppus blower mounted over the ullage opening.
- e. The tank blowing had been in progress for a half hour.
- f. There was no materiel damage.

27. There were no company or vessel written procedures or safety instructions on the VENUS relative to tank washing. The standard procedure (and the one used on the day of the explosion) for performing this operation on the VENUS was basically as follows: One of the fire pumps and the fire main were used as the source of water for the Butterworth equipment. Wash water at approximately 90 p.s.i. was heated by a steam injector operated at 120-150 p.s.i. from an independent boiler in the engine room. On the day of the explosion, the wash water temperature was estimated to be 150 - 160°F which was considered somewhat cooler than usual due to the early season and the effect of low sea water temperatures. The Butterworth equipment was lowered by its hose attachment through the two deck openings provided for this operation in each tank compartment. In the center tanks, one drop of approximately 9 feet was made for 30 minutes washing time in each opening. In the wing tanks, due to tank structural members, a drop of 6 feet and one of 15 feet were made in each opening for 10 minutes washing time on each drop. The total washing time for the center tanks was 60 minutes and the wing tanks was 40 minutes. The wash water was pumped to a tank reserved for the slop and later disposed of at a proper shore facility. The hoses used with the Butterworth system were led from special connections conveniently located on the fire main and are of electrically bonded construction. Normally the washing operation on the VENUS was not done in conjunction with the use of the steam driven mechanical blowers in the other tanks due to capacity limitations of the independent boilers. Data taken from the two Butterworth machines used on the VENUS indicated the following:

Hilbert A/A 5920
No. 11
No. 12

The hoses were marked as being manufactured by the Butterworth Company of Bayonne, New Jersey.

Marine Board of Investigation, M/V VENUS

28. There were no company or vessel written procedures or safety instructions on the VENUS relative to tank gas-freeing. The standard procedure (and the one used on the day of the explosion) for performing this operation on the VENUS, was basically as follows: Portable steam driven Coppus blowers are placed over the Butterworth openings in the deck. The blowers were placed over the studs but were not bolted down. The steam was provided by an independent boiler in the engine room at 120-150 p.s.i. The steam was supplied through a permanent steam line that runs the full extent of the main deck, with conveniently located hose connection valves for the blowers' electrically bonded rubber hoses. Prior to operating the blowers, the tank covers over the expansion trunks were raised to permit direct egress of the gases from the tank to the atmosphere. After blowing the tank for approximately one hour, the tank was carefully checked by a deck officer with an explosimeter. The VENUS was equipped with a Mine Safety Appliance Company explosimeter, Model 2. After all parts of the tank have been tested, crew personnel normally enter the tank for final "mucking out" operations of remaining residue water, scale and mud. On the VENUS this operation was usually not extensive due to the frequency of cleaning tanks. Data taken from the two blowers used on the VENUS indicated they were Coppus Turbo Blowers - Type E manufactured by the Coppus Engineering Corporation of Worcester, Massachusetts. The blowers had two nozzles and were marked as follows:

No. 3 - 16	Size 12 - Serial No. 59Y711
No. 13 - 16	Size 12 - Serial No. 59U1112

The steam hose used came in 50 foot lengths with 1" connections manufactured by Boss Dixon U. & C. Company with patent number 2166524.

29. Two companionways are located on the forward deck leading down to the port and starboard side of the forward lower crew quarters. Each companionway faces aft and has a heavy wooden door closure with a double hinged section to permit the door to be flapped back alongside the companionway structure thus permitting free access from the tank deck. Hold back hooks are provided. Each door is equipped with an ordinary door latch and knobs. The port companionway door is 6' - 05" forward of the No. 1 center tank hatch opening. Following the explosion the port door was found to be swollen or warped sufficiently to prevent the door from completely entering the jamb and when closed was difficult to open. The doors are not equipped with self-closing devices. The doors are not marked in any way.

30. The forward lower crew quarters' after bulkhead is bounded by a cofferdam, or segregation space, except for the upper 18 inches which extends above the center tank top level. This part of the bulkhead is penetrated by two 1-1/2" electrical conduit connectors which were open to the tank deck.

Marine Board of Investigation, M/V VENUS

These openings are approximately 6' - 5" forward of the No. 1 center tank hatch opening. They are located under portable deck walkway plating. The deck over the forward lower crew quarters is provided with a 8-1/2" mushroom vent, approximately 7" high, leading to the officers' bathroom. The mushroom vent was located 9 feet forward of the No. 1 center tank hatch opening. After the explosion the vent was found to be bent and jammed open.

31. The forward crew quarters on the main deck consist of the rooms for the deck officers and unlicensed deck crew, including washrooms and toilets, forming a periphery around a central area used as a secondary lounge and called "the crew hall". Aft of the crew hall there are several utility compartments partitioned with thin steel bulkheads that accommodate a paint locker, laundry room, ventilation fan room, officer washroom, deck stores locker, oilskin locker, and access stairwell to the lower hold. In the after end there are stairs on each side of the utility area leading to the companionways on the cargo tank top deck, and in the forward end an emergency escape ladder and hatch to the forecastle deck. The crew hall lounge area has several chairs, reading material, and a large bucket half filled with water to serve as an ash receptacle for smokers.

32. The deck locker is located on the port side of the utility area, measures approximately 5' x 5', and has shelving. The locker has a metal door which is not locked and normally is left open. The locker provides storage for tools, cleaning supplies, bleaches, gaskets, new swabs, tarred hemp, heaving line, gauge tapes and other miscellaneous stores, including a rag bin located on the after end. This deck locker was completely burned out during the casualty. Following the explosion and fire, the after boundary bulkhead of the deck locker showed considerable blistering of paint on its exterior in the lower hold stairwell. Except in the immediate vicinity of the deck locker, other compartments, rooms and the crew hall showed no indications of fire damage. The paint locker on the starboard side, filled with paint products (some open) and some cargo (toluene and gasoline) samples, in bottles, jars and cans labelled with dates from the last shipping season, was unscathed.

33. A steam radiator for compartment heating was located just forward of the paint locker at the after end of the lounge area in the crew hall. The radiator consisted of 5' sections of 1-1/4" steel piping arranged in five rows with return bends. It was protected by a punched steel sheet metal screen. The top of the screen was flat and measured approximately 9" x 5'. The top was frequently used by the crew as a place to dry gloves or other gear. Steam was supplied to this radiator at 40 lbs p.s.i. Remains of burned gloves were found along with other debris in the crew hall following the casualty.

34. There were several signs posted aboard the VENUS which indicated that smoking on board by crewmembers was permitted only in areas designated by

Marine Board of Investigation, M/V VENUS

the Master. It was generally understood aboard the VENUS by personnel that smoking was permitted in the wheelhouse, individual rooms, engine room, recreation room, forward crew hall, messroom and the after deck while at sea. It was also generally understood that smoking was specifically prohibited on the cargo tank deck at all times and anywhere on deck while in port. This information was passed on from crew member to crew member as personnel changes were made on the vessel. "No Smoking" signs were posted on the cargo tank deck and in the access to the pump room. The areas where smoking was permitted by custom or prohibited under certain operating conditions were not promulgated to the crew personnel in any positive or written manner. Those areas where smoking was permitted were not marked nor was a list of them posted.

35. On 9 April 1972, the VENUS completed a Coast Guard biennial inspection for certification at Sturgeon Bay, Wisconsin. The inspection was conducted by personnel assigned to the Marine Inspection Detachment at Sturgeon Bay, a sub-unit of the Marine Inspection Office, Chicago, Illinois. The inspection commenced on 14 January 1972 and continued during the vessel's normal Great Lakes winter lay-up at the Bay Shipbuilding Corporation shipyard. A test of the longitudinal bulkheads had been made on or about 12 January 1972 by the owners' representatives and shipyard personnel by heading up the center tanks with water. During the course of the inspection, all tank compartments were entered and individually examined internally. A joint shipyard and owners' listing of necessary structural repairs was made. This listing was included in the vessel's Coast Guard inspection file. All deficiencies were termed minor; there were no deficiencies listed for the No. 1 tank compartments. All deficiencies noted were corrected during the lay-up period. During the lay-up months, the vessel's fire hoses were drained and stored below in an unheated compartment forward. On 3 April 1972, during the Spring fit-out, 700 feet of hose were fitted together and tested. The deck inspector conducting the test was satisfied with 100 pounds pressure on the fire hose measured on a Coast Guard gauge fitted to the end. There were no indications in the record or testimony given to the Board that the fire main and hose test were coordinated, or that the test was conducted to the pressure of the relief valve setting. Chief Engineer Arthur J. Anderson testified that the relief valves were not tested on the fire pumps during the inspection. Title 46 Code of Federal Regulations 31.10-18(g) requires that all fire hose shall be subjected to a test pressure equivalent to the maximum pressure to which they may be subjected in service, but not less than 100 lbs. p.s.i. Inspection of the crew accommodation areas forward, relative to comprehensive safety items, usually was conducted in conjunction with and at times when other inspection activities were in progress. There was no inspection record or testimony which indicated that a concerted inspection of this area was performed.

36. The permanent Master of the VENUS was Captain Robert B. Robbins, who was licensed as a Master of steam and motor vessels of any gross tons upon the Great Lakes and their connecting and tributary waters; also First Class

Marine Board of Investigation, M/V VENUS

Pilot between Duluth, Gary, Buffalo and Oswego (License #366339 and USMMD BK-176074). Captain Robbins has been Master of Great Lakes tankers for 33 of his 39 years of marine experience. Captain Stanley, commencing the 1972 navigation season as Chief Officer of the VENUS, relieved Captain Robbins on 26 April 1972. This system of relief had been practiced by the two officers since 1967, when the VENUS was purchased by Cleveland Tankers, Inc. During the course of the operating season Captain Stanley served as the Master approximately 25% of the time.

37. The following publications were said to have been on board the VENUS for reference:

CG-174 - A Manual for the Safe Handling of Inflammable and Combustible Liquids

CG-329 - Fire Fighting Manual for Tank Vessels

CG-123 - Rules and Regulations for Tank Vessels

There were no indications that any of the publications were used for formal instructional purposes. Crew members who testified indicated only a perfunctory knowledge of the publications. There was no Chemical Data Guide for Bulk Shipment by Water (CG-388) on board, although some commodities listed in the publication were normally carried on the VENUS.

38. At the time of the casualty the VENUS was short a Third Assistant Engineer required by the Certificate of Inspection. Since 15 April 1972, while awaiting a replacement the Assistant Engineers had been standing six-hour watches with six hours off.

39. Entries in the log book of the VENUS indicated that fire and boat drills were conducted on 8 April 1972 and 21 April 1972 prior to the casualty. Testimony of Chief Engineer Anderson indicated that drills were carried out at least once a month and at times at more frequent intervals.

CONCLUSIONS

1. The cause of the initial explosion on the VENUS was ignition of the airborne gasoline vapors vented from the No. 1 center tank compartment hatch which had infiltrated the forward lower crew accommodation area in sufficient strength to render those spaces in the explosive range. Although the specific source of the ignition could not be determined from the information adduced, it is concluded that the most probable source was located in the forward lower crew accommodations where unrestricted smoking was permitted. It is considered most probable that some smoking article was the source, although the possibility of spontaneous combustion of articles of apparel left on the radiator or gear and rags stored in the deck gear locker cannot be ruled out entirely.

2. In view of the conditions which existed on board the VENUS just prior to the casualty, the following are considered to be contributory causal factors:
 - a. The failure to close securely, and to keep closed, the companionway doors to the forward lower crew accommodation area. These doors were in close proximity to the No. 1 center tank hatch trunk and led to an area where unrestricted smoking was permitted.

 - b. The relative wind direction as the vessel laid at anchor, which forced the vented gasoline fumes toward the open companionway doors.

 - c. The low external height of the officers' bathroom mushroom vent and its location downwind from and proximity to the No. 1 center tank hatch trunk.

 - d. The failure to maintain a fume-tight bulkhead from the tank deck into the forward lower crew accommodation space.

3. The cause of the second explosion was ignition of vapors drawn into the immediate vicinity of the No. 1 center tank by the implosive after effects of the first explosion. The sources of flammable vapors are believed to have been the remaining rich vapors from the lower areas of the No. 1 center tank which were not consumed by the first blast, and those from the fume rich No. 1 port wing tank. Ignition was caused by incandescent material on deck, the No. 1 center tank, or in the quarters, which was ignited by the first explosion. The avenue of the vapor source from the No. 1 port wing tank and the flame into it is not known; however, one or more of the following are considered as distinct possibilities:
 - a. The rupture and penetration of the longitudinal bulkhead between the No. 1 center tank and the No. 1 port wing tank.

 - b. The rupture of piping leading from the No. 1 center tank to the No. 1 port wing tank.

 - c. The common 3-1/2" vent lines which, in effect, connected the No. 1 center and port wing tanks.

Marine Board of Investigation, M/V VENUS

4. The Master, Charles S. Stanley, died as a direct result of this casualty when he was struck by flying debris from the second and more violent explosion.
5. There was no positive policy for training or indoctrinating the constantly changing personnel on board the VENUS. Written instructions and safety procedures were non-existent. Verbal instructions were the only means of passing vessel policy to new men, and there is nothing in the record to indicate that this was done in a systematic manner. The areas where smoking was permitted by the Master were not specifically designated, nor was it made clear to all crew members by any means where these were. Although the Master at the time of the casualty inherited the policies of the regular Master, he was familiar with the vessel's administration and apparently concurred with it, having served as regular Chief Officer and relief Master for several years.
6. Incendiary sparking due to electrostatic phenomena was not considered by this Board as a source of ignition. Although it is probable that a charged mist existed inside the No. 1 center tank, it is believed that the equipment in use, the manner in which it was connected to its steam supply, and the time elapsed since the washing operation, would have precluded build-up of a static charge with sufficient energy to produce an incendiary spark.
7. The reasons for the No. 1 starboard wing tank not exploding were that its deck appurtenances were closed and its integrity was not breached during the first explosion. The tank was gassy; however the atmosphere was probably above "the upper explosive limit." Those tanks aft of the ballasted No. 2 port wing, center and starboard wing tanks failed to explode for the same reasons.
8. The failure, under pressure, of the two fire hoses used in fighting the fires following the explosions resulted in no particular complications during the extinguishment of the fires. These failures did indicate, however, that testing techniques utilized at the time of the inspection for certification may require improvement. While failure of fire hoses in service cannot be accurately predicted by anyone, it is concluded, based upon examination of both hoses by this Board, that defects of the type noted would have been discovered at the time of the biennial inspection for certification, 26 days earlier, had the hoses been properly examined and tested to full fire pump discharge pressure.
9. Third Officer Dugan, although licensed as a ship's officer, had no practical experience in tank vessels or in the gas-freeing operations he was in charge of at the time of the explosion. Although the relative wind direction, open companionway doors, and the heavy gasoline fumes would indicate that a possible hazardous situation was developing, it was not recognized by him or by the relatively experienced crew personnel working under him.

Marine Board of Investigation, M/V VENUS

10. There is evidence in the record that fire and boat drills had not been conducted at weekly intervals as required by 46 Code of Federal Regulations 35.10-5(d) on the VENUS during the period since its biennial inspection for certification and the casualty. There is no significant indication that the failure had an effect on the crew's performance generally or on their efforts to fight the fire following the explosions.

11. The shortage of a Third Assistant Engineer on the VENUS at the time of the casualty was not related to the cause, nor did it have any significant effect on emergency measures undertaken by engine room personnel following the explosions.

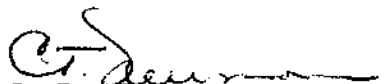
12. There is evidence which indicates that Third Officer Dugan's performance of duty on the night of the casualty was less than that which is expected of a licensed officer in charge of seamen performing a hazardous task. Although the evidence indicates he failed to recognize the incipient hazardous conditions symptomatic of tank vessel casualties, the Board believes the quality of evidence is insufficient to sustain a charge of negligence under the Revocation and Suspension Proceedings of R.S. 4450. The Board has noted that the General Safety Rules contained in the Rules and Regulations for Tank Vessels do not address potential dangers while gas-freeing operations are in progress, nor does the publication list any required inspections or duties of the senior deck officer similar to those set forth in subpart 35.35, Cargo Handling. It was further noted by the Board that the Manual for the Safe Handling of Inflammable and Combustible Liquids (CG-174) refers only to vapor ignition sources in the work areas during gas-freeing operations.

13. There is no further evidence of violations of law or regulations on the part of surviving licensed personnel which would warrant referral to the United States Attorney or action under R.S. 4450.

Marine Board of Investigation, M/V VENUS

RECOMMENDATIONS

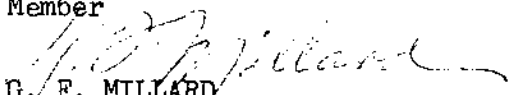
1. That, this report be given wide dissemination to the marine field by means of the Marine Safety Council Proceedings after final action by the Commandant and the National Transportation Safety Board. The Board believes that by publicizing the factors which led to this casualty, many mariners will relate them to their own shipboard operations, perhaps recognizing potential hazardous situations in time to take necessary corrective action.
2. That, the Coast Guard should institute a review of 46 U. S. Code 391a(6) which permits licensed officers of inspected vessels of the United States to serve as a tankerman. Many of these officers reach this status without any practical experience or training in tanker operations. An amendment to the existing regulations which would require tankerman endorsements on all officer licenses is recommended. Endorsements would be continued on the license upon renewal only if recency of service on tankers could be shown, or if the license renewal applicant showed, by written test or exercise, his continued knowledge of the handling of combustibile or flammable liquid cargoes and the cleaning and gas-freeing of tanks.
3. That, the General Safety Rules in Subpart 35.30 of the Rules and Regulations for Tank Vessels be amended to include a section on safety for tank cleaning and tank gas-freeing operations with the duties of the senior deck officer before the commencement and during the operations listed.
4. That, Chapter 8 of the Manual for the Safe Handling of Inflammable and Combustible Liquids (CG-174), when revised, include general safety precautions to be exercised during cleaning and gas-freeing of cargo tanks.
5. That, the Merchant Marine Safety Manual should be amended to include in Chapter 3 - Inspection of Vessels - a section on the proper testing of fire hose in the field. The section should include the close coordination of boiler and hull inspectors in order to insure that the hoses are tested to full fire pump discharge pressure.



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