

MVI

19 April 1954

(TICONDEROGA - C-11 B1)

From: Chief, Merchant Vessel Inspection Division
To: Commandant
Via: Chief, Office of Merchant Marine Safety

Subj: Marine Board of Investigation; explosion on the SS TICONDEROGA
27 September 1953

1. The SS TICONDEROGA, a tanker of 10,172 g.t., in ballast, was en route from Kahului, T. H., to San Pedro, California. The vessel's cargo tanks were provided with means for the control of internal corrosion. Certain tanks were fitted with magnesium anodes and the remainder with a system of piping for chemicals, "Nitrox". On 27 September 1953 the weather was clear and dry with slight sea and swell, and tank cleaning operations were in progress. Shortly before the explosion, ballast was being removed from Nos. 3 center, 7 center, and 8 port and starboard cargo tanks. No. 5 center had been ballasted but No. 5 port and starboard had not. At 1608 an explosion occurred in No. 5 port cargo tank, which in turn set off explosions in other tanks. The source of ignition is unknown, but is assumed to have been from heat generated by (a) loose objects in the tank, (b) falling scale, or (c) structural failure of the hull. There was no loss of life or serious injuries. The damage to the vessel was estimated at \$1,500,000.

2. Pursuant to the provisions of Title 46 C.F.R. Part 136, the record of the Marine Board of Investigation convened to investigate subject casualty, together with its Findings of Fact, Opinions and Recommendations, has been reviewed and is forwarded herewith.

REMARKS

3. The Recommendations of the Board are far-reaching in implications and effect and will be presented for consideration by the Merchant Marine Council and its appropriate panel.

Chief, MVI Division, to
Commandant

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(TICONDEROGA - C-11 Bd)

4. Subject to the foregoing Remarks it is recommended that the Findings of Fact, Opinions and Recommendations of the Marine Board of Investigation convened to investigate subject casualty be approved.

(signed) P. A. Ovenden

P. A. OVENDEN

FIRST ENDORSEMENT ON MVI memorandum of 19 April 1954

22 April 1954

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From: Chief, Office of Merchant Marine Safety
To: Commandant

Forwarded, recommending approval.

(signed) R. A. Smyth
R. A. SMYTH
Acting

APPROVED: 23 APR 1954

(signed) Merlin O'Neill

MERLIN O'NEILL

REPORT OF
MARINE BOARD
of
INVESTIGATION
convened by the
COMMANDANT, U. S. COAST GUARD
at the
Office of the
Commander, Eleventh Coast Guard District

on

Wednesday, 30 September, 1953

To inquire into the explosion on the SS TICONDEROGA

Neither the board, the recorder, nor the party in interest desired to call any more witnesses.

The investigation was finished.

The board then, at 12:15 p.m., adjourned.

The board reconvened at 1:30 p.m., Friday, 5 March, 1954.

Present: All the members and the recorder.

After full and mature deliberation, the board finds as follows:

FINDINGS OF FACT

1. At or about 1608 on 27 September, 1953, the SS TICONDEROGA, in ballast, was on a voyage from Kahului, T. H., to San Pedro, California, when an explosion occurred in No. 4 and 5 main cargo tanks.

2. The SS TICONDEROGA is an ocean tank ship, Official Number 242244, of 10,172 gross tons. She is of welded steel construction, built at Chester, Pennsylvania, in 1942 and documented at Wilmington, Delaware. She is classed by the American Bureau of Shipping. The TICONDEROGA was last dry-docked on 30 May, 1953, at Seattle, Washington, where the last Annual Inspection was completed on 4 June, 1953. The TICONDEROGA was inspected and approved for the carriage of inflammable or combustible liquids of Grade "A", not to exceed 25 pounds Reid Vapor pressure and all lower grades. Cargo capacity was 141,158 barrels.

3. The TICONDEROGA is owned and operated by the Keystone Tankship Corporation, 1000 Broad Street, Philadelphia, Pennsylvania. The TICONDEROGA's crew is required to be licensed or certificated by the Coast Guard.

4. The TICONDEROGA was fitted with crack arrestors and reinforced in accordance with the requirements of the American Bureau of Shipping and Coast Guard Regulations.

5. The vessel's main cargo tanks are provided with means for the control of internal corrosion. In main cargo tanks Nos. 3, 5, 7, center and Nos. 2, 4, 6, 8, port and starboard magnesium anodes were fitted to suitable frame work. The above tanks are used for ballast when cargo is discharged therefrom. Main cargo tanks Nos. 2, 4, 6, 8, 9, center and Nos. 1, 3, 5, 7, 9, port and starboard were fitted with a piping system so that these tanks may be chemically treated after cargo is discharged. Normally, ballast is not carried in tanks which are chemically treated. The chemicals "Nitrox" are carried and mixed in a section of the after starboard cofferdam. This method of corrosion control is explained in

detail in the Society of Naval Architects and Marine Engineer's Paper No. 8, dated 14 November 1952, by A. B. Kurz. The Master was supplied with a copy of corrosion control instructions dated 31 July, 1950. William G. Dougan, the Master, has served on tank ships for approximately 22 years, 10 years of this service in the capacity of master.

6. At the last dry-docking of vessel, approximately 150 minor fractures in cargo tank bulkheads and internal members, including heating coil brackets, were welded and repaired. There is no record of an internal inspection in No. 4 center, No. 5 center, No. 5 port and starboard main cargo tanks since the last dry-docking. No. 4 port and No. 4 starboard were examined internally by the Chief Mate on or about 22 August, 1953. No fractures were noted in the bulkheads or internal members at this examination.

7. On 13 September, 1953, the vessel departed Wilmington, California, with a cargo of bulk petroleum products distributed in the main cargo tanks as follows: Gasoline in Nos. 2, 3, 4, 5, 6, 7, 8, 9 center and in Nos. 2, 3, 4, 5, 6, 8, 9 port and starboard. Diesel oil in Nos. 1 and 7, port and starboard. Also on board was a batch of "Nitrox" stored in the after cofferdam starboard side in dry form ready for use. The "Nitrox" had been taken on board at Portland, Oregon, on 9 September, 1953, and placed in the cofferdam on the following day. Draft on departure was 28' 03" forward and 32' 01" aft.

8. Weather conditions on the passage from Wilmington to Honolulu were good, the heaviest weather occurring on 15 September, when the wind was NW force 3, moderate northwesterly sea and swell. The vessel arrived at Honolulu, T. H., on 19 September, 1953. Arrival draft was 29' 00" forward, 30' 06" aft. The greater portion of the cargo was discharged. When the vessel departed Honolulu, T. H., on 21 September, cargo remained in Nos. 1 port, 4 center, 7 port and starboard, and 8 center. The departure draft was 5' 01" forward, 20' 07" aft.

9. The vessel arrived at Kahului, T. H., on 21 September, 1953, with cargo as before and ballast in No. 5 center, 6 port and starboard cargo tanks. Ballast was loaded upon departure from Honolulu. Arrival draft was 7' 06" forward, 21' 10" aft. At or about 1845, on 21 September, the vessel departed Kahului, T. H., with ballast in No. 2 port and starboard full, Nos. 5, 9 center half full, Nos. 5, 6, 8 port and starboard half full. Departure draft was 9' 06" forward, 19' 06" aft.

10. On 22 September the vessel was underway at sea bound towards San Pedro, California. All the chemically treated tanks were washed with the "Nitrox" solution. On 23 September the ballast tanks were hand-hosed. Ballast was discharged; where necessary, some ballast was replaced. No. 1 port and starboard, No. 2 center were gas freed, and on 24 September accumulated rust and scale was removed from these tanks. Nos. 4 and 5 main cargo tanks were not entered nor were they gas freed. On 26 September some ballast was discharged; all the ballast was removed from No. 5 center. On 27 September discharging of ballast was resumed. It was reported that the vessel was in good trim at all times during the cleaning and ballasting operations from time of departure on 21 September until the afternoon of 27 September. On the passage from Kahului, T. H., to San Pedro, California, the weather conditions varied from northeasterly wind force 4, moderate to rough northeasterly sea and swell on 22 and 23 September to a northeasterly wind force 4, moderate northerly sea and heavy northerly swell on the morning of 27 September, 1953.

11. On the morning of 27 September, the Boatswain, Theodore Metz, who has more than 35 years' experience on tank ships, was engaged in cleaning and painting the main deck plating located in the shelter deck space amidships. Assisting the Boatswain was Luchian Delatti, a seaman for more than forty years with 12 years' experience on tank vessels. During the time that the Boatswain and Delatti were so employed, persons observed entering the shelter deck space were: Chief Engineer, who did so to check the level of the water in the fresh water tanks located therein; the Chief Steward, who shifted soiled linen from the linen locker to the starboard passageway for easy removal upon arrival in port. The linen locker, while used primarily for the stowage of linen, also had stowed therein, steward's department equipment and stores, including safety matches. The Chief Engineer and Chief Steward have many years' experience at sea on tank ships. The Chief Pumpman, who was employed in discharging ballast, also passed through the area several times in the performance of his duties. The two forward and the two after doors serving the shelter deck space were open. The steel plate door in the way of the tonnage opening was closed.

12. At or about 1500 on 27 September, the Boatswain and Delatti completed painting the deck; they then went aft for coffee. At or about 1520 the Boatswain and Delatti returned to the Shelter deck area and removed tools and gear from the Quartermaster's locker which is located on the starboard side, after part of the shelter deck space. They raised the midship boom in the way of the starboard manifold, provided slings, wrenches, etc., so that all would be in readiness for connecting the cargo hoses upon arrival at San Pedro, California.

13. At or about 1545 the Boatswain dismissed Dalatti so he could relieve the watch at 1600. The Boatswain then removed the paint pots and brushes from the shelter deck space and took them forward to the paint locker located under the forecastle head. The Boatswain squared up the paint locker and tossed some unusable brushes and a paint bucket over the side. He was about to drop another paint bucket when an explosion occurred amidships. The Boatswain was the only eye witness to the explosion. He was standing on the main deck at the starboard rail at the break of the forecastle head. The Boatswain testified that when the explosion occurred, he was facing aft and to starboard. At the time of the explosion, he saw black smoke, red flames and debris extend outboard and to starboard from the shelter deck space. He then went below into the chain locker for safety. When no further explosions occurred, he returned to the deck.

14. Chief Pumpman, Milton Autry, discharged the ballast from No. 5 center on Saturday, 26 September, 1953. On 27 September he resumed discharging ballast. At or about 1600, when the ballast in No. 4 port and starboard was approximately 12 inches in depth, the valves were closed. It was the intention of the pumpman to use the stripping pump to remove the remainder. The ullage hole covers on No. 5 cargo tanks and No. 4 center were closed, but not dogged down; those on No. 4, port and starboard tanks were open. Flame screens were shipped in all ullage holes.

15. At or about 1600 on 27 September and at the time of the explosion, ballast was being removed from Nos. 3 center, No. 7 center, No. 8 port and starboard main cargo tanks. Three main cargo pumps were in operation for this purpose. The pumpman testified that immediately prior to the time the explosion occurred he went forward through the port passage in the shelter deck space and after looking into No. 3 center tank, returned aft, passing through the shelter deck space on the starboard side. The explosion occurred when the pumpman was abreast of No. 6 starboard cargo tank. The pumpman was thrown aft and down on his hands and knees by the force of the explosion; he was not burned nor injured.

16. At or about 1600, Daniel Lee, Second Mate, relieved the watch. Knut O. Adamson, Quartermaster, relieved the helmsman. The weather was clear, dry, wind NNW, force 2, small NW sea and swell, with unlimited visibility, temperature of air 65°, temperature of sea 63°. The vessel was underway at near full speed, approximately 89 RPM, on course 38° true. Mr. Lee, upon relieving the watch, scanned the horizon and noted that no surface craft or aircraft was visible. No excessive vibration of the vessel was noted. The radio batteries, which were located in a battery box on the boat deck abaft the radio room, were on charge.

17. At or about 1608 on 27 September, 1953, a violent explosion occurred in No. 4 and 5 main cargo tanks. Fire then broke out in the shelter deck space amidships. The fire burned with the greatest intensity on the starboard side of the shelter deck space in the way of the steward's linen locker. Samples of previous cargoes contained in one quart glass containers were stored in the quartermaster's locker adjacent to the steward's linen locker, and added to the intensity of the fire. At the time the explosion occurred, the Master was in his cabin asleep. The Chief Mate was in his cabin preparing loading reports. The Second Mate and Radio Operator were in the chart room; the Quartermaster on watch was at the wheel in the pilothouse. The Third Mate was standing in the Chief Mate's cabin. The Junior Third Mate was asleep in his cabin. On deck the Boatwain was forward at the starboard rail, and the pumpman was abreast of No. 6 starboard cargo tank. All other personnel were aft. The approximate position of the vessel at the time of the explosion was $33^{\circ} 10' N.$, $119^{\circ} 09' W.$

18. Immediately after the explosion, Rutvens B. Hammer, the engineer on watch, stopped the main engine. He fixed the time at 1608. The Master ran to the bridge, closed the general alarm circuit, and with the other personnel went aft. The after lifeboats were prepared for launching. A fire party was organized, hoses were led from a hydrant on the poop deck. While the fire party under the direct supervision of the Master was fighting the flames in the starboard side of the midship shelter deck space, others launched No. 4 lifeboat and remained standing by. All the engineering personnel went to their stations in the engine room immediately following the explosion. The steam smothering system was turned on in all cargo tanks aft of No. 5 main cargo tanks.

At or about 1720 on 27 September, 1953, the fire was brought under control; the flames were extinguished.

At or about 1740 No. 4 lifeboat was placed on board and preparations made to get underway. The after station was manned.

19. At or about 1742 the main engine was put on slow ahead and the vessel proceeded towards San Pedro, California. A reduced speed of from 30 to 40 RPMs was maintained until the vessel arrived off San Pedro Bay, California, at or about 0230, on 28 September, 1953.

At or about 0800 on 28 September the TICONDEROGA entered Los Angeles Harbor. With the assistance of tugs, the vessel was moored alongside wharf at the plant of Todd Shipyards Corporation, San Pedro, California.

20. The explosion which occurred at or about 1608 on 27 September, 1953, caused extensive damage to the hull structure from frame 56 $\frac{1}{2}$ to frame 75. Extensive damage was caused to the midship house structure which is located directly above No. 4 and No. 5 main cargo tanks. All pilothouse equipment, radio equipment, life-saving equipment, fire lines and steam smothering lines located amidships were damaged. No messages were transmitted by the vessel until its arrival off San Pedro Bay, where visual signals were used.

21. Upon the TICONDEROGA's arrival at Todd's Shipyard, an examination of the shelter deck space amidships was made by members of the Board and a marine inspector from the materiel section. All the light fixtures located therein were explosion proof of an approved type and still intact. The electric light and power cables were of an approved type for this class of vessel. There were no outlet boxes nor any circuit interrupting devices located within the shelter deck space. The main deck plating within the midship shelter deck space was not penetrated by valve controls, Butterworth openings, etc. The underwater body of the vessel was examined immediately after de-watering of the dry dock. No marks or other evidence of an external force acting upon the hull structure were found.

22. No lives were lost as a result of this casualty. The seven persons listed below received injuries as a result of this casualty:

- (1) William G. Dougan, Master: Perineal sprain;
- (2) Richard C. Correll, Chief Mate: Lacerations and contusions;
- (3) David A. Lee, Second Mate: Multiple contusions, abrasions, and lacerations
- (4) Knute O. Adamson, Quartermaster: Lacerations, contusions, and abrasions;
- (5) Harold B. Johnston, Radio Operator: Contusions and abrasions;
- (6) Garon V. Arnold, Jr., Third Assistant Engineer: Lacerations, contusions, and abrasions;
- (7) Jean A. Lloyd, Fireman/Watertender: Deep abrasion.

23. The extent of damage to the vessel was estimated to be approximately \$1,500,000.

OPINION

1. That the explosion originated in No. 5 port cargo tank, which in turn set off No. 5 center, No. 5 starboard and No. 4 starboard, No. 4 center and No. 4 port tanks.
2. The main deck in way of No. 5 tanks was well opened up; in way of No. 4 tanks the deck was intact. The pressures in No. 4 tanks found release through the deck and hull ruptures caused by the initial explosion in No. 5 tanks.
3. The complex of ruptured, cracked and distorted metal gave a picture of the transverse bulkhead between No. 4 and No. 5 tanks being first ruptured and blown forward by the initial explosion in No. 5 tanks. Then the secondary explosion in No. 4 tanks partly curled the bent parts back again towards No. 5 tank.
4. The explosion was of internal origin. Had the vessel struck a mine, a geyser of water would have been created; such was not observed. The ship's skin would have been bent inward; it was bent outward.
5. The area of greatest pressures apexed in the midship house above No. 5 port tank. This would tend to eliminate No. 5 starboard tank as the source of the explosion. Each succeeding explosion would tend to expand into ruptures already made and further expand damage in way of the original explosion. None of the tanks involved had been gas freed but No. 5 center had been ballasted, whereas No. 5 port and starboard had not been ballasted or washed out and undoubtedly contained substantial strata of gasoline fumes, at least in their lower levels. The pumping out of the ballast in No. 5 center had been completed the day before the explosion and there had been ample time for the hydrogen from the anodic action to dissipate through the vents.
6. The cause of the explosion must be assumed to have been ignition of fumes from heat generated by: (a) loose objects in the tank, such as a heater coil bracket or a ladder; (b) falling scale; (c) a structural failure of the hull.
7. The ladders and heating coil brackets showed little corrosion and no indication of loose handrails, ladders, or other objects appeared to the pumpman or the mate who had been observing the tanks and working near them constantly.

8. The tanks showed scale in spots up to 1/8" in thickness and this could very likely have fallen from a high location, such as the hatch structures to the bottom of the tanks. The heat and spark could have been ignited by the sodium nitrite scale and dry rust which covered the tank bottoms.
9. The hull in the way of No. 5 port tank showed a clean crack several feet long and there were other cracks in the deck which, however, did not join the hull crack. Whether these cracks occurred before or during the explosion is a matter of conjecture at this time. Certainly the heat created by a metal structure of several thousand tons weight fracturing in any of its parts would be sufficient to ignite sodium nitrite and gasoline fumes, both of which have very low ignition temperatures.
10. It is not inconceivable or even unlikely that the accumulation of sodium nitrite, rust, and chemical residue from the cargo in the bilges of No. 5 port tank contained the physical and chemical properties necessary to spontaneous ignition.
11. The board can only conclude that there were four possible sources of ignition present. As to which one of these sources caused ignition, it is impossible to determine.
12. Concerning the electro-chemical anti-corrosion methods used, there is doubt that the degree of rust inhibition obtained justified the risks incident to the bringing on board, storing and mixing of sodium nitrite. It could be spilled and tracked about the decks or get into the pockets or trouser cuffs of the handlers and be carried to various parts of the ship where it could become mixed with organic matter, trod under foot and start a fire. The research reports available to this board make no mention of tests for safety. Even if brought on board in an aqueous solution, it still, at times, would be in a dry state in the bilges of the cargo tanks. No fixed doctrine, instructions or practice as to immediate mixing with water were observed by the vessel.
13. As to the anode installation, again no fixed doctrine, instructions or practice existed to prevent accumulation of hydrogen in partly ballasted cargo tanks.
14. At the time of the explosion, open ullage lids of No. 4 wing tanks made available a source of hydrogen. The relative wind was in just the right direction to carry the possibly explosive mixture through the nearby open doors of the midship house. Here a quantity of soiled mess jackets, aprons and linen was piled four feet high on a painted deck which was only

partly dry. Stewards' stores of matches, metal polish, and the Lord only knows what else, had been or was presently stored therein.

15. Various departments of the ship had supplies there. On some vessels at least, the midship house main deck level has become a catch-all since no hard and fast rules exist as to its use. On subject vessel gasoline samples were placed in the quartermaster's locker where they remained for one or two voyages, or until it was certain that there was no complaint about the cargo sampled.

16. Bringing these samples on board, carrying them about the decks, passing them from hand to hand, appears to this board to be an unnecessary risk. The samples could just as well be in custody of an agent on shore.

17. With the exceptions noted above, there was no negligence, inattention to duty, nor misconduct on the part of the ship's personnel. Subsequent to the explosion, the ship's personnel conducted themselves in the highest traditions of the American merchant service in bringing the vessel safely to port without additional damage.

Accordingly, the board makes the following

RECOMMENDATIONS

1. That CG-123, Rules and Regulations for Tank Vessels, be amended to:
 - (a) Require that cargo tanks equipped with anodes be either empty or fully ballasted;
 - (b) Regulate the handling, storage and use of nitrite compounds;
 - (c) Enumerate things that may not be stowed in the main deck level of the midship house to include rags, matches, inflammable substances (including floor wax, metal polish, cargo samples and paint), soiled linens and oxidizing substances.
2. That U. S. Coast Guard Headquarters cause to be conducted chemical tests and mechanical test of ships' metal covered with Nitrox scale to determine if it is a safe product to use.
3. It is further recommended that the portable radio apparatus required by Section 33.15-3 be kept in the after section of this class of vessel

handy to the after lifeboat stations.

4. That the cargo samples, if retained aboard for the duration of the current voyage, they shall be stowed in a properly marked container within the approved paint or lamp locker.

(signed) Paul B. Cronk
PAUL B. CRONK
Captain, U. S. Coast Guard
Chairman

(signed) Herbert E. Peters
HERBERT E. PETERS
Commander, U. S. Coast Guard
Member

(signed) Lionel H. de Santy
LIONEL H. de SANTY
Commander, U. S. Coast Guard
Member and Recorder

The board then, at 3:55 p.m., adjourned to await the action of the convening authority.

(signed) Paul B. Cronk
PAUL B. CRONK
Captain, U. S. Coast Guard
Chairman

(signed) Lionel H. de Santy
LIONEL H. de SANTY
Commander, U. S. Coast Guard
Recorder