

MARINE CASUALTY REPORT

FIRE AND EXPLOSIONS ON TANK BARGE MOS 106
AT LA GRANGE, MISSOURI ON MISSISSIPPI RIVER,
ON MAY 12, 1969

U.S. COAST GUARD
MARINE BOARD of INVESTIGATION REPORT
and COMMANDANT'S ACTION

ACTION BY
NATIONAL TRANSPORTATION SAFETY BOARD

DEPARTMENT OF TRANSPORTATION
WASHINGTON D.C. 20591

RELEASED 9, MAR 1971

TANK BARGE MOS 106
FIRE AND EXPLOSION AT LA GRANGE, MISSOURI
ON MAY 12, 1969

TABLE OF CONTENTS

	<u>Page</u>
ACTION BY NATIONAL TRANSPORTATION SAFETY BOARD	
Synopsis.....	1
Summary of Facts.....	2
Analysis.....	4
Probable Cause.....	10
Recommendations.....	11
Attachment No. 1	13
ACTION BY COMMANDANT - U. S. COAST GUARD	
Synopsis of Findings of Marine Board of Investigation	14
Remarks.....	15
MARINE BOARD OF INVESTIGATION	
Findings of Fact.....	17
Conclusions.....	27
Recommendations.....	29



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

FIRE AND EXPLOSIONS ON TANK BARGE MOS 106
AT LA GRANGE, MISSOURI, ON MAY 12, 1969

ACTION BY NATIONAL TRANSPORTATION SAFETY BOARD

This casualty was investigated by a U. S. Coast Guard Marine Board of Investigation convened at Quincy, Illinois, on May 20, 1969. A representative of the National Transportation Safety Board attended the proceedings as an observer. 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 12, 1969, at about 2115 c.d.s.t., Meljoy Transport Company tank barge MOS 106 caught fire and exploded at the Triangle Oil Refining Company loading facility on the upper Mississippi River at La Grange, Missouri. Tank barge MOS 104 and towboat M/V MARTIN were also moored at that facility and were involved in the subsequent fire.

These three vessels, and two others downstream from them which also became involved in the fire, were damaged in varying degrees. The loading facility and a grain elevator were damaged by fire. The Chicago, Burlington and Quincy Railroad bridge, the Quincy waterfront and the town of Quincy, Illinois, itself, were endangered by the burning and drifting vessels. In addition, approximately 270 thousand gallons of gasoline were burned and/or lost into the waters of the river.

Six persons were killed, one was injured seriously.

The National Transportation Safety Board finds that the probable cause of this casualty was a gasoline spill on the deck of the MOS 106, producing an explosive gasoline vapor-air mixture which was ignited by the galley range on the towing vessel MARTIN.

The following are considered to be contributing causal factors:

1. The transfer of approximately 40,000 gallons of salvaged gasoline into tanks No. 1 starboard, No. 2 port, No. 2 starboard and No. 3 port.

2. An approximate 1° trim by the stern during the off-loading operations, which was not abnormal.
3. Either (a) a combination of a vapor pressure buildup and thermal expansion of the vapors and liquids in tanks No. 2 port and or No. 3 port, or (b) the gravitation of cargo from No. 2 port tank to No. 3 port tank, either of which resulted in an overflow of gasoline through the expansion trunk.
4. The absence of practical and specific recommendations or standards limiting the maximum allowable filling of tanks, both in the state of the art and in applicable Coast Guard rules, regulations, and manuals.

SUMMARY OF FACTS

A tow consisting of the uninspected towing vessel M/V MARTIN pushing the inspected tank barges MOS 104 and MOS 106, collided with the west span pier of the Cape Girardeau, Mo., highway bridge on May 6, 1969. The barges had been loaded with gasoline in West Memphis, Arkansas, and the tow was proceeding to La Grange, Mo., to discharge its cargo. As a result of the collision with the pier, the No. 1 port tank and No. 3 starboard tank of the MOS 106 were holed at the waterline. About 138,000 gallons of 94.2-octane gasoline were lost. Approximately 40,000 gallons of gasoline were salvaged from the damaged tanks, and distributed in the No. 1 starboard, No. 2 port and starboard, and No. 3 port tanks of MOS 106. Nos. 4 and 5 tanks contained 99.5-octane gasoline. However, the tank barge MOS 104 was carrying the 94.2-octane gasoline in all 10 tanks and had ullage space available for a portion of the salvaged gasoline, but this barge was not used.

A Coast Guard inspector issued the MOS 106 a permit to proceed to La Grange, Mo., to discharge her cargo prior to effecting permanent repairs. No leakage of gasoline was noted en route to her destination, which included transit of several locks. The tow arrived at the Triangle Oil Refining Company terminal at La Grange, on May 12th. The MOS 106 and MOS 104 were moored, stern to stern, alongside the terminal floating dock, with the MARTIN moored outboard of the barges, heading upriver. The oil-fired galley range on the tug was operating, and the galley door and windows were opened. A sketch of the arrangement of the tow at the oil terminal is attached for reference.

Weather conditions at the time of discharge operations were broken clouds, wind about 5 knots from the southwest, air temperature about 60° F., and water temperature 60° F. The wind was blowing from the direction of MOS 106 over the MARTIN. Sunset occurred at 2011.

Discharge operations on the MOS 106 commenced about 1900, using the tow's hose and diesel cargo pump. A small leak at the dock manifold developed when pumping started, but was corrected, and transfer resumed about 2000. The master, chief engineer, and deckhand of the MARTIN, along with two oil terminal employees, were on the MOS 106 at the time of the casualty. The master was not licensed, and was not required to be, but held a tankerman's certificate, and was in charge of operations. During the pumping operation, the mate of the MARTIN advised the master that he noticed a strong odor of gasoline in the quarters of the towing vessel, stronger than on deck of the barge. The master told him not to worry about it, and the mate went to bed.

The deckhand, who was the only surviving eyewitness of the casualty, stated that the master told him to wash off a gasoline spill on the barge, using a hose and broom. No other work was in progress on deck. About eight drums of gasoline were stowed on pallets over the No. 3 tanks and he was unable to sweep the gasoline from underneath them. Apparently, the gasoline had been pumped previously from the MOS 104 into the drums utilizing a portable pump. He stated the spill covered half the deck of the MOS 106, running over on the river side, astern of the MARTIN. The fire started at 2115 from the direction of the stern of the MOS 106 and ran toward the drums of gasoline stowed on deck over the No. 3 cargo tanks.

A series of explosions sprayed burning gasoline over the MOS 106, the stern of the MOS 104, the after port side of the MARTIN, and on the floating terminal dock. At the time of the casualty, the starboard No. 1 tank and about one-third of starboard No. 2 tank had been discharged into a terminal tank. The deckhand, wearing a life preserver, jumped off the rake end of the barge and swam ashore. The four other persons on deck, a deckhand asleep on the MARTIN, and a truck driver on the floating dock were killed. A record of the soundings of gasoline in the MOS 106 tanks on arrival at the Triangle Oil Terminal was burned with the clothing of the master of the MARTIN.

Damage to the MOS 106 was concentrated in the forward tanks, No. 1 starboard, No. 2 port and No. 2 starboard. These tanks were bulged and ruptured on deck, and on the sides. No substantive damage resulted in the after portion of this barge. The drums over No. 3 tanks exploded. The MOS 104 was not damaged appreciably, the galley and living spaces on the MARTIN were gutted by fire, and the north end of the dock barge sank. After the fire threatened the shore facilities, an unidentified person severed the wire securing the rake end of the MOS 104 to a deadman on shore. The nylon lines connecting the stern ends of the two barges burned, and the two barges and the MARTIN drifted downstream. Burning gasoline from the MOS 106 spread over the river surrounding the barge, and ignited a nearby grain elevator downstream. The drifting tow also collided with the barges CHEM 40 and UM 219, breaking these barges away from their moorings, and fire from the burning tow ignited them. The MOS 106 lodged against the upstream side of the Chicago, Burlington, and Quincy Railroad span, causing

some damage to railroad ties, due to the intensity of the fire. It was fortunate that the MOS 106 did not drift down on the waterfront facilities in Quincy, or more extensive damage could have occurred.

The fires on the CHEM 40, UM 219, MOS 104, and MARTIN burned themselves out. Shore firefighting forces extinguished the fire at the grain elevator. Firefighting equipment was supplied by the Coast Guard Captain of the Port in St. Louis and transported on a barge volunteered by the Northeast Power Company to extinguish the fire on the MOS 106. Examination of this barge after the fire revealed that all the hatch covers were off, and none of the securing dogs were stripped. Some of the dogs were melted, but it appeared that none had been secured prior to the fire.

ANALYSIS

The source of the explosive gasoline vapors and the source of ignition were not positively established by the investigation, due to the loss of all but one eyewitness. However, the report of the Coast Guard Marine Board of Investigation concludes that the most probable source of explosive gasoline vapors was a gasoline spill on deck of the MOS 106, possibly from overflow from No. 3 port tank. This report further indicates that the galley fire on the MARTIN was the most probable source of ignition. The Commandant's action on this report concurs in these general conclusions, but notes that the manner in which gasoline was deposited on deck was not revealed, and "it would be highly speculative to attempt to pinpoint one possibility over others without evidence."

The Safety Board concurs with the Marine Board and the Commandant in their conclusions that the most probable source of ignition was the flame in the galley range of the MARTIN. There is no evidence in the record which would indicate a more likely source.

The Safety Board analyzed the various sources of gasoline spills and gasoline vapors in order to determine the most probable cause of this casualty. It should be noted that the Board knows of no methods for calculating precise estimates of vapor concentrations in air for varying distances and atmospheric conditions where the source of the vapor is evaporation from the surface of liquid gasoline.

Several sources of gasoline vapor were developed by the investigation. Prior to the fire, about eight drums loaded with gasoline were located on wood dunnage on the centerline of the MOS 106 No. 3 tanks. These drums required venting to relieve pressure, suggesting that they had been overfilled. Presumably, they had been filled from the gasoline in the tanks of the MOS 104 or 106. Three portable gasoline pumps were available for such a transfer. A small drum of gasoline was stowed on the barges for fueling the portable pumps. The surviving deckhand testified he vented the drums, wiped up some gasoline from the drumheads, and left some rags and a small quantity of gasoline in an open bucket on the MOS 104.

Considering the small quantity of gasoline vapor involved, the location of it in open moving air and the distance from the probable source of ignition (over 150 feet), it is very unlikely that a sufficient quantity of vapors could have accumulated and reached the lower explosive limit.

Another small gasoline spill occurred on the floating dock during the initial stage of discharge. This was caused by a poor connection between the hose flange and the manifold. Additional bolts were installed, reducing the leak to a very slight drip which was caught in a drip pan. Estimates of this spill were a gallon or less. The fire and explosion occurred an hour and a quarter later. The quantity of gasoline available for evaporation during this time precludes this spill from being a logical source of the vapors which caused the fire and explosion on the MOS 106.

There is a possibility that some gasoline may have leaked from the barge MOS 106 due to the damage sustained in collision with the Cape Girardeau Highway Bridge. The Coast Guard inspector stated that there was a possibility that the damage in No. 3 starboard tank could have extended into No. 2 starboard. Fractures in the bulkhead between these two tanks, or on the starboard side of the barge at this bulkhead, could have caused leakage through the hole in the side of No. 3 starboard tank. However, no evidence of leakage from this tank was noted during the trip from Cape Girardeau to La Grange, including transit of several locks. Leakage from either side would be carried downstream on the surface of the river by the two knot current, away from the MARTIN. Therefore, this possible source of explosive gasoline vapors does not appear to be a contributing cause.

Although not developed by the investigation, there is a possibility that a gasoline spill could have resulted from a rupture of the transfer hose. This hose was burned, so there is no evidence of this possible source of a gasoline spill. The pumping operations had been in progress for an hour and a quarter, with four persons in the vicinity of the pump. Had the hose burst, the pump could have been stopped quickly by one of these experienced persons. Moreover, the fire damage was concentrated in the area forward of the No. 3 tanks. Little fire damage occurred in the after portion of the barge where the pump and transfer hose were located. This virtually rules out the hose as a source of a gasoline spill.

Another source of gasoline vapor was the terminal storage tank in which the gasoline was transferred. The MOS 106 pumping rate was about 2900 bbls/hour; approximately 271 cu. ft./minute of air, with some gasoline vapor, would be displaced from the tank. This tank was about 4,000 feet from the dock. It is possible that some gasoline vapor would be carried by the light westerly breeze over the barges and towing vessel. However, the dispersal characteristics of these vapors in air which has moved more than 4,000 feet make it unlikely that this gasoline/air mixture would be in the explosive range by the time it reached the dock area.

There is also the possibility of evaporation and vapor diffusion from open cargo tank expansion trunk hatches on the MOS 106. These covers were oval in shape, approximately 18 by 20 inches. Even assuming all 10 hatches were open, which is doubtful, there would have been an area of about 21 square feet for evaporation and vapor diffusion to take place. Due to the wide spacing of these hatches over the deck of the barge, there was little likelihood of the evaporated vapors reaching the lower explosive limit near any source of ignition.

Other possible sources of spillage on deck include leaks in the deck, expansion trunks, joints, or around the cargo valve reach rods, and leakage from the drums of gasoline on deck. The record does not support any of these possibilities.

Another possible source would be a gasoline spill caused by a buildup of vapor pressure in the cargo tanks resulting in the gasoline being forced out through the open hatches in the expansion trunks. In order to evaluate this possibility, the following technical information and facts of the case must be considered.

The approximate explosive range for gasoline vapor at 70° F, is from 1.4 to 6.0 percent by volume, or .004 lbs./ft.³ to .017 lbs./ft.³ by weight. An experimentally measured evaporation rate for gasoline has been reported to be .57 inches per hour with about a 2-m.p.h. wind at 60° F. For the concentration of gasoline in moving air to reach the lower explosive limit, assuming all the evaporated gasoline built up the vapor concentration cumulatively, a 1 foot wide patch of air would have to travel at least 6.7 linear feet at 2 miles per hour over a gasoline surface. These calculations provide a coarse estimate only, because of the complexities involved in diffusion of evaporated vapors in open air.

Only a large gasoline spill would have covered an area with a diameter larger than the minimal 6.7 linear feet. The surviving deckhand testified that the gasoline on the deck of this barge covered more than half the deck with gasoline, extending from a foot or two of the dock side, to the river side of the barge, including the area on No. 3 tanks where the gasoline drums were located. While washing down, the gasoline and wash water spilled over the port or river side of the barge. The southwest wind would blow the vapors over the MARTIN. The mate's testimony substantiates the presence of strong gasoline vapors on board the vessel. He stated the gasoline vapors were stronger on the MARTIN than on the barge.

The hatch covers were apparently not dogged down after soundings were taken on arrival at the Triangle Oil Terminal. The record of these soundings was lost but an estimate can be made of the amount of gasoline in the tanks which received the gasoline salvaged after the collision with the highway bridge.

<u>Tank No.</u>	<u>Amount originally loaded, Gals.</u>	<u>Capacity of Tank, Gals.</u>	<u>Amount to fill to capacity</u>
No. 1 stbd.	96,976	109,165	12,189
No. 2 stbd.	94,426	109,165	11,739
No. 2 port	95,571	109,165	13,594
No. 3 port	100,103	109,165	9,062
			46,584

Approximately 40,000 gallons of gasoline salvaged from the damaged No. 1 port and No. 3 starboard tanks were distributed in these four tanks. Thus there was only 6,548 gallons of total slack space in these tanks. The distribution of the salvaged gasoline among these four tanks is not available. Neither is the sequence of topping them off with the additional gasoline. Therefore, it is quite possible one or more of these four tanks could have been filled to capacity. Apparently, the after four tanks were not used because they contained higher octane gasoline. The tanks topped off were filled to 98.5 percent of capacity, in the aggregate, compared with 84.4 percent when originally loaded. This would be an average of 5 inches of slack in each tank if each was evenly filled.

If the tanks were full, and the hatches not dogged down, a 2° trim by the stern would cause an overflow from the top of an expansion trunk. These expansion trunks were 1 foot 9 inches high, 36 inches in diameter, and the after part of the trunks were 48 feet 3 inches from the forward bulkhead in the tank. With 5 inches of slack in a tank, (assuming even distribution of the salvaged gasoline in the four tanks), the bottom of the expansion trunk would be covered if the vessel were trimmed .5° by the stern.

After pumping for an hour and a quarter, all the gasoline in No. 1 starboard and one-third of the gasoline in No. 2 starboard had been pumped ashore. At the time of the casualty, the barge had about a 1° of trim by the stern. This trim alone would not have caused a spill of gasoline from the expansion trunks, but during this period of discharge, the gasoline would have covered the bottom of at least one of these trunks. This is predicated on there being 6,584 gallons of aggregate ullage in the tanks, topped off with the salvaged gasoline.

As the bottom of the expansion trunk became covered by the level of the gasoline, thus sealing off the tank vents located in the expansion trunks, the vapors in the vapor space could no longer escape to the atmosphere. At the same time, warming of the liquid gasoline would accelerate the evaporation process, thus increasing the vapor pressure. Also, a limited amount of thermal expansion of the vapor and the liquid

would occur. This combination of events, coupled with the fact that the expansion trunk covers were not secured, would result in a rise in the liquid level in the expansion trunk.

For each 0.1 p.s.i. increase in pressure, there would be a rise in the liquid level in the expansion trunk of about 3.8 inches. A temperature rise of about 3.5° F. in the vapor space would create a 0.1 p.s.i. pressure rise. Thus, approximately a 15° rise in temperature of the vapor space and the liquid, combined with the increased trim by the stern as the cargo was being transferred from the forward tanks, could be expected to raise the liquid level in the expansion trunks of the filled tanks. The barge deck plates, warmed throughout the day by the sunshine, provided a substantial heat source to supply the heat to raise the gasoline and vapor space temperatures, even though ambient temperatures had begun to decline as the barge was being unloaded.

Evidence developed by the Marine Board supports the occurrence of these phenomena. First, the increase in vapor pressure in the drums stowed on deck which resulted in the generation of internal pressure in the drums, to such a degree the pressure had to be relieved manually by the deckhand. Secondly, the thermal expansion of the gasoline in one or more of the drums caused small quantities to spill onto the tops of the drums. Because of their size and location, the drums would have been warmed more quickly and to a greater degree than the cargo tanks, but the same warming tendency would have existed for both on the day of the casualty.

It therefore follows that the sun, almost at its maximum declination on this day, heated the deck plating of the MOS 106, causing an increase in the vapor pressure in the cargo tanks. While the sun had set before the casualty, the heat reservoir formed by the deck plating would continue the warming, thus causing an increase in vapor pressure in such tanks well beyond the time of the casualty. This warming, in conjunction with the increase in trim by the stern, probably forced gasoline from the expansion trunks from either or both the port Nos. 2 and 3 tanks. At the time of the casualty, the other tanks were not as fully loaded. No. 1 port and No. 3 starboard contained water, Nos. 1 and 2 starboard had been discharged. The No. 4 tanks had almost 3 feet of ullage, and the No. 5 tanks about 11 inches of ullage (expansion trunks on No. 5 tanks are located forward in the tanks).

Another condition which could have caused gasoline to overflow through an open hatch cover in No. 3 port tank would be a lack of watertight integrity between Nos. 2 and 3 port tanks. If the transverse bulkhead between these two tanks leaked directly below the main deck, the gasoline in No. 2 could gravitate into No. 3.

The vertical crack in this bulkhead specifically referred to in the testimony, most likely was the result of one of the explosions during the casualty. However, accelerated corrosion of the deck stringers and the upper portion of tank bulkheads is not an unusual occurrence in older gasoline barges.

If such a condition did exist, it could account for both a spillage through the expansion trunk hatch in No. 3 port and the fact that an explosion occurred in No. 2 port but not in No. 3 port. Obviously, if enough gasoline gravitated from No. 2 port to No. 3 port, the latter would have very little if any vapor in it while the former would have an increased amount of air in it to create a hazardous mixture of gasoline vapor and air. Therefore, the likelihood of an explosion occurring would be greater in No. 2 port than in No. 3 port.

It is concluded that the spillage of gasoline occurred from the No. 2 port tank and/or the No. 3 port tank via the open hatches. The cause of the spill could have been either a combination of a vapor pressure buildup and thermal expansion or a gravitation of cargo from No. 2 port into No. 3 port. The deckhand's testimony and the damages sustained by the barge support this conclusion. In the absence of testimony or evidence of the exact ullages in each tank, we can not assign greater probability to one or the other possible causes.

The Board has also considered the implications of the relatively large volume of liquid overflowed in the spill. It would appear that a large volume could be accounted for by the continued vaporization of liquid fuel which would continue to vaporize after a pressure had been reached inside the tank sufficient to cause the overflow. Vaporization increases the volume of liquid fuel by several hundred times so that the vaporization of only one-tenth of a gallon under these conditions could cause an overflow of 30 to 60 gallons from the expansion trunk. Similarly, continued leakage through the crack between the two tanks could account for a large volume of fuel.

The galley range is the most probable source of ignition of the explosive gasoline vapor. There are other possible sources, such as electrical equipment on the MARTIN, smoking on board the towing vessel or barge, static electricity, and sparks produced by metal-to-metal impact, but none of these are supported by the evidence. It is known that the oil fired galley range was burning at the time of the casualty. Also, gasoline vapors in the galley would be drawn into the range by the blower and exhaust system during its normal operation.

The Board has considered whether the issuance of the permit to proceed by the Coast Guard inspector after the Certificate of Inspection had been withdrawn should be considered a causal factor in this casualty. The permit to proceed was issued after the fuel had been redistributed in other tanks of the MOS 106. It appears that neither the Coast Guard inspector nor the master of the M/V MARTIN gave consideration to the possibility of over-filling the tanks.

A permit to proceed is accompanied by careful analysis of the safety of the movement including all the factors, particularly with reference to the protection of the general public. The accident might have been avoided

by requiring that the cargo be redistributed into MOS 104 as well as the available tanks of MOS 106. However, there were no specific standards available at the time of this accident to enable the master or the Coast Guard inspector to determine the maximum safe cargo capacity for each tank. Although "A Manual for Safe Handling of Inflammable and Combustible Liquids" (CG-174) provides a general guideline of 1 to 3 percent ullage to allow for possible temperature increase during a voyage, this guideline is too general to be of practical use to the man in charge of topping off the tanks on board a tank vessel. Also, this brief one-sentence guideline gives inadequate emphasis to this potential danger. In other modes of transportation, more specific and useful criteria are provided. For example, Title 49 CFR, Part 173.116 provides criteria for the filling of containers with inflammable liquids which are transported by rail, highway, or water. This explanation of the accident has been developed only by the most careful analysis which considered several areas of expertise. Also, this analysis took place at a time after the possibility of the hazard was pointed out by the occurrence of the accident. The prediction of this phenomenon by a single Coast Guard inspector working under field conditions would not normally be anticipated.

Thus the issuance of the permit to proceed is not regarded as a causal factor. The absence of practical and specific guidelines, recommendations, or standards establishing limits for the filling of tanks is a significant causal factor.

PROBABLE CAUSE

The National Transportation Safety Board finds that the probable cause of this casualty was a gasoline spill on the deck of the MOS 106, producing an explosive gasoline vapor-air mixture which was ignited by the galley range on the towing vessel MARTIN.

The following are considered to be contributing causal factors:

1. The transfer of approximately 40,000 gallons of salvaged gasoline into tanks No. 1 starboard, No. 2 port, No. 2 starboard and No. 3 port.
2. An approximate 1° trim by the stern during the off-loading operations, which was not abnormal.
3. Either (a) a combination of a vapor pressure buildup and thermal expansion of the vapors and liquids in tanks No. 2 port and or No. 3 port, or (b) the gravitation of cargo from No. 2 port tank to No. 3 port tank, either of which resulted in an overflow of gasoline through the expansion trunk.

4. The absence of practical and specific recommendations or standards limiting the maximum allowable filling of tanks, both in the state of the art and in applicable Coast Guard rules, regulations, and manuals.

The Safety Board concurs in the conclusions of the Marine Board that the following were also contributory causal factors:

1. The presence of the M/V MARTIN and its potential sources of ignition immediately alongside the barges during discharge operations.
2. Failure of the master to investigate and ascertain the source of the vapors.
3. Failure of the master to take timely action to eliminate the source of the vapors.
4. Failure of the master to keep the tank hatch covers securely closed.

Loss of life was caused by the violent release of energy due to ignition of explosive vapors near the deck of the barge, dispersal of flaming gasoline from explosive rupture of the loaded drums caught in the fire, and the wind borne dispersal of burning gasoline vapors over the MARTIN and the floating dock.

RECOMMENDATIONS

The Safety Board concurs in the recommendations of the Marine Board of Investigation. We further support such recurrent training programs as the tankerman course proposed for the National River Academy. Such educational and recurrent training programs are effective methods for reducing accidents involving dangerous cargo. They should receive the full support of the maritime industry.

In addition, it is recommended that:

1. The owners and operators of all tank vessels and tank barges which are not required to have loadlines, provide each vessel or barge with a maximum loading capacity guide, such guide to cover the petroleum products normally carried and the seasonal temperature variations normally encountered in the area of operations.
2. The Coast Guard, as a part of its review of tank vessel and tank barge casualties, evaluate the effectiveness of the safe handling procedures as recommended by the Rules and Regulations

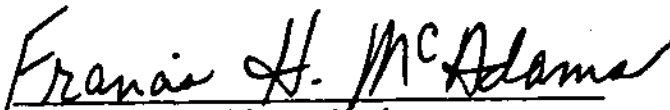
for Tank Vessels (Title 46 CFR, Parts 30 to 40) and the Manual for the Safe Handling of Inflammable and Combustible Liquids. The intent of such a review would be to determine whether some of the current recommended procedures should be made mandatory by regulation.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

Adopted this 7th day of January, 1971:


John H. Reed, Chairman


Oscar M. Laurel, Member


Francis H. McAdams, Member


Louis M. Thayer, Member


Isabel A. Burgess, Member



DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

Address reply to:
COMMANDANT (MVI-3)
U.S. COAST GUARD
WASHINGTON, D.C. 20591

• 5943/MOS-106
A-2 Bd
22 JUL 1970

Commandant's Action

on

The Marine Board of Investigation convened to investigate the fire and explosion on the tank barge MOS 106 at La Grange, Missouri, on 12 May 1969, 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.

SYNOPSIS OF FINDINGS OF MARINE BOARD OF INVESTIGATION

1. While discharging a cargo of gasoline a fire and explosion occurred on the tank barge MOS 106 at about 2115 CDST, 12 May 1969. The MOS 106, along with the tank barge MOS 104 and towboat M/V MARTIN, was moored to the floating dock barge of the Triangle Oil Refining Company at La Grange, Missouri, on the Upper Mississippi River. The casualty resulted in the loss of six lives.
2. The MOS 106 had been loaded with 908,000 gallons of gasoline at West Memphis, Arkansas on 5 May 1969. 2500 barrels (Approximately 138,000 gallons) of this cargo were lost at Cape Girardeau, Missouri on 9 May 1969 when two tanks were ruptured as a result of striking a highway bridge. The remainder of the cargo from the two damaged tanks was transferred to four other tanks of the barge.
3. Upon arriving at La Grange at 1745 on 12 May 1969, the MOS 106 and MOS 104 were made fast to the Triangle Oil Refining Company's dock barge, whereupon the discharge hose was connected to the MOS 106 to unload the cargo. A leak was discovered at the flange of the hose on the dock barge when pumping began, and pumping was stopped until the joint was repaired. When the pumping resumed, there was only a small intermittent drip of gasoline from the discharge flange and was caught in a drip pan on the dock barge.

4. There were approximately twenty fifty-five gallon drums stowed on the centerline of MOS 106 in the vicinity of number three cargo tank. It was reported that eight of these drums were filled with gasoline.

5. Just prior to the fire a deckhand was washing down the deck of the MOS 106 and sweeping the wash water over the side of the barge. He stated that gasoline was mixed with the water he was washing overboard. He saw a small flame coming down the deck toward him from the upstream end of the barge, ran aft, and jumped over the side at the time of the first explosion.

6. Evidence in the record shows that the hatch covers on the MOS 106 were open at the time of the casualty and that a strong gasoline vapor surrounded the MOS 106 and the M/V MARTIN prior to the fire and explosion. The record discloses that the oil-fired galley range on the M/V MARTIN was in operation prior to and during the fire.

REMARKS

1. The specific source of and the exact location of the fire and explosion could not be determined due to the lack of eye witnesses and the great amount of structural damage found after the casualty.

2. While a concentration of gasoline vapors undoubtedly supplied the explosive mixture causing this casualty, any determination as to the source of ignition must be purely conjectural based upon the limited facts available. However, assuming the initial explosion to have occurred and fire to have started on the MOS 106, a number of potential sources of gasoline vapor becomes evident. The open hatch covers and the gasoline on the deck of the barge are two sources that reflect this possibility.

3. Although the source of ignition was not positively determined, the most likely area of ignition was the flame in the galley range. There could have been other sources of ignition; however, this is not supported in the record. The manner in which the gasoline was deposited on deck of the MOS 106 is not revealed. There are several possibilities; however, it would be highly speculative to attempt to pinpoint one possibility over others without evidence.


4. Legislation requiring the licensing of persons in charge of the navigational watch of towing vessels is now pending in Congress.

5. The Coast Guard is conducting a long range study of towing vessels and gathering other statistical information from towing vessel casualties. Methods of reducing hazards on towing vessels operating with tank barges will be included.

6. The dangers of transporting, handling and storing gasoline will be emphasized through widespread circulation of this report. The Proceedings of the Merchant Marine Council will feature the entire report in a future publication. By this Action, managers recommending candidates for certification as tankerman are urged to have them study the hazards involved of handling gasoline. Familiarity with the following publications are included:

- a. A Manual for the Safe Handling of Inflammable and Combustible Liquids, CG-174.
- b. Rules and Regulations for Tank Vessels, CG-123.
- c. Fire Fighting Manual for Tank Vessels, CG-329.

These publications are available at no charge from all Coast Guard Marine Inspection Offices and from Coast Guard Headquarters.


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



DEPARTMENT OF TRANSPORTATION
 UNITED STATES COAST GUARD

Address reply to:
 COMMANDER
 Second Coast Guard District
 Federal Bldg.
 1520 Market St.
 St. Louis, Mo. 63103
 5943/ Marine Board
 of Investigation
 MOS 106, Fire and
 Explosion
 5 November 1969

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

Subj: MOS 106, Tank Barge, Fire and Explosion on 12 May
 1969 at LaGrange, Missouri (Upper Mississippi River);
 involving M/V MARTIN, MOS 104, UM 219, CHEM 40; with
 loss of life

1. At or about 2115 CDST on 12 May 1969, fire and explosions occurred on the tank barge MOS 106 while unloading a cargo of gasoline at the Triangle Oil Refining Company's loading facility on the Upper Mississippi River at LaGrange, Missouri. The tank barges MOS 106 and the MOS 104 with the towboat M/V MARTIN alongside were docked at a floating dock-barge. The casualty resulted in the loss of life of six persons who were on board or in the vicinity of the MOS 106. Two persons were injured resulting in their incapacitation for a period of excess of 72 hours. There was material damage to five vessels, including two barges downstream from the terminal facility which were damaged by burning gasoline on the water and by collision after the three vessels at the dock-barge were set adrift after the fire started.

2. Vessel data:

NAME:	M/V MARTIN	MOS 106	MOS 104
O.N.:	260333	270535	270534
SERVICE:	Towboat	Tank Barge	Tank Barge
BUILT:	1950	1955	1955
GROSS TONS:	183	1428	1368
NET TONS:	124	1428	1368
LENGTH:	100'	290'	290'
BREADTH:	26'	50'	48'
DEPTH:	9'	12'	12'
PROP:	Motor	Non-self Propelled	Non-self Propelled
MANNING	9	Unmanned	Unmanned
HOMEPORT:	Peoria, Ill.	Peoria, Ill.	Peoria, Ill.
OWNER	Meljoy Trans. Company	Meljoy Trans. Company	Meljoy Trans. Company
OPERATOR	Owner	Owner	Owner

CERTIFICATED:	Uninspected	Grade B Cargo	Grade B Cargo
DATE:	NA	13 April 1968	2 Mar 68
PORT:	NA	Memphis, Tenn.	Port Arthur Texas
RE-INSP:	NA		
DATE:	NA	20 Feb 1969	20 Feb 1969
PORT:	NA	Memphis, Tenn.	Memphis, Tenn.
NAME:	UM 219		CHEM 40
O.N.:	244453		295716
SERVICE:	Hopper Barge		Tank Barge
BUILT:	1965		1964
GROSS TONS:	945		822
NET TONS:	945		822
LENGTH:	195'		195'
BREADTH:	35'		35'
DEPTH:	12'		12'
PROP:	Non-self Propelled		Non-self Propelled
MANNING:	Unmanned		Unmanned
HOMEPORT:	Minneapolis, Minn.		Wilmington, Delaware
OWNER:	Upper Miss. Towing Co.		American Commercial Barge Line Co.
OPERATOR:	Owner		Owner
CERTIFICATED:	Uninspected		
DATE:	NA		10 May 1968
PORT:	NA		Port Arthur, Texas
RE-INSP:	NA		
DATE:	NA		
PORT:	NA		

The MOS 104 and MOS 106 were steel tank barges of similar construction with ten cargo tanks, a sloping bow rake compartment and a box end stern rake compartment. The barges were divided longitudinally by one centerline bulkhead and six transverse bulkheads between tanks. The cargo transfer piping located near the centerline bulkhead at the bottom of each tank was fitted with valves in each compartment controlled by means of reach rods located on deck to regulate the transfer of cargo. Each tank had an expansion trunk, fitted with a manhole and an approved type pressure vacuum relief valve. Each manhole was fitted with a gasket and four dogs for securing the cover. No sounding tubes were fitted on the expansion trunks. Each vessel was equipped with a deep well cargo pump driven by a six cylinder, GM 71 series diesel engine mounted on the deck.

The CHEM 40 was a double skin barge loaded with a cargo of non-flammable, non-hazardous liquid fertilizer.

The UM 219 was an open hopper type barge used for the transportation of grain and other non-hazardous materials.

The M/V MARTIN was a single shaft steel towboat powered by a 1200 HP diesel engine and was being used to push the barges MOS 106 and MOS 104.

3. The following persons died as a result of the casualty:

William R. OPITZ - License No. 293545 endorsed as master of steam and/or motor vessels of not over 1400 tons upon rivers; also, first class pilot from Mi. 26.7 UMR to Mi. 605.3 LMR. Master of the M/V MARTIN. Address: Memphis, Tenn. Captain Opitz died at St. Mary's Hospital in Quincy, Illinois on 16 May 1969 as a result of burn injuries.

Walter C. MITCHELL - USMMD Z-344706 endorsed as Tankerman, Grade "B". Employed as Triangle Oil Refinery Manager, LaGrange, Mo.

Albert FRIEDEN - Employed as Triangle Oil Refinery Company Terminal Assistant, LaGrange, Mo.

Lewis HAGANHOFF - Truck driver, LaGrange, Mo.

Aaron JEAN - Deckhand, M/V MARTIN, Address: Alton, Ill.

Glenn H. MAPLES - USMMD Z-1068681 endorsed as Tankerman, Grade "B". Triangle Oil Refinery Manager, LaGrange, Mo.

The following persons were injured as a result of this casualty and incapacitated in excess of 72 hours. They were treated at Blessing Hospital and St. Mary's Hospital in Quincy, Illinois:

W. A. MORRISON - Unlicensed Assistant Engineer of the M/V MARTIN. Address: Marble Hill, Mo.

Oren McPHERSON - Cook of the M/V MARTIN. Address: Memphis, Tenn.

4. The weather at the time of the casualty was clear with a slight westerly wind. The water was calm with a river current of approximately two knots.

5. On 5 May the M/V MARTIN with the tank barges MOS 104 and MOS 106 arrived at the Oklahoma Mississippi River Pipeline Co. loading facility dock in West Memphis, Arkansas, where 908,000 gallons of gasoline were loaded in the tank barge MOS 106 and 922,000 gallons in the MOS 104. The draft of the MOS 104 was 8'8" forward and 9' aft.

The draft of the MOS 106 was 8'9" forward and 9' aft. Approximately twenty empty 55-gallon drums were received aboard and stowed on dunnage along the centerline of the MOS 106, in the vicinity of no. 3 cargo tank. At or about 2255 on 6 May the M/V MARTIN departed upbound in the Mississippi River with loaded tank barges MOS 106 and MOS 104, enroute to LaGrange, Mo. The two barges were coupled together stern to stern in tandem with the MOS 104 as the lead barge and the M/V MARTIN coupled to and pushing on the rake end of the MOS 106.

6. At or about 0530 on 9 May 1969, the M/V MARTIN and MOS 106 sustained damage due to a collision with the west span pier of the Cape Girardeau, Mo. highway route 146 bridge while being navigated by George T. Reeves, an unlicensed pilot. The collision broke the coupling wires and the vessels were set against nearby structures and other vessels by the current. Damage to the MOS 106 included indentations in the shell plating, an 8" fracture in way of number 3 starboard cargo tank, and an 8" diameter hole in way of number 1 port cargo tank. (The tanks are numbered 1 to 5 starting at the rake end of the barge) A large quantity of gasoline cargo, approximately 2500 barrels, was lost into the river from the two damaged tanks. A wooden plug was driven into the hole in number 1 port cargo tank shell plating and the MOS 106 was moved to the American Oil Co. dock at Cape Girardeau, Mo. The M/V MARTIN suffered damage to the engine cooling system (skin cooler) and required drydocking at Cape Girardeau.

7. All of the gasoline cargo contained in number 1 port cargo tank escaped. The cargo remaining in number 3 starboard cargo tank (about 40,000 gallons) was transferred by the use of shore pumping facilities by pumping into number 3 port tank and gravitating from that tank to number 1 starboard tank and number 2 port and starboard tanks. The tank soundings prior to this transfer were 11'2" in number 3 port; 10'8" in number 2 port; 10'9-5/8" in number 2 starboard and 10'9-3/8" in number 1 starboard. Ullages in these tanks after the transfer of cargo were not available.

The Officer in Charge, Marine Inspection, Cairo, Ill., was notified of the casualty and a Coast Guard marine inspector was sent to the scene. Following his examination of the damage, the certificate of inspection was withdrawn from the MOS 106. Subsequently, after it was determined that there was little likelihood of any further leakage of gasoline, the MOS 106 was found safe to continue its voyage and a Permit to Proceed was issued.

The tow, made up as before, continued upbound passing through five locks without incident. No leakage of gasoline from the damaged tanks was noted. Upon arrival of the M/V MARTIN and tow at the Triangle Oil Refining Co. facility at LaGrange, Mo., at or about 1745 on 12 May 1969, the barge CHEM 40 was moved from the Triangle facility dock barge and tied up approximately 200 feet downstream alongside the barge UM 219 at a grain elevator. This move was accomplished by the MARTIN alongside the CHEM 40, with her two

gasoline barges still made up forward of the MARTIN. When the cargo discharge hose from the CHEM 40 was disconnected, there was a spillage of liquid fertilizer on the dock barge, some of which was later tracked onto the MOS 104 and 106. The MOS 104 and MOS 106 were moored at the facility with the stern couplings of both barges approximately amidship on the Triangle Oil Refining Company's dock barge. This steel mooring barge was a converted gravel barge approximately 128' long and 26' wide. It was permanently moored, by means of cables and spars and was equipped with a metal catwalk to the bank. It contained an electrically driven deep well cargo transfer pump, headers and associated piping for offloading of cargo. A metal shed was constructed on the upstream end of the barge to house tools and a small office. There was a rubber cargo hose located beneath the catwalk to transfer the cargo between the barge and shoreside facilities. The deck of the barge was covered with concrete to provide a working platform. After positioning the tank barges MOS 104 and MOS 106, the M/V MARTIN tied up on the outboard side of the tow with its port side amidship, directly adjacent to the coupling between the two barges with the bow headed upstream.

9. The discharge hose was connected to the MOS 106 by Mr. George T. Reeves, the pilot, Mr. Joseph Stevens, the mate, and Aaron Gean, one of the deckhands. When the hose was connected to the MOS 106, Chief Engineer Walter Mitchell came out on the barge from the MARTIN and started the diesel pump engine of the MOS 106 (the pump that was to be used for off-loading the cargo) and let it run at idling speed. Captain Opitz, the M/V MARTIN's Master; Mr. Glenn Maples, Triangle Oil Company dock manager, and Mr. Albert Frieden, Mr. Maples' assistant, were gauging the tanks while the preparations for off-loading were being made. When Mr. Maples indicated he was ready to commence pumping the pump was engaged. A leak was noted at the flanged fitting to the discharge hose on the dock barge, whereupon the pump was shut down at the request of Mr. Maples while the joint was repaired. This was done by installing more bolts in the flange and tightening the existing bolts. While the joint was being tightened, Chief Mitchell departed the barge and returned to the towboat. Mr. Reeves engaged the pump and started off-loading cargo from number 1 starboard tank with only a small intermittent drip of gasoline from this flange fitting. Leakage from this connection was caught in a drip pan.

10. While going ashore at or about 2030 Reeves, the pilot, observed Captain Opitz laying out a garden hose from the MARTIN to the MOS 106. This was also observed by the mate, Joseph Stevens, who directed the deckhand, Larry Thompson to assist the Captain. Thompson used the water hose to wash down the deck and swept the wash water over the outboard side of the barge. Some of the wash water which he could not reach remained under the drums located on deck near number 3 cargo tank hatches. Thompson stated that eight of these drums had been filled with gasoline during the voyage. He was of the opinion that the substance he

was washing from the deck was gasoline. Thompson, age 19 was the only surviving witness on deck at the time the fire started and had only limited experience on vessels. He had joined the M/V MARTIN at Hartford, Illinois, on the day prior to the casualty. His prior service on vessels of any type had been four days as deckhand on another towboat handling coal barges.

11. While unloading, a strong odor of gasoline was noticed approximately 15 minutes before the first explosion by the mate Joseph Stevens, while he was getting ready for bed on board the M/V MARTIN. The number 1 starboard cargo tank had been emptied and approximately one-third of the cargo had been pumped from the number 2 starboard tank when the fire started at or about 2115. There was an explosion soon after the fire started, followed by a series of explosions, throwing gasoline on the MOS 104, the M/V MARTIN, and the terminal facility barge. The shell plating of the MOS 106 at number 2 port and number 2 starboard tanks ruptured, allowing burning gasoline to be carried downstream, partially engulfing the CHEM 40 and the UM 219 at the grain elevator. Shortly afterward, the head wire of the MOS 104 was cut by someone, allowing the tow to swing out into the stream. The swinging of the tow damaged and sank the dock barge. The tow broke loose and was carried downstream by the river current where it collided with CHEM 40 and UM 219, breaking their moorings and throwing burning gasoline on their decks in addition to setting the grain elevator on fire. This allowed all five vessels to be carried downstream. The five vessels, the loading facility, and the grain elevator were then on fire. Fires on the grain elevator and loading facility were eventually extinguished by local firemen. The fires on the CHEM 40 and UM 219 burned themselves out and the barges grounded on wing dikes in the river. The M/V MARTIN and the MOS 104, adrift and still on fire, also grounded on wing dikes at mile 329 and 330 Upper Mississippi River. The MOS 106, burning intensely, lodged against the upstream side of the Chicago, Burlington and Quincy Railroad Bridge span at mile 328.

12. The Coast Guard Rescue Coordination Center in St. Louis, Mo. was notified at 2222 on 12 May 1969. At 2350 three officers from the Captain of the Port's office in St. Louis were dispatched to the scene, arriving there at 0215 on 13 May 1969. Evaluation of the situation revealed a serious threat to the Quincy, Illinois waterfront, should the burning tank barge MOS 106 become dislodged from the railroad bridge piers. Contact was made with the local fire department with regard to water transportable firefighting equipment. The fire department advised that the only equipment they had was a pumper type truck which was not transportable by water. Corps of Engineers officials, city officials and railroad officers requested Coast Guard assistance in extinguishing this fire. The On-Scene Commander from St. Louis Captain of the Port office agreed that the Coast Guard should assist in extinguishing the barge fires if it became apparent that the town of Quincy was endangered. In preparation for such assistance, the On-Scene Commander, at about 0230, requested additional men and equipment from Coast Guard forces in St. Louis, Mo. At about 0530, seven

Coast Guardsmen with six P-60 pumps and 500 gallons of foam concentrate departed St. Louis in two trucks bound for Quincy. At about this time, the fires on the MOS 104 and the M/V MARTIN, still on the wing dikes, burned themselves out. At about 1100, the barge MOS 106 started to sag and the port side amidship became awash extinguishing some of the intense flames near the center section, but there was still a great amount of fire from the tank hatch openings and from the gasoline on the water. When it became evident that the barge might break in half and dislodge itself from the bridge, fire fighting efforts were started by the On-Scene Commander using the equipment that had arrived from the Coast Guard Base, St. Louis, Mo. This equipment was placed on a 100 foot barge which had been volunteered by Mr. M. W. Boudreaux of the Northeast Power Co., Palmyra, Mo. The towboat pushing this barge was operated by Mr. Charles Leabig of Quincy, Ill. The approach to the burning barge was made by heading upstream from Quincy to the railroad bridge. Fortunately, the breeze was also upstream blowing smoke and flames away from the firefighters on the bow of the Northeast Power Co. barge. The fire was extinguished at or about 1250. Two hundred-seventy-five gallons of foam were applied by eight Coast Guardsmen from St. Louis, and six firemen from Quincy, Ill. The Coast Guard Cutter GOLDENROD arrived at 1300. This vessel stood by throughout the remainder of the day as a reflash watch and remained in the area until 19 May 1969, when she departed for her homeport at Keokuk, Iowa. The MOS 106 remained hung up on the bridge until the evening of 14 May, at which time it was removed by the owner to a point 2 miles upstream from the bridge where it was later off-loaded safely.

13. There were four men on the MOS 106 and three men in the immediate vicinity of the Triangle facility barge at the time of the casualty. Mr. Larry Thompson was the only one of these seven men to survive. The other six men were killed by burns or drowning. One of these six men was Lewis Haganhoff, a truck driver who was not employed by either the owner of the loading facility or the owner of the vessels involved. Thompson testified that while he was washing and sweeping down the deck, he observed a small flame coming down the deck toward him from the upstream end of the barge. He dropped his broom and ran to the south end of the MOS 106 where he met Aaron Gean, the other deckhand. When the first explosion occurred, the two deckhands jumped into the river. Aaron Gean did not have a lifejacket on, so Thompson told Gean to hold on to his life-jacket and try to swim toward the bank. They were carried downstream by the current into the CHEM 40 where Gean held on until his hand slipped off and he went under the barge. Thompson was carried downstream where he reached the bank below the grain elevator. He rested, then walked to LaGrange where he was taken to the hospital in Quincy, Ill. for treatment of a knee injury. Immediately after the first explosion, W. A. Morrison, the

assistant engineer, and Ray Crawley, the deckhand, ran into Stevens' (the mate's) room from the adjoining compartment and told him the barge was on fire and that it had blown fire into their berthing compartment. Stevens left his room and started back toward the stern for a fire extinguisher where he met McPherson who had already obtained an extinguisher. They both went in through Stevens' room in an attempt to extinguish the fire in the adjoining room, but the smoke was so bad they were forced out. Stevens got dressed and went with the other three men to the bow of the towboat at which time another explosion took place. Stevens ran back to his room for a lifejacket and returned to the bow of the towboat. Then going to the deck of the MOS 104, he jumped overboard from the inshore side.

Reeves, the pilot, observed the fire from a bar and restaurant located approximately 100 yards from the loading facility. He saw a large burst of flame in the direction of the dock barge followed by an explosion. He noted a man being blown through the air toward the bank. As Reeves ran toward the barges, he saw a man in flames run across the deck of the MOS 104 and jump in the river just forward (upstream) of the M/V MARTIN. When he got near the forward barge, he noticed that four men from the towboat; Stevens the mate, McPherson the cook, W. A. Morrison, the assistant engineer, and Ray Crawley, the deckhand, had run out on the bow of the MOS 104. He yelled at them to jump into the river. Stevens did jump and was being carried under the dock barge by the current when McPherson pulled him out. Reeves then ran back to Pete's Boathouse and asked Pete Brandt, the owner, to get his boat. The two men put out in Brandt's small boat and took the four men ashore from the port bow of the MOS 104. Reeves and Brandt then returned in the boat to the M/V MARTIN to see if anyone was still aboard. As they approached the MARTIN, the entire after section was on fire and there were flames from the gasoline pouring out into the river from the MOS 106. In fear of getting caught in the flames, they returned to the dock at Pete's Boathouse.

There were four men in a gasoline service station located approximately 300 yards from the loading facility. One of these men was standing at the rear window when he saw and heard flames come up from the midsection of the MOS 106. Soon thereafter, he saw three men running toward the edge of the barge on the bank side. He did not see these men after the first of several explosions which occurred shortly after the first flames appeared. By the time the four men from the service station reached the scene, the entire barge MOS 106 was on fire.

14. The galley range of the M/V MARTIN was in operation at the time of the casualty. After the evening meal the range had been cleaned and the oil burner had been relighted by Oren McPherson, the cook. This was common practice on the M/V MARTIN

as the galley range provided the only means of supplying hot water to the showers and wash basins. The galley door facing the barges MOS 104 and 106 in the vicinity of the cargo hose connections was open.

15. Conditions on the MOS 106 following the casualty and the extinguishment of the fire were as follows:

- a. No. 1 starboard tank bulged and ruptured.
- b. No. 2 port and starboard tank bulged and ruptured.
- c. No. 3 port tank split at the bulkhead of no. 2 tank from deck knuckle to keel.
- d. All bulkheads to cargo tanks one, two, and three; port and starboard, were ruptured allowing the remaining cargo to escape into the river.
- e. Both forward and after void compartments were dry and watertight.
- f. Vessel had sagged approximately six feet in the center section.
- g. All hatch covers were off. None of the securing dog bolts were stripped. (Indicating that the hatch covers had been open or at least not dogged down)
- h. No. 4 port and starboard tank and no. 5 port and starboard tanks had approximately ten feet of gasoline in each tank.
- i. Approximately 15 empty 55 gallon drums were scattered about the deck amidship. Half of these drums had exploded.
- j. The after section in the vicinity of the pump engine was badly scorched, but not severely burned.
- k. The remains of three small portable gasoline driven stripping pumps were located on deck - one forward, one amidship, and one aft. The amidships portable pump engine did not have a muffler attached and burned out hose couplings were still attached to the suction and discharge connections of the pump. These pumps were not in use at the time of the casualty.

The MOS 106 continued to leak gasoline from number 3 port tank, continuing until the evening of 15 May 1969, at which time there were no longer indications of gasoline downstream from the barge.

16. During the afternoon of 13 May 1969, the M/V MARTIN was removed from the wing dike and brought to Quincy, Ill. The complete interior of the crews' quarters and galley were burned out by the fire. The M/V MARTIN was later towed downstream to Greenville, Miss. The MOS 104 was removed from the wing dike at Mile 330 on the morning of 14 May 1969, and taken to Alexandria, Mo. to be off-loaded. None of the cargo on this barge was burned or lost.

On 15 May 1969, the CHEM 40 and UM 219 were picked up by down-bound tows and taken to the St. Louis area for repair of fire damage and hull damage sustained when they had been struck by

the burning tow drifting down the river.

On 16 May 1969, the MOS 104 was brought back downstream from Alexandria, Mo., empty, and moored alongside the MOS 106. Off-loading of the No. 4 and 5 port and starboard tanks of the MOS 106 onto the MOS 104 commenced on the morning of 17 May. The cargo pump and engine on the MOS 106 had not been substantially damaged by the fire and were used for this operation.

17. Searches for survivors along the river were unsuccessful and the Quincy Volunteer Rescue Squadron conducted dragging operations throughout the week of 12 - 17 May 1969 with negative results. In addition to the dragging operations, this rescue squad provided around the clock patrols to keep sightseers and boaters away from the hazardous areas. The bodies of Aaron Gean, Walter Mitchell and Lewis Haganhoff have subsequently been found on the bank downstream from LaGrange, Missouri.

CONCLUSIONS

1. The cause of the casualty to the extent determinable was the ignition of a concentration of explosive gasoline vapors surrounding the tank barges and towboat. The most probable source of vapor ignition was the open-flame galley range which was in operation on board the M/V MARTIN at the time of the casualty. While there are a number of potential sources of vapor ignition under the circumstances prevailing in this case (for which precautions must always be taken) the only direct evidence of such a source at the time of the explosion was the fire in the galley range. The most probable cause of the explosive vapors was a gasoline spill on one of the barges. While there was no direct evidence as to the source of such a spill (due to the unfortunate death of all experienced witnesses who would have been in a position to know) it was possibly caused by an overflow of gasoline from the open hatch of number three port tank, the area where the first explosion occurred. There was evidence of the presence of gasoline in that area along with the water that was being used to wash down the decks and undamaged threads on the dogs for the missing hatch cover of no. 3 tank indicate that the cover was not securely closed at the time of the explosion. It is likely that number three port was almost completely full following the transfer of cargo from the damaged tanks into the forward tanks at Cape Girardeau, Mo. on 9 May 1969. It follows that gasoline may have overflowed from that tank due to a change in trim as number 1 and number 2 cargo tanks were discharged.

2. The following failures are considered to be contributing causes of the casualty and negligence on the part of the certified tankermen and the deck officer on duty. (All of these personnel are deceased):

a. Failure to remove the M/V MARTIN and it's potential sources of ignition from the immediate vicinity of the off-loading barges.

b. Failure to investigate and ascertain the source of the vapors.

c. Failure to take timely action to eliminate the cause of the vapors.

d. Failure to secure the off-loading operation after a gasoline spill.

e. Failure to maintain the cargo tank hatch covers securely closed.

3. There is no evidence that the damage sustained by the Barge MOS-106 as a result of the collision with the Cape Girardeau, Mo. bridge on 9 May 1969 was contributory to this casualty. Since the damaged tanks were emptied shortly after that earlier incident there was no leakage of gasoline from them at LaGrange, Mo. or while transitting the river and various locks enroute.

4. There is no evidence of violations of laws relating to vessels warranting referral to the U. S. Attorney or action under the administrative penalty provisions.

5. a. The casualty may have been prevented had proper precautions been exercised to prevent the accumulation of gasoline vapors in hazardous concentrations during the cargo transfer operation and had immediate remedial measures been instituted upon discovery of the accumulation of vapors. Removal of the M/V MARTIN from the immediate proximity of the cargo connections on the barges would have eliminated several sources of ignition and, as well, reduced the number of victims by removing the off duty personnel from the vicinity.

b. Precautions that should have been exercised while handling the gasoline cargo are described in "A Manual for the Safe Handling of Inflammable and Combustible Liquids, CG 174" and in "Rules and Regulations for Tank Vessels, CG 123." These publications contain simple, easy to read instructions regarding general safety precautions and cargo handling, including material on pertinent subjects:

(1) Overflow of "topped off" tank due to change of vessel trim.

(2) Fires or open flames in compartments facing, open or adjacent to that part of the deck in which cargo connections have been made.

(3) Inspection to determine whether galley fires can be maintained with reasonable safety.

(4) Vessels coming alongside in way of cargo tanks.

(5) Stopping transfer when there is a bad spill on deck.

(6) Prompt report of leakage to the person in charge.

(7) Proper hose connections with drip pans.

RECOMMENDATIONS

1. That continued support be given to legislation requiring the licensing of responsible operating personnel on towing vessels. In addition to enhanced safety resulting from greater competency based on professional knowledge, experience, and background, a licensing program would provide better means of enforcing safety rules including revocation or suspension proceedings against licenses or certificates of offenders.

2. That the Coast Guard institute a study to determine the feasibility of and methods of implementing and enforcing requirements to reduce hazards on towing vessels operating with tank barges. For example: (1) Preventing vessels with a source of ignition from being alongside and (2) Keeping all cargo tank hatch covers securely closed during the loading and off-loading of flammable products.

3. That, in the interim, appropriate action should be taken to alert all persons engaged in the handling of hazardous cargoes as to the dangers involved and how they may be reduced by proper operating practices. This should include the continued publication of instruction manuals and wide dissemination of this report, after action by the Commandant and the National Transportation Safety Board.

Robert F. Barber

ROBERT F. BARBER
Captain, U. S. Coast Guard
Chairman

Forrest E. Stewart

FORREST E. STEWART
Commander, U. S. Coast Guard
Member

David W. Reineke

DAVID W. REINEKE
Lieutenant Commander, U.S. Coast Guard
Member and Recorder

