



TREASURY DEPARTMENT  
UNITED STATES COAST GUARD

Address reply to:  
COMMANDANT (MVI-3)  
U.S. COAST GUARD  
WASHINGTON, D.C. 20226

. 5943/BUNKER HILL  
A-13 Bd  
8 MAY 1965

Commandant's Action

on

Marine Board of Investigation; explosion of the  
SS BUNKER HILL in Rosario Straits near Anacortes,  
Washington, on 6 March 1964

1. The record of the Marine Board of Investigation convened to investigate subject casualty, together with the Findings of Fact, Conclusions and Recommendations, has been reviewed.

2. At approximately 0402 (PST) on 6 March 1964 while the SS BUNKER HILL was en route from Tacoma, Washington, to Anacortes, Washington, and in approximate position 48 degrees 23 minutes North, 122 degrees 45 minutes West, an explosion occurred in the No. 9 cargo tanks causing the vessel to break in two. In less than an hour, the vessel had sunk. Of the 31 persons on board, the Master and four crewmembers who were in the midship house are missing and presumed to have been lost.

3. The SS BUNKER HILL was a T-2 type tankship of 10,590 gross tons, 504 ft. long, built in 1942 and certificated to carry Grade A inflammable and combustible liquids. The horsepower of the main propulsion machinery had been increased from 6,000 h.p. to 7,000 h.p. by an electrical modification to the main propulsion motor. To control corrosion in the cargo tanks, a combination of sacrificial magnesium anodes and a chemical wash system had been installed. The use of the chemical wash system had been discontinued; however, the special piping which had been installed had not been removed. It was described as being in a deteriorated condition and evidence was received that pieces of the deteriorated pipe had fallen in the tanks. Evidence was also received that the magnesium anodes were deteriorated and that the steel bolts which fastened their brackets to the supporting structure were wasted. Crewmembers testified that on occasion both anodes and brackets had been found in the bottom of the tanks and that others were loose and hanging by only one wasted bolt. The No. 7 cargo tanks across were fitted with magnesium anodes; the No. 8 cargo tanks across were fitted with the abandoned chemical wash system; the No. 9 port and starboard wing tanks were fitted with the chemical wash system while the No. 9 center had both magnesium anodes and the chemical wash system.



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4. The following complement of licensed officers and crew was required by the Coast Guard Certificate of Inspection:

	1 Master
	1 Chief Mate
	1 Second Mate
	1 Third Mate
	1 Radio Officer
	1 Chief Engineer
	1 First Assistant Engineer
	1 Second Assistant Engineer
	1 Third Assistant Engineer
	6 Able Seamen
	3 Ordinary Seamen
	3 Firemen/Watertenders
	3 Oilers
Subtotal -	<u>24</u>

20 Other persons could be carried as crewmembers  
4 Persons could be carried in addition to the crew  
Total - 48

When the vessel departed Tacoma, Washington, it was manned as follows:

Licensed Personnel

	1 Master
	1 Chief Mate
	1 Junior Third Mate
	1 Chief Engineer
	1 Assistant Engineer
	(Night Engineer HAMMER)
Subtotal -	<u>5</u>

Unlicensed Personnel

	7 Able Bodied Seamen
	3 Ordinary Seamen
	2 Oilers
	3 Firemen/Watertenders
	<u>11</u> Other persons
Subtotal -	<u>26</u>
Total -	31

5. The last cargo carried by the BUNKER HILL was as follows:

<u>TANK NO.</u>	<u>PORT</u>	<u>CENTER</u>	<u>STARBOARD</u>
Deep Tanks	diesel oil	no tank	diesel oil
No. 1	diesel oil	no tank	diesel oil
No. 2	diesel oil	gasoline	diesel oil
No. 3	kerosene	kerosene	kerosene
No. 4	gasoline	gasoline	gasoline
No. 5	gasoline	gasoline	gasoline
No. 6	heavy fuel oil	heavy fuel oil	heavy fuel oil
No. 7	gasoline	gasoline	gasoline
No. 8	gasoline	gasoline	gasoline
No. 9	gasoline	gasoline	gasoline

6. Having discharged the last of the cargo, the BUNKER HILL departed Tacoma, Washington, at about 2330 (PST), 5 March 1964, for Anacortes, Washington, a distance of about 86 miles and a run of about 6-1/2 hours. The draft was 2 feet, 6 inches forward and 19 feet, 6 inches aft. The No. 6 center tank was ballasted.

7. On the bridge, the Master and Junior Third Mate were in charge of the navigation of the vessel and would remain on watch until it arrived at Anacortes. The Night Engineer who had assumed the engineroom watch at 1700 on 5 March 1964 was in charge of the engineroom and was to remain on watch until 0800 on 6 March 1964. He had stood a similar 15 hour watch the night before. The only regularly assigned licensed engineer on board was the Chief Engineer who was in his room and available in the event of an emergency.

8. On deck, the Chief Pumpman and two seamen under the direct supervision of the Chief Mate were cleaning certain cargo tanks and associated piping. It was not intended to gas-free the tanks but only to prevent contamination of the next cargo. The No. 1 tanks were stripped into the bilges of the forward pumproom and the residue pumped overboard. Cargo tanks 2 across, 3 across and 9 across were each given an approximate ten minute cold water wash by inserting a 2-1/2 inch hose through the ullage opening. The water and residual cargo was pumped overboard through the after pumproom sea chest. Several of the on-deck cargo lines were drained directly

onto the deck, and the product in them permitted to run overboard. When this work was completed at approximately 0300, the Chief Mate released the two seamen, and he and the Chief Pumpman remained to complete the operation. The final cleaning of the tanks was accomplished by using a gas exhauster to draw liquid and vapor from the tank by its cargo suction line and discharge line. The two men working together applied the gas exhauster for about five minutes to each of the nine tanks which had been water-washed. When this was completed, the Chief Mate secured the gas exhauster and the Chief Pumpman the valves and stripping pumps in the after pumproom. While the Chief Pumpman was preparing the after pumproom to receive the next cargo, the Chief Mate entered the after pumproom to seal the sea valves and left, presumably to go to his room. The Chief Pumpman completed his work and left the after pumproom at about 0350.

9. A few minutes before four o'clock, the unlicensed deck and engine-room watch standers were relieved. On deck, all work had ceased and the relieved Lookout and Helmsman had returned to the after deckhouse. Evidence was received that some of the ullage covers were opened and one flame screen had not been inserted. The vessel was proceeding at about 15 knots on a northerly course in Rosario Straits expecting to arrive at Anacortes at about 0600. Due to the vessel's light load condition and the speed it was making in calm water, it experienced severe vibration. All operating equipment and machinery was functioning normally.

10. At about 0402, a violent explosion occurred in the way of the No. 9 cargo tanks. The vessel broke in two along a diagonal line between the after end of the No. 9 port wing tank and the forward end of the No. 9 starboard wing tank. The forward portion of the vessel veered to port and immediately started settling by the after end. As soon as the first violent explosion was over, the Lookout who was on the bow went into the rope locker below and obtained a life preserver. By the time he started back up the ladder to the foc'sle head the after portion of the bow section had settled in the water sufficiently that the deck was at an angle of about 45° to the horizontal. As the Lookout completed putting on his life preserver, a second violent explosion occurred in the No. 4 center tank, and fire engulfed him. He testified that he does not know how he got off the burning vessel but remembers surfacing in water covered with burning oil. He was able to swim out of the fire area and was rescued by a helicopter approximately 45 minutes later.

11. Following the explosion, the Night Engineer on watch in the engine-room slowed the main propulsion turbine and left the engine room. He stated that because the emergency lighting had come on, the 440 volt, 400 KW generator circuit breaker must have tripped, stopping most of the electric motors including the main and auxiliary circulating pumps. The Night Engineer was followed out of the engine room by the Fireman/Watertender who, prior to leaving the engine room, had secured the blowers

and fuel pumps to the boilers. The Oiler telephoned the Chief Engineer and remained in the engineroom until the Chief Engineer arrived. At this point, water was entering the engineroom through the bulkhead which separates it from the after pumproom. The Chief Engineer ordered the Oiler out of the engineroom, and after a quick inspection to assure that there was no one left in the engineroom and that the machinery was in a safe condition, left the engineroom.

12. On the after portion of the vessel, crewmembers attempted to launch the starboard lifeboat. In the darkness someone inadvertently released the inboard gripes first. The increasing starboard list created a hazardous situation for anyone attempting to release the outboard gripes, and the port lifeboat was lowered. While being lowered, the boat was flooded, reportedly by water coming out of the overboard discharge from the main condenser. Thus, the boat was in a swamped condition when it left the side of the ship. Seven crewmembers remained on the after portion of the vessel, and the remainder abandoned the ship either by entering directly into the water or by means of the lifeboat.

13. The explosion of the BUNKER HILL was observed by Navy men in the Naval Air Station Control Tower at Ault Field, Whidbey Island about five miles away. Rescue operations were immediately initiated, and within forty-five minutes all survivors were rescued. Four men were picked up by a Coast Guard helicopter and the remaining twenty-two men by a Navy Crash Boat.

#### REMARKS

1. Concurring in the Board's conclusions, it appears that the explosion occurred in way of the No. 9 tanks; that the source of ignition was due to a magnesium anode or a piece of the chemical wash pipe falling in the tank; and that the application of the gas exhauster lowered the petroleum vapor-air concentration to the critical range for explosion. The Board's recommendation that magnesium anodes be removed from tank vessels is also concurred in. The regulations for tank vessels have been amended to prohibit the installation or use of sacrificial anodes of a type capable of producing an incendive spark as the result of falling in tanks used for the carriage of inflammable or combustible liquids.

2. Further concurring with the Board, there is evidence that the BUNKER HILL violated the Oil Pollution Acts. However, the record does not support the conclusion that violations of the Oil Pollution Acts are widespread on tankships and that scant heed is being paid to the provisions of these Acts. There are, no doubt, incidents such as this where violations occur. In order to reduce the number of such incidents the

program for the enforcement of the Oil Pollution Acts has been under study for sometime. The Coast Guard is continuing its study of the many problems involved in the subject of oil pollution in the United States and in International Waters and will continue to consult with the Oil Pollution Panel to the Merchant Marine Council and with the American Petroleum Institute in this regard.

3. The Board's conclusion that the main and auxiliary circulating pumps were not operating after the initial explosion tripped out the 440 volt AC power, and that despite this, water from the overboard discharge flowed into the port lifeboat when it was launched, requires considerable qualification. The main condenser overboard discharge is located more than two feet above the main condenser. Since the vessel took an almost immediate starboard list, it must be concluded that the only possible way for water to flow out of the main condenser overboard discharge in sufficient quantity to flood the lifeboat was for the main circulating pump to have been operating. The possibility exists that the water which flooded the boat drained from the six-inch overboard discharge of the main propulsion generator air coolers and other auxiliaries. There is also a remote possibility that it may have drained from the high sea suction. With this type of vessel in the full load or fully ballasted condition without any appreciable list, the main condenser overboard discharge should be just below the surface of the water. When the vessel is in a lighter load or ballast condition, it is possible for the main condenser overboard discharge to enter the forward end of No. 4 or the after port lifeboat when the lifeboat is alongside after having been lowered to the surface of the water. Present Coast Guard regulations for new construction do not permit such a situation; however, existing vessels built during World War II were not prohibited from having overboard discharges in way of lifeboat locations. Normally, it is assumed that under abandon ship conditions, with the main condenser discharge above the water surface or with the vessel being listed to starboard, the main and auxiliary circulating pumps would be shut off to prevent discharging water into No. 4 lifeboat. There is insufficient evidence in the record to show exactly what did happen during the lowering of No. 4 lifeboat. In view of the above, a change in the regulations at this time to require alteration of the overboard discharge arrangements of existing vessels is not felt to be justified. No problem is deemed to exist except under abandon ship conditions wherein the main circulating pump has been left running instead of having been secured. The forward boats are customarily used at sea for other boat operations such as transfer of personnel and rescue purposes.

4. The Board's conclusion that the BUNKER HILL was inadequately manned with licensed officers, both deck and engineering, for an 86-mile voyage from Tacoma to Anacortes is concurred in. This cannot be equated with shifting a vessel from pier to pier in a harbor. The statute, 46 U.S.C. 222, states that no vessel shall be navigated unless she shall have in her service and on board such complement of licensed officers and

crew as may in the judgment of the Coast Guard be necessary for her safe navigation. The applicable regulation, 46 CFR 31.15-1(a), places the responsibility for the determination of such minimum safe manning upon the Officer in Charge, Marine Inspection, who inspects the vessel. The prescribed crew shall be entered in the Certificate of Inspection but may be changed from time to time by endorsement on such certificate by the Officer in Charge, Marine Inspection, by reason of change of conditions or employment. In this case, since the vessel was frequently employed on short voyages between ports in the Puget Sound area, the Master, Owner or Agent could have requested an amendment to the certificate to allow a somewhat reduced complement for an operation of this nature. When a vessel certificated for an ocean route is operating on a short, domestic inland voyage, it seems reasonable that the same standard of manning should not be required. Additional study of this matter will be made, looking toward a practical solution to this apparent inequity.

5. The Board commented on the practice of the Fireman/Watertender and the Oiler relieving each other for supper when at sea and recommended that this practice not be condoned. Sufficient personnel are required by the Certificate of Inspection to be on board to provide an adequate watch for usual at-sea steaming conditions. The specific assignment and utilization of such personnel is within the responsibilities of the Chief Engineer and the licensed engineer watch officer. Dependent upon conditions at the time, the watch officer may permit watch personnel to depart the immediate engineroom while still controlling him by placing time limitations on his absence and by controlling the areas to which he may go. Thus, when conditions in the engineroom are normal it appears reasonable that he permit the normal watch one at a time to depart for the evening meal. When conditions are such in the engineroom that all watch personnel must be on duty, the Chief Engineer would have to arrange a relief method to permit the watch to eat, using other watch personnel or day workers to effect the relief.

6. The Board's conclusion that the Radio Officer should have been on board and standing watches for all port-to-port transits in Puget Sound has been considered. Although the Radio Officer is required by the Certificate of Inspection, he is in fact required "second-hand"; his actual presence being required by the Federal Communications Commission. As prescribed by 47 U.S.C. 351, the Federal Communications Commission requires a Radio Officer on a vessel of this type when it is being navigated in the open sea outside a harbor or port. In the instant case the boundary line between Inland Waters and International Waters as described in 33 CFR 82.120 constitutes the line of demarcation.


7. The Board's recommendation that the regulations be amended to provide for stowage of the portable radiotelegraph apparatus in the after deckhouse on tank vessels is in accordance with Regulation 13, Chapter 3 of SOLAS 1960. The Rules and Regulations for Tank Vessels (CG-123) are being amended to comply with the Convention which will become effective on 26 May 1965.

8. The Board's recommendation that a regulation be promulgated to require that life preservers be available to personnel who perform duties in locations where it would be difficult in an emergency for them to return to their quarters to procure a life preserver is concurred in. Since the bridge and engine room watches are already provided for in the regulations, the matter of providing the Lookout with a life preserver will be referred to the Merchant Marine Council for consideration.

9. The Board's comments concerning the organization and training of the crew in emergency procedures is not entirely concurred in. When consideration is given to all the circumstances involved, it appears remarkable that there was no greater loss of life. Because the Maritime Administration has been involved in the past with the training of merchant marine personnel, a copy of the Board's report will be forwarded to the Administrator for such action as he considers to be appropriate. The Coast Guard will review existing requirements for merchant vessels to hold emergency drills and will consider appropriate revisions to raise the standards of competence of merchant marine personnel in such drills.

10. The Board's recommendation that the instrumentation of tank vessels be radically improved so that the vapor conditions inside cargo tanks can be quickly determined and continuously monitored is approved to the extent that explosimeters (combustible gas indicators) are now required on all manned U. S. flag tank vessels.

11. Subject to the foregoing remarks, the Record of the Marine Board of Investigation is approved.



W. D. SHIELDS  
Vice Admiral, U. S. Coast Guard  
Acting Commandant



UNITED STATES COAST GUARD



ADDRESS REPLY TO:  
Officer in Charge  
Marine Inspection  
618 Second Avenue  
Seattle 4, Washington

5943/36-64  
22 MAY 1964

From: Marine Board of Investigation  
To: Commandant

Subj: SS BUNKER HILL, O.N. 241 580; fire and explosion,  
subsequent sinking on 6 March 1964 in Rosario Strait  
near Anacortes, Washington, with loss of life

FINDINGS OF FACT

1. The SS BUNKER HILL was underway from Tacoma, Washington to Anacortes, Washington in Rosario Strait on 6 March 1964 when commencing at approximately 0402 P.S.T. she experienced a series of explosions, accompanied by fire and smoke, which broke the vessel into two or more portions. In less than an hour all major parts of the vessel had sunk. The vessel was without cargo and was not gas free as defined in 46 CFR 30.10-29. She was partially ballasted in No. 6 center tank. As a result of this casualty the Master and four other members of the crew, who were in the midship house, are missing.

2. The SS BUNKER HILL, O.N. 241 580, was a T-2 tank ship, built in 1942 at Chester, Pennsylvania. She was 10,590 gross tons, 6,417 net tons, steam turbo-electric drive, and 504' length, 68.2' breadth and 39.2' depth. She was owned by Keystone Tankship Corporation (Delaware). The operator was Keystone Shipping Company, Philadelphia, Pennsylvania, and her home port of record was Wilmington, Delaware. She was last certificated by the Coast Guard for Ocean routes on 21 September 1962 at the port of Portland, Oregon. The mid-period inspection was conducted on 24 July 1963 in Portland, Oregon. The last drydock examination was by Portland, Oregon Marine Inspection Office personnel on 26 June 1963 at Swan Island Shipyard, Portland, Oregon.

The BUNKER HILL had a 7,000 horsepower main propulsion unit as compared with the usual 6,000 horsepower installation typical of T-2 tankers. This was accomplished by an electrical modification of the main propulsion motor. The propulsion generator, turbine, and boilers had sufficient capacity to provide a 7,000 horsepower output without change. As a result of this change, the BUNKER HILL was capable of higher speed than the typical standard T-2.

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3. The persons who are missing as a result of this casualty to the SS BUNKER HILL are as follows:

Michael J. ABRAHAM, [REDACTED]  
[REDACTED], Master's License No. [REDACTED] serving as Master.  
His next of kin is Mrs. [REDACTED] same address.

Robert H. BLAKE, [REDACTED]  
License No. [REDACTED] as Master; serving as Chief Mate. His next  
of kin is Mrs. [REDACTED], same address.

[REDACTED], License No. [REDACTED] as Second Mate; serving as Junior  
Third Mate. His next of kin is Mrs. [REDACTED], same  
address.

[REDACTED]  
USMMD No. [REDACTED]; serving as Quartermaster. His next of  
kin is Mrs. [REDACTED] same address.

[REDACTED]  
USMMD No. [REDACTED] serving as Steward. His next of kin are  
[REDACTED] daughter, c/o Wolfstone & Piehler,  
Attorneys at Law, Central Building, Seattle, Washington; [REDACTED]  
[REDACTED] stepfather, [REDACTED]

4. The following persons were reported injured as a result of  
the explosion and fire and the subsequent exposure and immersion  
during the abandonment of the SS BUNKER HILL:

[REDACTED]  
Quartermaster - [REDACTED]

[REDACTED]  
Able Seaman - [REDACTED]

[REDACTED]  
Chief Pumpman, [REDACTED]

[REDACTED]  
Fireman/Watertender - [REDACTED]

[REDACTED]  
Wiper - [REDACTED]

[REDACTED]  
Chief Cook - [REDACTED]

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Utilityman - [REDACTED]

Utilityman - [REDACTED]

Messman - [REDACTED]

Galleyman - [REDACTED]

Boatswain - [REDACTED]

5. Weather conditions at the time and place of the casualty were as follows: clear night, visibility 10 miles, wind 5 knots from SE, sea calm. Weather and sea conditions played no part in this casualty.

6. The BUNKER HILL'S cargo tanks were arranged as shown in the General Arrangement Plan, Exhibit 4, which is a typical cargo tank arrangement for a T-2 tanker. The vessel had departed Anacortes on 3 March 1964 with a cargo of combustible and flammable petroleum products scheduled for discharge in Seattle and Tacoma. She was loaded in accordance with the following plan:

<u>TANK NO.</u>	<u>PORT</u>	<u>CENTER</u>	<u>STARBOARD</u>
Deep Tanks	diesel oil	no tank	diesel oil
No. 1	diesel oil	no tank	diesel oil
No. 2	diesel oil	gasoline	diesel oil
No. 3	kerosene	kerosene	kerosene
No. 4	gasoline	gasoline	gasoline
No. 5	gasoline	gasoline	gasoline
No. 6	heavy fuel oil	heavy fuel oil	heavy fuel oil
No. 7	gasoline	gasoline	gasoline
No. 8	gasoline	gasoline	gasoline
No. 9	gasoline	gasoline	gasoline

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7. On 4 and 5 March 1964, the SS BUNKER HILL was in the Puget Sound ports of Seattle and Tacoma discharging her cargo of diversified petroleum products. Immediately after unloading the last of her cargo, she took departure from Tacoma at about 2330 P.S.T., 5 March 1964, bound for Anacortes, Washington where another petroleum cargo was awaiting her. The distance to Anacortes from Tacoma is 86 miles and the expected duration of the run was about 6½ hours in good weather. At the time of departure, the vessel's draft forward was 2'06" and draft aft was 19'06", so that there was a drag of 17 feet.

8. Shortly after getting underway, cargo tank washing operations commenced under the supervision of Chief Mate Robert H. BLAKE. The tank washing operations were for the purpose of readying the BUNKER HILL for loading the next petroleum cargo in Anacortes, and to assure, thereby, that there would be no cargo contamination. The estimated time of arrival in Anacortes was about 0600 on 6 March, and the washing operation was to be completed before the vessel's arrival there.

9. The Coast Guard Certificate of Inspection required the following manning scale:

1	Master
1	Chief Mate
1	Second Mate
1	Third Mate
1	Radio Officer
1	Chief Engineer
1	First Assistant Engineer
1	Second Assistant Engineer
1	Third Assistant Engineer
6	Able Seamen
3	Ordinary Seamen
3	Firemen/Watertenders
3	Oilers
20	Other persons as crewmembers, authorized
<u>4</u>	In addition to the crew, authorized
48	Total

The last Coastwise Shipping Articles and Form CG-735T, "Report of Ship Personnel not Shipped or Discharged before a U. S. Shipping Commissioner," as modified by sign-ons and discharges in the Puget Sound area, listed a crew of 42 and the Master, a total of 43 persons. When the vessel departed Tacoma on the evening of 5 March 1964, there were only 30 crewmembers on board including the Master. A "Night Engineer" Clyde Louis HAMMER, licensed as Chief Engineer - steam - any horsepower,

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was not on Articles but was on a scheduled engine room watch from 1700, 5 March to 0800, 6 March, and he was the 31st person on board for the voyage from Tacoma to Anacortes. Only one of the regularly assigned licensed engineer officers was on board, Chief Engineer [REDACTED]. The deck officers on board were Captain M. J. ABRAHAM, Chief Mate R. H. BLAKE, and Junior Third Mate [REDACTED]. Another Mate, [REDACTED], arrived at the pier in Tacoma just as the BUNKER HILL cast off lines and departed the pier. Chief Mate [REDACTED] called out to Mr. [REDACTED] to meet the ship in Anacortes. The Radio Officer, [REDACTED], departed the vessel on 2 March 1964, returning to his home in Richmond, California, and he was not on board for this voyage. The required number of unlicensed deck and engine room crew to stand proper watches were on board.

At the time of departure from Tacoma, the vessel was manned as follows:

Licensed Personnel

1	Master
1	Chief Mate
1	Junior Third Mate
1	Chief Engineer
1	Assistant Engineer (Night Engineer HAMMER)
<u>5</u>	Subtotal

Unlicensed Personnel

7	Able Bodied Seamen
3	Ordinary Seamen
2	Oilers
3	Firemen/Watertenders
<u>11</u>	Other persons
<u>26</u>	Subtotal

31 Grand total

10. After the deck department had unmoored the vessel, Mr. [REDACTED] assigned certain of them to tank washing. Boatswain [REDACTED], Deck Maintenceman [REDACTED], and Chief Pumpman [REDACTED] performed this work under Mr. [REDACTED] immediate supervision. The plan was to pump down and strip the No. 1 port and starboard tanks. The No. 2 tanks across (No. 2 port, No. 2 center, and No. 2 stbd.), the No. 3 tanks across, and the No. 9 tanks across were to be cold water washed, pumped down as much as possible with the electric stripping pumps, and then dried by use of the vessel's gas exhauster.

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11. The gas exhauster is a device operating on the venturi principle utilizing auxiliary steam at about 150 p.s.i. to draw liquid and vapor from a tank via its cargo suction line and discharge line. The liquid that is picked up by the suction from the gas exhauster in the cargo suction line goes by the stripping pump suction and is picked up by that pump, while the vapor continues past the pump into the discharge line and out through the gas exhauster. A detailed description of the type gas exhauster on the BUNKER HILL is found in Exhibit 7. The gas exhauster was called the "bazooka" by the crewmembers of the BUNKER HILL, and it will be referred to by that name in this report.

12. Chief Pumpman [REDACTED] pumped down the residue of No. 1 tanks, port and starboard, by taking suction with the so-called No. 1 special pump (a reciprocating steam pump in the forward pump room) and discharging the diesel oil residue from these tanks directly into the forward pump room bilges. In this way, about 50 gallons of diesel oil were added to the forward pump room bilges. The No. 1 tanks, port and starboard, were not washed.

13. On deck, Mr. [REDACTED] directed [REDACTED] and [REDACTED] to rig a wash hose (a Butterworth hose about 50 feet long with the end cut off). Mr. [REDACTED] ordered a 10-minute cold water wash of each of nine tanks (2 across, 3 across and 9 across). For a typical tank, this was done by lowering the wash hose through the ullage opening approximately 4 to 6 feet into the tank and directing a stream of water into the tank. The wash water was obtained from the fire main. Meanwhile, [REDACTED] lined up the two electric stripping pumps in the after pump room so that suction could be taken from these nine tanks via the No. 3 main line. Suction was controlled for an individual tank by opening and closing the suction valve in the tank, using the reach rod to the main deck.

The discharge lines from No. 1 special pump, No. 2 wing special pump, and No. 2 center special pump, were drained on deck in accordance with Mr. [REDACTED] orders. Because of the pronounced trim by the stern, the petroleum products draining on deck ran aft to the after scuppers and then drained over the side into Puget Sound. The deep well pump discharge line was drained directly over the side by means of a hose. CRIBBINS, SHEA, and [REDACTED] all participated in the above operation as a team, under the supervision of Mr. [REDACTED]. After the tanks had been thus water washed, pumped as dry as possible, and the lines drained, Mr. [REDACTED] released CRIBBINS and SHEA. Mr. [REDACTED] and [REDACTED] remained to perform the last operation with the bazooka.

14. [redacted] lined up the valves in the after pump room for the bazooka operation, obtained from the engine room an increase in the deck steam line pressure (to about 150 p.s.i.), and lined up the bazooka itself which was located on the upper deck port side just aft of the midship house. Next, Mr. [redacted] and [redacted], working together, applied the bazooka to each of the nine tanks which had been water washed. The bazooka was applied for about 5 minutes to each tank. Conditions in the tanks were observed through the ullage openings, illumination being provided by flashlight. The bazooka operation was completed at about 0320, 6 March 1964.

15. The method used for draining lines, tank washing, stripping, and gas exhausting was intended only for the purpose of preventing contamination of the next cargo of petroleum products. It was not intended to produce in the cargo tanks a gas free condition (as defined by 46 CFR 30.10-29).

16. Upon completion of the bazooka operation, [redacted] secured the necessary valves in the after pump room and secured the electric stripping pumps; Mr. [redacted] secured the bazooka. [redacted] remained below in the after pump room to line up certain blinds and blanks in preparation for receiving the next cargo. While [redacted] was doing this, Mr. [redacted] entered the after pump room to check the sealing of certain valves and to assure that the valve arrangement was proper; he then departed. Mr. [redacted] did not record the seal numbers at this time. [redacted] completed his work and departed the after pump room at about 0350.

17. At 0350, 6 March 1964, when Chief Pumpman [redacted] had completed his work in the after pump room, all cargo valves were closed there, except No. 9 special, in expectation that loading the new cargo would not be through the after pump room. On deck, some of the ullage holes were open and without flame screens. This was the usual practice on the BUNKER HILL when in Puget Sound, for the purpose of airing out the cargo tanks.

18. At about 0350, 6 March 1964, the various watches on deck and in the engine room commenced changing. In the engine room [redacted] assumed the watch as Oiler and [redacted] took over the FWI watch in the boiler room. Mr. [redacted], the night relief engineer, remained on watch without relief. On the bridge, [redacted] assumed the watch as Quartermaster. Mr. [redacted], the Junior Third Mate, continued as deck watch officer without relief. The Master, Captain M. J. ABRAHAM, also continued his piloting duties on the bridge. In the bow, [redacted] relieved [redacted] as bow lookout. As 0400 approached, all deck work had ceased, the watch had been relieved, and the vessel was proceeding on a northerly course in Rosario Strait at a speed of about 15 knots. All operating equipment and machinery was functioning normally and there were no signs apparent to those on board of the impending catastrophe.

19. At about 0402 the BUNKER HILL experienced a violent explosion between the midship house and the after deck house. The vessel broke between the midship house and after deck house. The forward section veered off to port and the after section commenced listing to starboard. The vessel's two sections were connected on the port side for a brief time, then broke apart. Smoke and flames were in evidence in way of the break.

Ashore, the explosion appeared as a large bright flash on the western horizon to two Navy men in the Naval Air Station Control Tower at Ault Field, Whidbey Island, about five miles away, followed by the sound of an explosion which rattled the windows of the control tower.

██████████ the bow lookout on the forecastle, (and the only survivor of this casualty who was not in the after deck house) was first aware of the explosion when he was knocked down. He could see flames and light in the after part of the ship through the shelter deck of the midship house. The sound of metal tearing during the fracture was particularly noticed by ██████████

20. Upon separating from the stern section, the bow section trimmed by its stern.

After being knocked down by the first explosion, ██████████ arose and proceeded below to the rope locker in the forecastle to search for a life preserver, fortunately finding one there. He returned to the main deck and proceeded up the ladder to the forecastle head. As his head came level with the forecastle deck, ██████████ saw the mooring lines on that deck sliding aft toward him. He stepped off the ladder onto a ventilation duct and donned his life preserver. The angle of inclination of the keel with the horizontal at this time was about 30° - 45°, and increasing.

At this moment, ██████████ witnessed another severe explosion, this time in No. 4 center cargo tank. This last explosion lifted the midship house several feet from the deck, and then the part of the bow section in way of the midship house sank beneath the water as the bow section assumed an almost vertical attitude. ██████████ witnessed still more explosions, and huge balls of fire came up at him. His next recollection was that he was in the water, surfacing. He is unsure whether he jumped or was blown into the water. Upon surfacing, ██████████ found himself in an area where oil was burning on the water's surface, but he was able to swim a few strokes and get away from the burning oil. The port side of the stern section was nearby and ██████████ noticed that it was severed from the bow section on a diagonal line from about the after port cofferdam to about the forward portion of No. 9 tank on the starboard side. After being in the water for about 45 minutes, ██████████ was rescued by a Coast Guard helicopter.



21. Initially, the forward end of the stern section heaved upward, and thereafter the stern section took on a starboard list which gradually increased. The 25 crewmembers who were aft commenced taking action toward survival. The three men on watch in the machinery spaces departed; Mr. [REDACTED] the engineering watch officer being the first to leave; then [REDACTED] the FWT; and finally [REDACTED] the Oiler. Before [REDACTED] left, he descended part way down the ladder to the lower engine room and saw water entering through a crack in the forward lower engine room bulkhead which adjoins the after pump room in way of the air compressors. Chief Engineer [REDACTED] who was on a last tour of the machinery spaces to assure that everyone had departed and that the status of the machinery was such that further explosions would not occur from that source, ordered [REDACTED] out of the engine room, and shortly afterward [REDACTED] followed topside. All the 440 volt AC power had been tripped out by the first explosion, and this stopped most of the electric motors, including the main and auxiliary circulating pumps.

22. Some of the crew obtained life preservers; others found life rings; but some were without any means of buoyant assistance. An attempt was made to lower the starboard lifeboat (No. 3 boat) but the starboard list made it dangerous for anyone to release the outboard gripes, since the inboard gripes had been released first. Therefore, attention was directed to lowering the port lifeboat (No. 4 boat). After some difficulty, this was accomplished, and most of the surviving crew were in this boat. Before the falls could be released and cast off, water from the main overboard discharge swamped the boat. In the confusion and darkness, and with the boat almost filled with water, the lever to release the falls could not be located, so the manila falls were cut and the boat was shoved away from the side. The buoyancy tanks of the lifeboat kept the boat afloat despite its being loaded with equipment and personnel and almost full of water.

23. Prior to the arrival of rescue units, seven men remained on board the fantail of the BUNKER HILL of their own volition; eighteen men went over the side from the stern section either in the lifeboat or directly into the water; one man ([REDACTED]) went into the water from the bow section. The five men in the midship house were not seen at any time after the explosion. After about 45 minutes, a Coast Guard helicopter from Coast Guard Air Station, Port Angeles, Washington and a Navy crash boat from Naval Air Station, Whidbey Island, arrived for rescue operations. Four men were picked up by the Coast Guard helicopter and the remaining 22 were picked up by the Navy crash boat. All the survivors were given appropriate treatment according to their individual needs. Only three were initially hospitalized,

██████████ and ██████████. Of these, ██████████ was the most seriously injured, having suffered burns of the face, hands, and other parts of his body, plus exposure and possibly other injuries. Later, eight more members of the crew received medical treatment from the U.S. Public Health Service, a total of eleven, as listed in Finding No. 4 of this report.

24. After the first explosion at 0402 on 6 March, no one saw anything whatever of the five persons in the midship house. Two men, ██████████ and ██████████ particularly observed the bridge but they did not see or hear anything of Captain ABRAHAM, Junior Third Mate ██████████, or Quartermaster ██████████, all of whom were on the bridge. There is some doubt as to the exact whereabouts of Chief Mate BLAKE because an Able Seaman, ██████████, stated that he saw someone proceeding forward on the upper deck at about 0355 on the starboard side just forward of the midship house. Mr. ██████████ had one more task in the after pump room, to record in his notebook the serial numbers of the valve seals. PHILLIPS left the after pump room at 0350 and Mr. ██████████ had not yet appeared there for this final task by that time. The bow lookout, ██████████, was looking forward and he was unaware of anyone else forward of the midship house after ██████████ departed the bow. Concerning ██████████, the Steward, no one could report anything except that he was presumed to be in his room in the midship house when the explosion took place. No trace has been found of any of the five men in the midship house as of the date of this report.

25. The engineering personnel who testified were unable to explain why the main overboard discharge flooded the No. 4 boat when it was lowered over the side. The main circulating pump and the auxiliary circulating pump were powered by 440 volt AC motors. The initial explosion tripped out the 440 volt AC system and it was not reactivated. Chief Engineer ██████████ and others speculated on the possibility that the water might have gravitated out the overboard discharge from the main condenser.

26. In less than an hour, both sections of the BUNKER HILL sank. Two sections were located by the vessel NEPER by means of sonic equipment, and these locations are shown in Exhibits 8 and 8b. The owners announced abandonment of the vessel on 11 March 1964. The U. S. Army, Corps of Engineers acknowledged on 16 March 1964 the announcement of the abandonment, but advised the Keystone Tankship Corporation not to construe the acknowledgement as acceptance of the abandonment.

27. The BUNKER HILL had two systems designed to reduce the rate of corrosion in the cargo tanks, a chemical wash system

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and magnesium anodes. No. 9 center tank had both systems; no other tank had both systems. The system installed in each of the after tanks was as follows:

<u>Tank No.</u>	<u>Port</u>	<u>Center</u>	<u>Starboard</u>
6	Mg Anodes	Chem. Wash	Mg Anodes
7	Mg Anodes	Mg Anodes	Mg Anodes
8	Chem. Wash	Chem. Wash	Chem. Wash
9	Chem. Wash	Mg Anodes and Chem. Wash	Chem. Wash

The chemical wash system was badly wasted and had not been used for several years.

28. The magnesium anode installation is described in Exhibits 11a and 11b with supplementary information on Page 958 of the Transcript of Proceedings. In general, centerline tanks which were so equipped had 48 magnesium anodes each and wing tanks so equipped had 32 magnesium anodes each. The anodes were mounted on vertical angle iron supports which ran nearly the full height of the cargo tank, about 32 feet to 34 feet. Four to six anodes were attached to each support, spaced fairly evenly from top to bottom. A typical anode consisted of a piece of magnesium of dimensions 4" x 4" x 36" which was cast around a "C" shaped steel bracket. The anode bracket was attached to the angle iron support by two 1/2" steel bolts (and nuts). There is evidence that some of these bolts were corroded and that on several occasions, in the recent past, magnesium anodes were found lying in the bottoms of cargo tanks.

29. A number of technical research papers describe experiments concerning ignitive spark production from a falling piece of magnesium striking steel (Exhibits 15, 25, 26 and 27). These technical publications show that there is a very great probability that an ignitive spark would be produced if a magnesium anode, such as existed in the cargo tanks of the BUNKER HILL, should fall and strike the rusty steel inner bottom framing or plating.

30. Occasionally, ladders in cargo tanks on the BUNKER HILL would become loose because of corroded fastenings. However, repairs were made without undue delay when this particular deficiency was found.

31. The machinery and electric equipment were in good condition and there is no evidence that they could have been a source of vapor ignition. There was testimony concerning steam leaks and other leaks from piping on deck, but these deficiencies were corrected (or correctible) by gasket renewal and other such simple repairs, and no one acknowledged this as a possible source of vapor ignition.

32. There was no testimony that the hull structure was not sound and seaworthy. Certain minor cracks and holes were noted in the cargo tank bulkheads and frames within the past several years, but they were typical of those found in T-2 tankers and the defects were promptly repaired. On 5 March 1964, the ship had no deficiencies to diminish the strength of the hull structure below the proper requirements. The owners had undertaken an extensive renewal program for hull plating, bulkheads, framing members, etc. At the time the BUNKER HILL was lost, the owners had renewed (since 1953) a total of 2,087,639 pounds of steel at a cost of \$1,065,469.52. There were no Coast Guard issued requirements outstanding when the BUNKER HILL was lost.

33. The testimony of the unlicensed members of the deck department, including [redacted] and [redacted], the two pumpmen, related many incidents of dumping of petroleum products directly overboard in Puget Sound, within 50 miles of the coast line between the mouth of the Columbia River and the Straits of Juan de Fuca, and in the Columbia River. Upon inquiry, these witnesses testified that the incidents of pollution by the BUNKER HILL transpired because of Chief Mate BLAKE's direct orders. There was testimony that such practices were common on other tankships also.

34. The Oil Record Book for Tanker, issued by the Department of the Army, Corps of Engineers, was on board in the custody of Chief Mate BLAKE. It was company policy to keep this publication on board as part of the ship's records. It was lost with the BUNKER HILL, along with all other ship's logs and records; therefore, no information is available as to the entries in the Oil Record Book for Tanker.

35. The SS BUNKER HILL experienced severe vibration when proceeding at full speed without cargo. The vibration was most noticeable aft and diminished toward the forward end of the ship.

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36. Inquiries were made of witnesses concerning the absence from the ship of thirteen members of the crew. Chief Engineer [redacted] and Captain [redacted] explained that, by terms of the company agreement with the Marine Engineers Beneficial Association, the assistant engineer officers were not required to be on board for a movement of the vessel at night between Tacoma and Anacortes, despite its being a journey of about 86 miles and of a duration of about 6 1/2 hours. These officers stated that this was considered to be a shift within a harbor area, no different from a shift from one pier to another within Seattle harbor, according to the union contract terms. The night engineer, Mr. [redacted] was on board for the purpose of standing any and all watches between 1700 and 0800. Mr. [redacted] stood an identical 1700 to 0800 watch the previous evening. The Certificate of Inspection requires 1-Chief Engineer, 1-First Assistant Engineer, 1-Second Assistant Engineer and 1-Third Assistant Engineer.

37. The SS BUNKER HILL was a "Four Mate" ship, carrying a Chief Mate, Second Mate, Third Mate and Junior Third Mate. The last three were watch standing officers while the Chief Mate's general duties were cargo officer and supervisor of deck maintenance. These duties resulted in long hours of work for Chief Mate BLAKE during the BUNKER HILL'S employment in Puget Sound because of frequent short voyages. On 5 March 1964, he supervised the cargo operations at Seattle and at Tacoma. These duties required that he be up and about until midnight. His duties carried over until at least 0330 on 6 March 1964 while he supervised tank washing operations and preparations to receive the next cargo. The Junior Third Mate, Mr. [redacted] was on board for underway watch standing duties on 6 March, and the Master, M. J. ABRAHAM, was on the bridge as pilot. The Certificate of Inspection requires 1-Master, 1-Chief Mate, 1-Second Mate and 1-Third Mate.

38. The company agreement with the American Radio Association concerning the presence of a radio officer, stipulates that the radio officer need not be on board after arrival from sea. The BUNKER HILL arrived in the Puget Sound area from sea on 1 March 1964, and Mr. [redacted] the Radio Officer, had no duties on board after that date. He actually departed the vessel for his home in [redacted] on 2 March 1964. The Certificate of Inspection requires 1-Radio Officer.

39. The unlicensed personnel were all provided by the National Maritime Union. Three unlicensed men on this voyage were absent by reason of being excused by their ship's officers.

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One point of interest in the NMJ agreement was that the FWT and Oiler relieve each other for supper at sea. Chief Engineer [REDACTED] stated that each man takes about 15 minutes for supper; therefore, for one-half hour every day the engine room was manned only with an engineer watch officer and one other man (either the FWT or the Oiler). The Certificate of Inspection requires all three men on watch in the machinery spaces.

40. There is evidence that the absences from the BUNKER HILL of the licensed engineer officers, deck officers, and radio officers for the voyage from Tacoma to Anacortes was not an isolated incident nor unique to the BUNKER HILL. Other tankships operating in Puget Sound have been following similar practices.

41. Chief Engineer [REDACTED] expressed an opinion that the initial cause of the casualty was an external source; that the ship hit something or something hit the ship. Counsel for Keystone Tankship Corporation attempted to relate the cause of the BUNKER HILL casualty to a mine or bomb. However, there was no substantial evidence that the initial explosion was from such an external source.

42. The pump rooms were equipped with liquid flooding alarm systems which would be activated by excessive fluid in the bilges of these compartments. The alarms were set to ring when the fluid in the bilges exceeded about 6 to 8 inches of depth. The alarm bell for the after pump room liquid flooding alarm system was located at the operating platform in the engine room. The alarm systems were supposed to be tested weekly. The Chief Mate had the responsibility of testing these alarms. Chief Engineer [REDACTED] testified that these alarms were properly tested weekly. However, the two pumpmen, [REDACTED] and [REDACTED], reported liquid levels in the pump rooms on 5 and 6 March to be considerably over the 6 to 8 inch depth at which the alarms were set to ring. Chief Engineer [REDACTED] stated, upon inquiry, that it was possible to tie down the float for the alarm so that it would not be operable.

43. The portable radiotelegraph apparatus for the lifeboats, required by 46 CFR 33.15-25, was located in the midship house of the BUNKER HILL. Because of the circumstances of this casualty, it would have been impossible for the surviving crewmembers in the after deck house to have availed themselves of this item of emergency equipment if there had been a need for it.

### CONCLUSIONS

1. The severe explosion experienced by the SS BUNKER HILL at 0402, 6 March 1964 in Rosario Strait, was an internal explosion in one of her after tanks. The result of this explosion was to immediately rupture deck plating and starboard side plating. This was shortly thereafter followed by fracturing of the port side and bottom plating, causing a severance of the vessel into two principal parts. The initial explosion was accompanied by fire which persisted.
2. After the vessel was in two sections, cargo tank 4-center exploded. This was accompanied by more fire and this, in turn, caused further explosions in the bow section. The explosions ruptured the deck, collapsed bulkheads, and caused the failure of the internal structure of the bow section, with the result that it sank rapidly.
3. The stern section, while not initially damaged as seriously as the bow section, experienced a rupture in the forward lower engine room bulkhead, which is also the after bulkhead for the after pump room. Flooding took place through this opening, and from this it is apparent that the after pump room was also open to the sea. The flooding of the machinery spaces through this ruptured forward lower engine room bulkhead caused a list to starboard and the eventual sinking of the stern section about one hour after the initial explosion.
4. The nature and position of the structural failure, with the port side shell plating still intact for some moments after the explosion, makes it probable that the initial blast occurred in 9-center or 9-starboard. The three No. 9 tanks had just been water washed and the bazooka applied for about 5 minutes to each tank. The treatment to the No. 9 tanks probably lowered the petroleum vapor-air concentration to the critical range for explosion so that only a source of vapor ignition was necessary to detonate this concentration of explosive vapor. Tanks 6, 7, and 8, by reason of not having been washed, probably contained too rich a vapor concentration so that ignition could not have taken place in those tanks even if a source of vapor ignition were present.
5. The source of vapor ignition in the cargo tank was a falling or rubbing metallic object causing an ignitive spark. There are several possibilities: a falling magnesium anode, a falling piece of chemical wash system piping, or a spark created by a loose ladder. From the technical literature appended to this report as exhibits, it is apparent that the possibility of the vapor ignition source being due to a falling magnesium

anode is much more likely than either of the others. The possibility of the ignitive spark being created by the impact of steel-on-rusty-steel caused by the fall of a piece of chemical wash line is considerably less, but it definitely is a possibility. The possibility that the movement of a loose ladder caused an ignitive spark is remote, but cannot be absolutely ruled out. However, it is the opinion of this Board that the source of vapor ignition was due to a falling magnesium anode. Therefore, it follows that the explosion initially occurred in cargo Tank No. 9-center, because that is the only cargo tank in No. 9 across which had magnesium anodes. Cargo Tanks 8-across did not have magnesium anodes installed.

6. The falling of the magnesium anode was caused by the deterioration of support bolts and the severe vibration of the after end of the BUNKER HILL while underway without cargo.

7. There is no evidence whatever that this explosion was due to bombs or mines in Rosario Strait or other external source.

8. The five men who are missing are presumed dead inasmuch as there has been no trace of them since the casualty to the BUNKER HILL occurred. Three men were on the bridge: Captain M. J. ABRAHAM, Junior Third Mate [REDACTED], and Quartermaster [REDACTED]. Steward [REDACTED] was probably asleep in his room. Chief Mate R. H. BLAKE's whereabouts are not exactly known but from comments that he intended to turn in and from the fact that his body has not been recovered, it is concluded that he was in his room in the midship house when the explosion occurred.

9. Rescue was performed efficiently by the personnel of the Coast Guard helicopter and the crew of the Navy crash boat. The 26 survivors received prompt medical treatment.

10. There is evidence of a number of incidents of violation of oil pollution acts (33 USC 1001-1015 incl. and 33 USC 431-437 incl.) by personnel of the BUNKER HILL in the recent past. The responsible officers were Captain M. J. ABRAHAM and Chief Mate Robert BLAKE. Also, there is evidence that these violations of oil pollution acts (33 USC 1001-1015 incl. and 33 USC 431-437 incl.) are widespread on tankers, and scant heed is being paid to the provisions of these laws.

11. The violations of the oil pollution acts (33 USC 1001-1015 incl. and 33 USC 431-437 incl.) occasioned by the deliberate draining of petroleum products on deck and then overboard, is a dangerous practice. Draining petroleum products on deck greatly increases the danger of fire and explosion, and makes the decks slippery and hazardous to personnel who must traverse them.



12. In general, the BUNKER HILL was a well equipped and maintained tankship. Although an old vessel, much steel renewal of her hull structure had been accomplished in recent years. The machinery and electrical equipment were in good condition. The only respect significant to this casualty in which the vessel was materially deficient and not properly maintained was the wastage of the magnesium anode supports and the deteriorated chemical wash piping system in the cargo tanks.

13. There was no life preserver specially provided in the bow for the bow lookout. Present regulations do not require that a life preserver be readily accessible and available to the bow lookout.

14. There is evidence of poor organization and lack of proper training in emergency techniques as shown by the inability of the crew to launch the starboard No. 3 lifeboat and the confusion in launching the port No. 4 lifeboat.

15. The main and auxiliary circulating pumps were not operating after the initial explosion tripped out the 440 volt AC power. Despite this, water from the overboard discharge flowed into No. 4 lifeboat when it was launched. There was no means installed to deflect the water from this overboard discharge from entering the boat. Present regulations exempt vessels of the age of the BUNKER HILL from requirements for deflectors on overboard discharges which are in way of boat launching stations.

16. The SS BUNKER HILL was inadequately manned with licensed officers, both deck and engineering, for a voyage from Tacoma to Anacortes, and for voyages in Puget Sound generally in the type of operation in which this vessel had been participating. Considering his responsibilities and hours of work, the Chief Mate could not be reasonably expected to stand underway deck watches in Puget Sound. Therefore, there should have been two watch standing Mates on board in addition to the Chief Mate. The most serious manning deficiency was in engineering officers. Mr. [REDACTED] 1700 to 0800 watch on the previous evening exceeded 12 consecutive hours, and he was expected to stand another watch in excess of 12 hours on 5-6 March with the ship underway in pilot waters much of the time. There should have been at least two licensed assistant engineers on board for watch standing. Concerning the radio officer, the Board is of the opinion that he should be on board and standing watches for all port to port transits in Puget Sound.

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17. There is evidence of violation of regulations set forth in 46 CFR 35.30-10 in that certain ullage holes were left open without flame screens and under no supervision whatever. The violation of this regulation contributed to the magnitude of this casualty in that it permitted the ignition of vapors escaping from the ullage holes as successive tanks filled with sea water.

#### PREFACE TO RECOMMENDATIONS

In summation, this casualty occurred because two conditions existed in the BUNKER HILL: (1) There was a petroleum vapor-air concentration in one or more tanks in the critical explosive range, and (2) There was a source of vapor ignition. If either one of these two conditions had not existed, the BUNKER HILL explosion and sinking could not have taken place.

Nearly all efforts toward controlling and eliminating the hazard of tankship explosion have been aimed at eliminating the source of vapor ignition. The rules against smoking, use of non-sparking tools, etc., are well known to all in the tanker industry. It is only when repairs by welding and burning are necessary that attention is directed to gas-freeing a vessel because, of course, at such a time the source of vapor ignition cannot be eliminated. This process of gas-freeing a tanker involves elimination of petroleum vapors and cleaning of the tank so that it is free of liquid petroleum products to the degree that a source of new vapor is not present (within certain limits).

It is the opinion of this Board that the emphasis toward eliminating sources of vapor ignition is correct and should continue. However, the BUNKER HILL case vividly illustrates that this, as a sole means of eliminating the explosive hazard on tankers, is not enough. The BUNKER HILL was a generally well maintained vessel. However, a single oversight was sufficient to cause its destruction. Perfect performance from human beings is a futile expectation. But anything less than perfection in guarding against sources of vapor ignition can result in death and destruction. The probabilities of the situation should be weighted more favorably toward the safety factors, and this leads to our

#### RECOMMENDATIONS

1. It is recommended that all magnesium anodes be immediately removed from the interiors of all tank vessels. The technical publications which are part of this report establish that magnesium anodes create a hotter spark, when they drop on rusty steel, than any other commonly used anode materials.

2. It is recommended that the instrumentation of tankers be radically improved so that the vapor conditions inside cargo tanks can be quickly determined and continuously monitored. Vessels are reasonably safe from explosion hazards on either side of the narrow critical range. Tanks must be cleaned to avoid cargo contamination. It is possible to clean tanks enough to assure cargo purity without bringing the vapor-air concentration to the critical range. Under present practices, supervising officers conduct tank cleaning operations with no knowledge of the vapor concentration in the tanks. If there were sufficient instrumentation to monitor the conditions in tanks, it would be possible to avoid the hazardous critical range, or at least take extra precautions against ignition if it is absolutely necessary to pass through the critical range while cleaning tanks.

3. It is recommended that the program for enforcement of the oil pollution acts (33 USC 1001-1015 incl. and 33 USC 431-437 incl.) be restudied. The compliance with the oil pollution acts leaves much to be desired. The BUNKER HILL was in violation of the provisions of these acts many times. The only recognition tendered to the existence of these laws was that the persistent petroleum products, such as diesel oil and industrial fuel, were dumped at night to minimize the possibility of detection. For a tanker in a coastwise trade, and this represents the great majority of U.S. flag tankers, the Oil Record Book is kept on board. It is beyond reasonable expectation that Masters and Mates will make self-incriminating entries in this book.

4. It is recommended that either the existing manning requirements, as itemized on the Certificate of Inspection, be rigidly enforced or, if the manning requirements are unnecessarily stringent for ocean vessels when on a Lakes, Bays and Sounds route, that an alternate list of required personnel be specified on the Certificate of Inspection for such routes. The wholesale absences of personnel from the BUNKER HILL while making long voyages in inland waters were in violation of the Certificate of Inspection and the Manning Regulations. A voyage of 86 miles from Tacoma to Anacortes cannot be equated with shifting a vessel from pier to pier in Seattle Harbor, but that is exactly what has taken place. The continuous absence of the Radio Officer after arrival in Puget Sound is a source

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of amazement and concern to the Board. Also, the practice of operating machinery spaces shorthanded during the supper period at sea, as described in Finding No. 39, should not be condoned. The above practices existed on the BUNKER HILL and from the wording of the various management-union agreements they undoubtedly are common to other American flag vessels.

5. It is recommended that the regulation concerning portable radiotelegraph apparatus, 46 CFR 33.15-25, be amended to provide that the stowage of this item of equipment be in the after deck house in tankers because of the greater probability of its being available for use in the event of casualty.

6. It is recommended that regulation 46 CFR 33.20-1(c)(5) be revised so that baffles, deflectors, or reach rods to skin valves be the only means permitted to prevent water from overboard discharges from swamping lifeboats launched in way of these discharges. In this casualty, main and auxiliary circulating pumps stopped when the first explosion took place. Despite this, the port No. 4 boat was flooded by the overboard discharge. A "remote means for stopping the pumps," if it had existed, would have been totally valueless. It is further recommended that this regulation, as amended, be made applicable to all vessels regardless of when built.

7. It is recommended that consideration be given to the improvement of training for tankship personnel in emergency procedures.

8. It is recommended that a regulation be promulgated to require that life preservers be available for personnel who perform duties in locations where it would be difficult in an emergency for them to return to their quarters to procure a life preserver. The plight of the bow lookout in the BUNKER HILL case particularly emphasizes the need for this.

9. The officers responsible for the violations noted in Conclusion 10 concerning the SS BUNKER HILL are presumed dead. Under the circumstances, it is recommended that no further action be taken for these violations.

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10. Other than the above recommendations, nothing further is offered by this Board and it is therefore recommended that this case be closed.

[REDACTED]  
R. D. SCHMIDTMAN  
Rear Admiral, U. S. Coast Guard, Chairman

[REDACTED]  
S. G. GUILL  
Captain, U. S. Coast Guard, Member

[REDACTED]  
J. E. EASTMAN  
Captain, U. S. Coast Guard, Member

[REDACTED]  
Lieutenant Commander, U. S. Coast Guard  
Member and Recorder